Summary plan

ZOE

AREAWIDE WASTE TREATMENT MANAGEMENT

Nassau·Suffolk Regional Planning Board

Dedication

THE HONORABLE H. LEE DENNISON, P.E.

First Suffolk County Executive, first in environmental planning, first in open space preservation, and first in the thoughts of his associates, constituents and friends.

NASSAU·SUFFOLK REGIONAL PLANNING BOARD

Areawide Waste Treatment Management Series

SUMMARY PLAN

INTERIM REPORT SERIES: 7

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NASSAU-SUFFOLK REGIONAL PLANNING BOARD

Hauppauge, New York

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Newsday Photo

Foreword

Water, life's ultimate indispensible mineral, is no match for its greatest enemy, man. But man's victory is hollow.

"Mommy, my toothbrush tastes funny." This scene could be early morning in Levittown, Lynbrook or Port Jefferson, as a typical Long Island family prepares to begin another day. The circumstances along with others similar in consequence could become reality in the absence of the comprehensive water quality management program contained in this multi-faceted work. Even with this document, they might come to pass. The program only shows the way Unless implemented, toothbrushes may indeed begin to taste funny and surface waters, commercially and recreationally, may become endangered hydrological species. In this brief context—citing hazards but knowing they can be eliminated—I write this introductory segment with utmost pride. This work, in my opinion, represents excellence unusually distinctive in quality, a demonstration of a public agency's ability to create, produce and execute at the highest level of competency.

Long Island possesses rich and unusual natural bounty: white and pebbleless ocean sands, vast expanses of salt meadow, white-cedar swamps, inland pine barrens, flat plains, colorful downs, fiordlike harbors, bays, ponds, lakes and freshwater bogs. It offers something to suit the taste for nature in each of us. It is a remarkably varied, beautiful and fertile insular tract, lying at the threshold of the greatest urban center in the nation. For 250 years after its first settlement Long Island changed little. From 1812 to the turn of the century Suffolk County's total population increase amounted to only 42,582 souls. Even the railroad did little to alter the generally rural atmosphere. All this serenity came to an abrupt end following World War II when people, equal in number to the population of more than a dozen states, emigrated eastward across the city line. Vast public works were carried out, parkways and expressways laced the largest island on the Atlantic seaboard. But it was not until 1974, two years after passage of the Federal Water Pollution Control Act Amendments, that the fruits of environmental management became apparent and resulted in this far-reaching document. Chronologically it represents the Region's fourth most important plan—following the Nassau County Charter in 1938, the Suffolk County Charter in 1959 and the Bi-county Comprehensive Development Plan in 1970—affecting the lives of all its residents.

There is a valid question concerning the Region's success in developing comprehensive studies. Would they be possible without a regional planning agency? Possibly, yes; anything is. But as timely and of such professional calibre; probably not. Therefore, the underlying wisdom in establishing an areawide regional planning agency has been amply justified. The Nassau-Suffolk Regional Planning Board was created in 1965 by adoption of ordinances and resolutions by the Boards of Supervisors of Nassau and Suffolk, in accordance with provisions of the General Municipal Laws of New York State. As the solutions to economic and social problems become increasingly regionwide in nature, having this agency with a proven track record in performance already in place will serve as a source of assurance to Long Island citizens.

It would be extremely shortsighted to view this plan as just another study—its pages like leaves on trees, decidious and gone, once fallen to the ground. Its direct value is in its use as a working document, important to the life-styles of future generations and business growth. Indirectly, the applicability of its analyses and findings renders it of national importance and in turn assures national recognition of Long Island as a homogeneous entity with identity well beyond its false reputation as simply a bedroom community.

There is a legal expression, "The evidence speaks for itself." So do the following pages. In the main, Long Island's water supply, derived solely from its own groundwater sources (and not even partially from Connecticut—the erroneous impression lingers) is adequate in terms of quantity. Tunnels from upstate or other outside sources are not only unnecessary, they are equally foolish even to consider. But there is the point-blank question of preserving the quality of our water This stern challenge must be met by the courage of government supported by an informed constituency, sensitive to parochial interests, yet willing to override them for the common good. Effective implementation will provide bread-and-butter benefits in preserving home values, protecting the quality of life and sustaining economic strength.

Elsewhere in this document the reader will find amply justified expressions of appreciation to the numerous private citizens who served on the technical and citizens advisory committees. Policy was always determined by Board members, past and present. Their cooperation along with that of elected officials was crucial to the completion of this work. In this regard our lasting gratitude is enthusiastically extended to the following: to former founding member and Chairman, Leonard W. Hall; former County Executives Ralph G. Caso and H. Lee Dennison; County Executives John V. N. Klein and Francis T. Purcell; former Board members, Thomas Halsey and Robert Flynn; and present Board members: Vice Chairman Seth Hubbard, Vincent Balletta, Robert Bell, Winfield Fromm and John Wickham. Finally, words are often weak and fruitless when attempting to describe the single most important contribution. For that I simply conclude with where it *all* began, was and will be, by use of proper noun: Dr. Lee E. Koppelman.

Harold V. Gleason
Chairman

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Prefatory Comments

Introduction

The passage of the Federal Water Pollution Control Act Amendments of 1972 heralded a new era in environmental management. National interest and purpose was stated in the goal to achieve "water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water" by 1983, wherever attainable. It not only set forth a timetable for action but also provided some new approaches to solving the problems of our nation's polluted waters. For the first time there is a clear recognition that improved quality and the prevention of further pollution will also require changes in land use and management of growth in addition to the prevailing practice of building sewage treatment works. Non-point sources of contamination which result from construction and agricultural activities, highway runoff, widespread discarding of the residues of modern society, and the lack of control over animal wastes, etc. must now be considered. The Act is a landmark in three other instances. It provides for a comprehensive planned approach, requires strong citizen participation in the planning process and mandates a committment from state and local governments to implement the results of the planning effort.

Section 208 of the Act specifically creates a comprehensive water quality management program to deal explicitly with both the treatment and the prevention of water pollution. The plans prepared under this program must include a process for meeting established water quality goals and must show that management institutions exist with sufficient financial and legal authorities to implement the plan, or that new institutional arrangements will be created to achieve this purpose.

The Nassau-Suffolk Regional Planning Board (NSRPB) was designated by Governor Malcolm Wilson in December 1974 as the regional planning entity to carry out Section 208 planning for Nassau and Suffolk Counties. Realizing that a program of this magnitude had to have the support and input from those governmental agencies that either have an interest in, or a mandated role to play in water pollution control, the NSRPB immediately established a Technical Advisory Committee (TAC) to assist it in the preparation of the plan. The initial voting constituency of the TAC included representatives from the Nassau County Departments of Health, Public Works and Planning. The Suffolk County participants were from the Departments of Health and Environmental Control and the Suffolk County Water Authority. The seventh member was the Executive Director of the Nassau-Suffolk Regional Planning Board who served as Chairman of the Technical Advisory Committee and Project Director for the overall program.

In addition to the seven voting members, representatives from the Interstate Sanitation Commission, Region II of the Environmental Protection Agency (EPA), the New York State Department of Environmental Conservation (NYSDEC), the United States Geological Survey (USGS), the Suffolk County Soil and Water Conservation District and the Soil Conservation Service (SCS), the Cooperative Extension Service (CES) and the New York State Department of Health (NYSDH) were invited to participate as resource members.

In accordance with the guidelines for Section 208, and prior practices of the Board in conducting other regional planning studies, the Citizens Advisory Committee (CAC) was created to provide input to the TAC from the general public, and to act as a forum for distributing the findings of the study to the general public.

The Program received a $5.2 million grant from the EPA to carry out the detailed work program necessary to comply with the requirements of the Act.

Between January 1975 and December 1977 the TAC, which was formed prior to the grant award in June 1975, met at least one day a week, first for the design of the program and selection of consultants, and then for the general conduct of the Program. The CAC met bi-weekly during this period.

The consultants retained to carry out specific technical tasks were selected by national solicitation on the basis of merit. This single factor was one of the key elements in achieving the high level of competence displayed in the Plan.

Report Description

This report is a summary of the numerous working reports and studies prepared by the various consultants and member agencies of the project. It is also a reflection of the original workplan submitted to the EPA, with additional materials developed to meet amendments to the project which resulted from changes in the federal regulations, or work elements generated from requests made by the CAC. In addition to the working reports, six interim reports that summarize the technical documents have been prepared for public distribution. They are: (1) *Population Estimates and Projections 1975-1995,* (2) *Modeling Studies,* (3) *Surface Water Quality,* (4) *Groundwater Conditions,* (5) *Management Options* and (6) *Virus Study.*

This summary report constitutes the last in the general series. The TAC also published a study prepared by the SCS. This discusses the impact of animal wastes as a major non-point source of pollutants to the ground and surface waters. The interim reports and the summary report affords the serious reader a reasonably sufficient exposition of the 208 Plan.

This presentation is in seven sections with two appendices. *Section One—General Background*—contains a descriptive discussion of regional ground and surface water considerations. This portion has three segments. The first is a discussion of groundwater, including its major uses, existing quality and contamination sources. The second segment discusses the surface waters of the two counties in similar fashion. The third segment describes major options of structural and non-structural nature, and a description of the various evaluation and selection factors that are used in making choices.

Section Two—Assessment of Conditions—is devoted to an assessment of conditions, including population and land use, pollutant sources from point and non-point origin, and a discussion of transport mechanisms. Groundwater quality and quantity, and surface water quality are summarized to include the major findings of the study. The last segment of this chapter describes the marine, fresh water and terrestrial ecological conditions.

Section Three—Alternative Wastewater Management Programs—the major segment of this report, presents various wastewater management alternatives to control point and non-point source pollution. It includes structural and non-structural approaches ranging from sewer installations with varying degrees of treatment, to best management practices (BMP) for runoff control, fresh water conservation, watershed management and land use controls.

The first segment contains a listing and brief explanation of the objectives that the planning options should achieve in order to insure: public health protection, and the protection, enhancement and conservation of the natural resources—freshwater, marine, wetlands and terrestrial—of the two counties..

The next segment contains a series of structural and non-structural plan alternatives that meet in whole or in part a suitable solution to a defined problem or objective. The alternatives relate both to the hydrogeological nature of the two counties, as expressed by eight distinct zones, and to the marine surface waters. Strong efforts were made to include all reasonable alternatives. In this fashion the public has a general scenario of the many ways in which waste treatment can be addressed, with some explanation of the constraints attendant to each solution, and the consequences thereof.

Section Four—Environmental Assessment—relates the environmental impacts for each of the Plan alternatives discussed in Section Three.

Section Five—Citizen Participation—is a two-part discussion of citizen participation. The first portion (5.0—5.5), written by the Project Director, contains a history and critique of the creation, functions, activities and contributions of the CAC. The second portion (5.6—5.11), prepared by the CAC, discusses their critique of the process and planning options developed in the 208 Program.

Section Six—Preferred Plan Alternatives—presents the options deemed by the TAC to achieve the objectives of water quality planning for Long Island in the most desirable fashion. Explanations and reasons for the selections are discussed.

Section Seven—Implementation—contains the recommendations for management responsibilities—existing, modified or new—to carry out the financing, design, construction, maintenance, monitoring or regulation of the Plan elements. Recommendations for amendments to existing laws or the enactment of new ones at various governmental levels are also mentioned.

Appendix A—Modeling—contains a synopsis of the various models used in the 208 Study to simulate the natural groundwater and surface water systems, and to allow the technicians to test a wide range of options as though the environment was undergoing stress. Some of the models were specifically designed to furnish responses for geographically specific areas, (the South Fork study by Princeton) or for specific contaminants (the CES nitrate study).

Appendix B—Bibliographic Data Summary—identifies the range of data used to reach the plans' conclusions. It also contains a listing of the almost 175 reports and publications prepared by the TAC agencies and consultants in the conduct of the study.

Appendix C—Memoranda of Agreement—contains the two statements of agreement between the Suffolk County Departments of Health Services and Environmental Control.

Administrative Observations

The Section 208 effort discussed herein has proven to be challenging and rewarding. Since the Program is entirely new from a national point of view, it can serve as an example for other parts of the nation. An indication of the strengths and weaknesses, successes and failures resulting from this initial effort can assist in the formulation of continuing programs to be carried out in this Region and in other parts of the country.

Among the strengths, we would have to acknowledge the strong interest and support received from Region II of EPA. They have recognized that

Nassau and Suffolk have: a dependence on groundwater for potable water supply; a varied and complex marine environment surrounding the entire Region; areas of human settlement that represent the full triad of planning concerns, *i.e.*, urban, urban-suburban interface, suburban-rural interface, and the impact of all three on the natural environment. This recognition on the part of EPA yielded sufficient funds well beyond the normal allocation formula to carry out the Program.

Second was the full cooperation in the best professional sense, of the various members of the TAC who represented organizations with sometimes strong and differing institutional biases. Third, we also have to acknowledge at this point the very high caliber of talent that exists in public service at all levels of government which is evidenced in the results of this Study. A fourth factor was the impartial selection of consultants by the TAC without any external political or parochial controls to inhibit its national search for the most competent firms. The fifth aspect was the establishment of a strong CAC who were self-organized and not hand selected by the agency.

The weaknesses of the Program were primarily of an administrative and timing nature. Two major limitations were imposed by the insistence of EPA on plan completion, including approval by the Governor, within a two-year planning period. Although the Act requires Plan development within twenty-four months, provisions existed for project design prior to this phase for up to twelve months. EPA determined to dispense with the pre-planning opportunity. In a sense this fiat is the antithesis of the planning concept itself. The Agency was forced to "learn on the job," thus creating plans by work assignment amendments. The problem was further compounded by the changes in guidelines, regulations and reporting procedures imposed by EPA after the contract and original work program were agreed upon and approved. In essence, EPA was also "learning on the job."

The remedy for these time constraints was either to curtail some of the work efforts or to rigorously manage the productivity of staff and consultants. We chose the latter course, thus placing all of the participants under constant pressure. This in not an optimal administrative choice.

The second shortfall may develop at the end of the planning period. Implementation, in the full sense of the term, often can take as much time as the Plan development process itself. If the intent is to achieve the sincere acceptance and approval of the general public and various elected and appointed officials—and not be the result of default—then the planners and CAC members must have adequate opportunity to present the case. This was attempted in part during the two year period. The Project Director delivered nearly 50 presentations to various governmental, professional, civic, environmental and business groups in the two counties. Other members of the TAC, CAC, and consultants also made many presentations. However, the Plan options themselves could only be finalized at the end of the planning process. Thus, the public information phase has to extend beyond the first two years. This is particularly the case in a Region of almost three million people. One, or even several, "public hearings" are simply not adequate.

The Act also prohibited any work that might have been deemed research, thereby requiring agencies to use only existing techniques. Strict interpretation of this clause served to limit the comprehensiveness of the Study. A detailed example of this last point is discussed in *Section Five—Citizen Participation.*

Lest this litany of pitfalls, pratfalls and problems be deemed a dire prediction, let me stress that I do consider the 208 Program as a challenge and opportunity. Granted, the first generation of plans may show scars and evidence of misfit between expectation and achievement. Nevertheless, optimism should be the hallmark. The Nassau-Suffolk Comprehensive Water Quality Management Plan does address and satisfy the requirements of Section 208 of the Act.

This is the first national effort to cope with major environmental issues on a multi-disciplinary and interdisciplinary basis as part of comprehensive regional planning. Any successes from the first programs should strengthen future efforts and also provide the methodological base for solving other environmental problems.

February 7, 1978

Lee Koppelman
Project Director

Section I General Background

1.0 Introduction

This section sets the stage for the discussion of the options available to the Nassau-Suffolk Region in coping with the management of its waste treatment over the next two decades. The planning boundaries are described, followed by a brief description of the physical characteristics and the problems of growth resulting from three decades of rapid urbanization. One of the key problems readily apparent is the need to protect and properly manage the groundwater—the sole source of potable water for the two counties. In addition, the quality of fresh and marine surface waters must be protected for both commercial and recreational use. The response to these needs are the essence of this report.

A description of the institutional setting, and a capsule summary of the work elements designed to produce a workable plan follow. The last segment discusses the key water quality and quantity issues.

1.1 Planning Boundaries

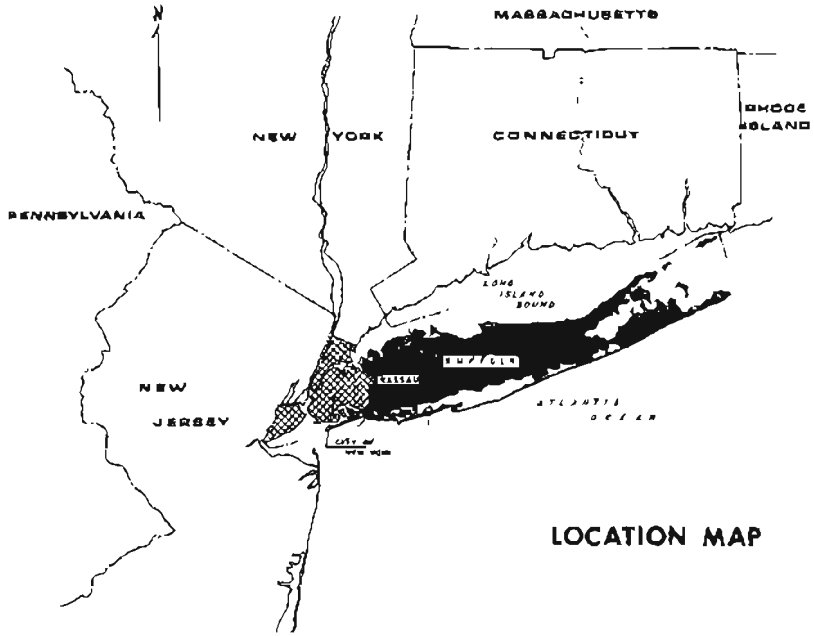
1.1.1 Location. Nassau and Suffolk Counties, occupying one-sixth of the land area of the New York Metropolitan Region, have been two of the fastest growing counties in the United States since the end of World War II. In 1960, the combined Nassau and Suffolk population of two million persons was one-eighth of the total Regional population of sixteen million. It is projected that 25 percent of the additional six million persons that will inhabit the Region by the year 1995 will be living in these two counties. The projected growth of the two counties indicates a potential increase in the impacts on the environment.

The counties, with their streams, lakes, rivers, ocean, bay and Sound frontages exceeding 1,000 linear miles in total, are familiar natural attributes to millions of persons interested in resort and recreation opportunities. Long Island Sound on the north and the Atlantic Ocean on the south and east afford a decidedly unique advantage for the proper development of marine resources. The south shore is paralleled by barrier beaches, which create bays between the south shore of the Island and the ocean from Long Beach on the west to the Hamptons in the Town of Southampton, Jones, Fire Island, Moriches and Shinnecock Inlets connect these bays to the ocean. This portion of the Long Island peninsula is over 100 miles long and 20 miles wide at its widest point, which is near the Nassau-Suffolk boundary. The major land area extends eastward from the Queens-Brooklyn and Nassau County border for approximately 60 miles to Riverhead. East of Riverhead two forks or peninsulas continue eastward, separated by the waters of Peconic and Gardiners Bays. The northern fork terminates at Orient Point and is approximately 27 miles in length. The southern fork terminates at Montauk and is about 44 miles long. The land areas of the two counties is approximately 1,200 square miles. Figure 1-1 depicts the municipal boundaries within the Region.

1.2 Geography

1.2.1 Physical Characteristics. A high ridge of glacial origin running approximately east and west from the northwesterly corner of Nassau County and then running in a southeasterly direction through Nassau from the North Shore reaches an elevation of about 300 feet above sea level. North of the ridge the topography is generally abrupt with an overall slope to Long Island Sound. South of the ridge is a long gentle slope terminating in the marsh and meadow land which borders the bays on the south. Four main river watersheds are located in Suffolk County. These are the Nissequogue in the Town of Smithtown, Connetquot in the Town of Islip, Carmans in the Town of Brookhaven and the Peconic in the Towns of Riverhead, Brookhaven and Southampton.

The area is mainly composed of unconsolidated deposits of sand, gravel and clay laid down in more or less parallel beds on a hard bedrock surface. The rock floor is tilted downward in a southeasterly direction, so



KEY TO MUNICIPALITIES IN NASSAU AND SUFFOLK COUNTIES

VILLAGES IN NASSAU COUNTY

Town of Hempstead

1. Atlantic Beach
2. Bellerose
3. Cedarhurst
4. East Rockaway
* 5 Floral Park (North Hempstead)
6. Freeport
7. Garden City
8. Hempstead
9. Hewlett Bay Park
10. Hewlett Harbor
11. Hewlett Neck
12. Island Park
13. Lawrence
14. Lynbrook
15. Malverne
16. Rockville Centre
17. South Floral Park
18. Stewart Manor
19. Valley Stream
20. Woodsburgh

Town of Oyster Bay

21. Bayville
22. Brookville
23. Centre Island
24. Cove Neck
25. Farmingdale
26. Lattingtown
27. Laurel Hollow
28. Massapequa Park
29. Mineola
30. Mill Neck
31. Muttontown
32. Old Brookville
33. Oyster Bay Cove
34. Sea Cliff
35. Upper Brookville

Town of North Hempstead

36. Baxter Estates
*37 East Hills (Oyster Bay)
38. East Williston
39. Flower Hill
40. Great Neck
41. Great Neck Estates
42. Great Neck Plaza
43. Kensington
44. Kings Point
45. Lake Success
46. Manorhaven
47. Mineola
48. Munsey Park
*49. New Hyde Park (Hempstead)
50. North Hills
*51. Old Westbury (Oyster Bay)
52. Plandome
53. Plandome Heights
54. Plandome Manor
55. Port Washington North
56. Roslyn
57. Roslyn Estates
*58. Roslyn Harbor (Oyster Bay)
59. Russell Gardens
60. Saddle Rock
61. Sands Point
62. Thomaston
63. Westbury
64. Williston Park

CITIES IN NASSAU COUNTY

65. City of Glen Cove
66. City of Long Beach

VILLAGES IN SUFFOLK COUNTY

Town of Huntington

67. Asharoken
68. Huntington Bay
69. Lloyd Harbor
70. Northport

Town of Babylon

71. Amityville
72. Babylon
73. Lindenhurst

Town of Smithtown

74. Head of the Harbor
75. Nissequogue
76. Village of the Branch

Town of Islip

77. Brightwaters
78. Ocean Beach
79. Saltaire

Town of Brookhaven

80. Belle Terre
81. Bellport
82. Lake Grove
83. Old Field
84. Patchogue
85. Poquott
86. Port Jefferson
87. Shoreham

Town of Southampton

88. North Haven
89. Quogue
*90. Sag Harbor (East Hampton)
91. Southampton
92. Westhampton Beach

Town of Southold

93. Greenport

Town of Shelter Island

94. Dering Harbor

Town of East Hampton

95. East Hampton

*Indicates that Village element within two towns

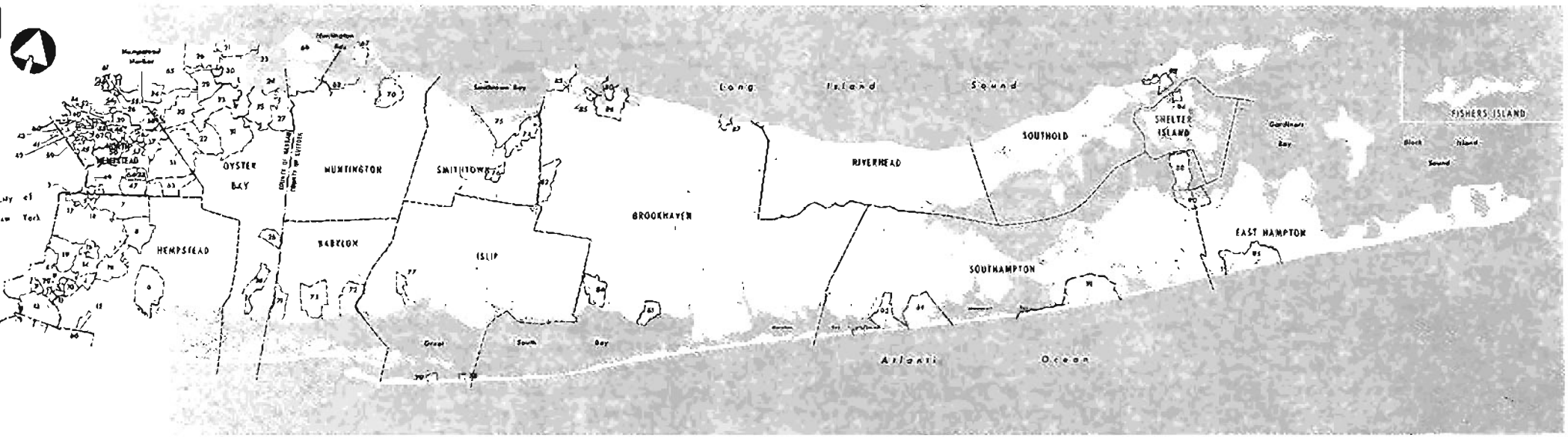


FIGURE 1–1 *Nassau and Suffolk Counties—Municipal Boundaries*

that from a position of surface outcroppings in the northwest end of Long Island (Queens County) it reaches a depth of 2,100 feet below sea level beneath Fire Island. The subsoil is generally sandy and yellow colored except on the ocean side of the south shore dunes, which are of light gray sea sand. The topsoil is particularly suited for agricultural uses in various parts of the Region. Elsewhere the ground is generally covered with scrub growth, mostly oaks and pine. North of the glacial ridge there is an abundance of flora including many of the hardwoods as well as evergreen cover.

Estuarine marshes and the off-shore waters abound in a variety of shell- and finfish. The inland fresh waters, particularly in Suffolk County, have an abundance of trout and other important sport fish.

The water supply for the Nassau-Suffolk Region is obtained entirely from groundwater. Natural replenishment of this supply is derived solely from precipitation (*i.e.*, rain, snow and sleet) which averages 44 inches per year. It has been estimated that approximately 50 percent of the precipitation is lost due to evapotranspiration and other factors, so that only about half of the precipitation reaches water-bearing strata.

1.2.2 Problems of Growth. Obviously, Long Island is an area where the quality of life and large segments of the economy are related to and dependent on the quality of its environment. Tourism, agriculture, seasonal homes and residential communities, thrive in areas of healthy and aesthetically attractive natural settings. There are a number of major surface and groundwater pollution problems. Marine water problems include excessive nutrient enrichment and the closing of beaches and shellfishing areas due to bacterial contamination, which is attributed to both point and non-point sources of pollution. Some portions of the fresh water streams have dried up and others are threatened because of lowered groundwater levels due to sewering and excessive well pumpage. Groundwater quality has been degraded by nitrates, chlorides and other contaminants from fertilizers, recharge of domestic and industrial wastewater, landfill leachate, and stormwater recharge. Water quality—both potable and marine—is the key to Long Island's future. Planning for the orderly growth of these communities and the management of their wastes is the linchpin that will determine the quality of the future.

In response to earlier perceived growth problems, *e.g.*, residential sprawl, transportation deficiencies, rapidly changing community characteristics, increased deterioration of older downtowns and housing, and shortages of community facilities, the Boards of Supervisors of Nassau and Suffolk Counties created the Nassau-Suffolk Regional Planning Board in 1965. This agency's prime task was the preparation of a comprehensive plan that would serve as a guide for all units of government in the two counties for coping with future growth and for reversing the negative aspects of past development.

The Comprehensive Land Use Plan was completed in July, 1970. In essence, it recommended controls on the ultimate size of growth, location and form of development, and institutional changes necessary to achieve implementation. Based on environmental data extant at the time, it was apparent that the most obvious limit to growth was the availability of potable water. It was also apparent that some degradation of these waters had already occurred. However, the projected total population of 3.3 million people by 1995, was less than 60 percent of the estimated population that could be sustained, and it was assumed that the Plan was environmentally prudent.

The Nassau-Suffolk Regional Planning Board also recommended that additional funds be sought to conduct water quality studies in order to insure that the two counties' sole source of potable water not be jeopardized. The advent of the 1972 Amendments to the Water Pollution Control Act (PL 92-500), and particularly the Section 208 planning provision, furnished the answer to this quest. In the next section, a brief discussion of the planning program will indicate the nature of the designation process and the organization of the technical staff and will identify the major substantive elements in the Program.

1.3 Institutional Setting

1.3.1 Designation. The 1972 Amendments to the Act provide that the Governor may designate regional planning agencies to engage in 208 planning. Where such agencies are not designated, the State is required to assume the planning responsibility. Several of the operating agencies in Nassau and Suffolk Counties, and the Nassau-Suffolk Regional Planning Board expressed interest in this designation. The two County Executives agreed that the Board should be the applicant.

All agencies that wished to be eligible for 100 percent funding had to receive designation before January 1, 1975 and receive contractual approval from EPA prior to July 1, 1975. In late November 1974, a preliminary work program was quickly assembled and a designation request was made to the Governor. On December 28th, Governor Malcolm Wilson gave the first designation in the State of New York to the Board.

1.3.2 Technical Staffing. The Program represents a joint effort of the Board and various regulatory, operating and planning agencies in Nassau and Suffolk Counties. A Technical Advisory Committee (TAC), with seven voting members, was formed. The Nassau Departments of Health, Public Works, and Planning were matched by representatives from the Suffolk County Water Authority and the Departments of Health Services and Environmental Control The Executive Director of the Board, who is Project Director for the Program, serves as the Chairman of the TAC.

In addition, the New York State Department of Environmental Conservation, Region II of EPA, and the Interstate Sanitation Commission also provide representatives to serve as non-voting resource persons. The TAC is composed totally of professionals. It was organized in this fashion with the recognition that the agencies with the responsibilities for carrying out portions of the Plan should have the opportunity to participate in its formu-

lation. Also these participants represented the cumulative local expertise and knowledge base at the onset of the Program.

Preparation of a detailed work program was the initial work conducted by the TAC. At first, a list was compiled of each agency's recommended projects. Much culling, additions, deletions and alterations occurred as the items were compared with the requirements and/or limitations of the Act. The document finally submitted to EPA and the State for contract approval was reduced from $17 million to $5.2 million during this iterative design stage, and quite faithfully adhered to the requirements in the Act.

A secondary concern during this pre-planning period was expressed in regard to the work to be conducted by consultants where specialized talents and equipment were needed. The TAC followed the procedure mandated by the Board, and sole source contracts were awarded only to those governmental and/or academic institutions that had a unique talent. In all other cases, the TAC prepared "Requests for Proposals," which were advertised nationally. This procedure was followed in order to secure the best talents in the country. Although this technique was time-consuming and often onerous, it has proven meritorious. The consultants were selected by the voting members of the TAC based on the technical merit of their proposals. Budget information was kept sealed until each selection was made.

1.3.3 Work Elements. The general goals of the Program to achieve water quality criteria established by Federal and State laws require an extensive knowledge of: the existing and proposed land uses and demography of the Region; the quantity, quality and hydrology of the ground and surface waters, including inter-relationships between both; the types, sources, amounts and impacts of contaminants entering the waters; the alternative technologies best suited to address any specific problems; the legal, fiscal and institutional arrangements, and the laws, agencies and regulations needed to implement the completed Plan. This aspect will be discussed in the implementation section of this report.

The Comprehensive Land Use Plan released by the Nassau-Suffolk Regional Planning Board in 1970 still serves as the basic guideline for growth in the two counties until 1985—1990. The Plan has been updated over the past three years as a result of a United States Department of Housing and Urban Development assisted project that involved the development and testing of a methodology for the integration of coastal zone science with the planning process. Fortuitously, only minor modifications were indicated to enable the Plan to meet specific environmental needs. This affords a strong advantage to the two counties' likelihood of producing a workable waste management plan—the land use plan already exists. Thus it is much easier to develop and test two major management approaches. If we assume that the land use plan will be realized, then it becomes a task of estimating the contamination loadings that will result from the various land uses and recommending treatment facilities, *e.g.*, sewers, treatment plants, etc. Conversely, the land use plan can be modified and population densities altered to avoid the need for structural solutions. Both approaches are examined in this Program.

Comprehensive water supply studies were conducted in each county during the 1960's and early 1970's. These studies evaluated the possible changes in groundwater quantity that might result from the implementation of various wastewater treatment proposals. The United States Geological Survey, which was chosen as one of the public agency consultants by the Board because of their extensive knowledge of Long Island's groundwater, has conducted studies in the bi-county area for many decades. During recent years, the Survey developed an electric analog model, which simulates the physical characteristics of the groundwater system. This model was used in the 208 Study to simulate water level responses to a number of hypothetical water-management options.

Water quality problems are usually of significantly greater complexity than questions of water levels or of water quantity. Investigations and monitoring programs are generally conducted for the purpose of providing information on ambient groundwater conditions, as well as of examining the adverse effects of known or suspected sources of pollution, and to assess water quality improvements attributable to correction measures (*e.g.*, sewers). For example, in the past, studies have been conducted addressing the impacts of individual on-lot sewage disposal systems, landfill leachate, detergents, sewage treatment effluent recharge, stormwater recharge, meteorological conditions, fertilizers and pesticides. The pollutants monitored were limited to those considered relevant to public health and natural resources, for which reliable monitoring procedures were available.

During the past few years, the increasing awareness of the presence of additional hazards to public health and natural resources, as well as the continuing development of sampling and analysis techniques, have resulted in the monitoring of additonal substances, *e.g.*, viruses and organic chemicals. The 208 Program included a study of organic chemicals, heavy metals and viruses in wastewater and groundwater in the bi-county area. Water sample locations were carefully selected to reflect the influence of various types of land use and wastewater activities. Samples were analyzed for heavy metals, organics in trace amounts and viruses.

In order to provide simulation capabilities for water quality evaluations, the Department of Civil Engineering of Princeton University was retained to adapt and apply existing digital models (one, two and three-dimensional) to simulate the impacts of various groundwater levels on saltwater intrusion, and further groundwater pollution. The modeling runs are paralleled with quality evaluations based on empirical data and related literature. The work also included a digitization of the Geological Survey's analog model to facilitate the testing of management alternatives.

Similar emphasis was placed on questions of surface water quality. Various estuarine steady-state and time-variable models were applied to specific bodies of water to estimate the effects of various waste treatment

schemes on receiving water quality.

The reliability of model results bears a direct relationship to the accuracy of pollutant loadings input into them. Point sources of contamination have been routinely identified and tested. In the past this was sufficient because wastewater studies were directed towards engineering solutions to these sources of contamination. Much of the current planning effort is also concerned with non-point sources of pollution—stormwater runoff, sedimentation, uncontrolled deposits of animal wastes, etc. Several responses to these more pervasive and usually unquantified sources were included in the Work Program. The Cooperative Extension Service conducted field studies and literature searches to identify and evaluate the volumes of pesticides, fertilizers and other home and agricultural chemicals used in the two counties. The impact of nitrogenous fertilizers, relative to other sources, was evaluated in part by means or a preliminary regional nitrogen balance. The Suffolk County Soil and Water Conservation District identified other non-point pollution problems associated with various animal populations, runoff and sedimentation. In addition, the two County Health Departments, the Suffolk County Department of Environmental Control (which was already engaged in a study of fertilizers), the Suffolk County Water Authority, and the Town of Islip Department of Environmental Control, all contributed substantially to the sampling and analysis of non-point sources.

The information gathered from the sampling and analysis programs served as inputs for the determination of engineering and non-structural alternatives for the achievement of water quality objectives. This approach afforded the broadest possible array of policy choices as to method, location, timing and cost of solutions.

The alternatives and their consequences have been considered by the TAC for the purpose of selecting the most viable combinations of solutions—structural and non-structural—that in the aggregate form the Comprehensive Areawide Waste Treatment Management Plan for Nassau and Suffolk Counties. The Citizens Advisory Commitee (CAC) has also reviewed and contributed to the final product. In some instances where more than one solution is viable, or where a consensus was not achieved, this report mentions the array of choices.

1.4 Regional Ground and Surface Water Considerations

Within the overall framework of the 208 Program, major technical issues have arisen which have had to be addressed as part of the Study. This segment of Section One includes a discussion of the major considerations. It relies upon the previous segments to describe the regional setting and then discusses ground and surface water uses, and quantity and quality problems. The segment is concluded by generalized descriptions of management options, which may be applicable to the Bi-county Region. It is presented to effect a transition between the planning issues and the scientific/engineering considerations.

1.4.1 Groundwater

1.4.1.1 Major Uses. Groundwater beneath Nassau and Suffolk Counties is the only source of potable water for almost three million people. Pumpage and use characteristics within the Region are complex and fragmented. The user of groundwater can be a single facility operating its own domestic well on a small parcel of land, a large water district with a dozen individual high capacity wells located miles apart in several different communities, a private water company with a single well field serving one subdivision, or an industry partially supplied by its own well system and partially dependent on a local utility. Thus, pumpage for different well owners can range from a few hundred gallons to many millions of gallons per day.

The use of water withdrawn is equally varied. Groundwater pumpage satisfies not only domestic requirements, such as drinking water, but also must meet the needs of industry, commerce, agriculture and recreation.

Water supplies are developed principally from two major water-bearing units: the Upper Glacial and Magothy aquifers. A relatively unexploited third aquifer, the Lloyd, lies beneath the upper two formations, and is separated from them by a thick, confining bed of clay. Total withdrawal from all aquifers now approaches 400 MGD (million gallons per day).

The pattern of pumpage is not uniform. The development of multiple sources of supply, even when not necessitated by fragmented supplies, was deliberate in order to more uniformly withdraw from the system and then minimize the disruption of equilibrium conditions. Major concentrations of pumpage have been developed near areas of dense population, leaving other portions of the subsurface reservoirs underutilized. This has resulted in a pronounced east-west imbalance in pumpage distribution. Also, degradation of water quality in the Upper Glacial aquifer beneath urbanized areas has led to the abandonment of shallow wells, in favor of withdrawing water from progressively deeper aquifer zones. Thus, the principal water supply aquifer in Nassau County and western Suffolk is the Magothy, whereas the principal water supply aquifer in eastern Suffolk County is the Upper Glacial.

Groundwater discharge supports streamflow for most of each year. The volume of groundwater underflow discharged to surrounding saltwater bodies can affect surface water salinity. Relatively small fluctuations in water table elevations, on the order of a few feet, can cause pronounced changes in stream discharge. On the other hand, underflow to saltwater bodies is not very sensitive to such fluctuations. It has been estimated that substantial changes in consumptive use of groundwater in the Region would be required to significantly affect underflow.

A certain amount of underflow is also needed to maintain the fresh-salt water interface at an equilibrium position. The position of the boundary between fresh and saline groundwater is dependent upon changes in water levels in the various aquifers. However, the fresh-salt water interface is generally some distance offshore in the confined aquifers of Long Island. Therefore, changes in head at the interface, resulting from reductions in

natural recharge or increases in pumpage and consumptive water use, are generally small and localized. Inland movement of saline groundwater is very slow, even in areas where the interface is already on shore and in close proximity to centers of pumpage.

1.4.1.2 Existing Quality. The quality of groundwater in the aquifers of Long Island is dependent upon a number of factors. In undeveloped areas, recharge from relatively good quality rainfall, together with whatever natural treatment and pollutant retention is provided by the vegetation, soils and geologic sediments have resulted in the availability of very high quality groundwater in the underlying aquifers. Where the land has been subjected to heavy use or modification by man, groundwater quality has been degraded. The degree of degradation is dependent upon the type of land use; the location of individual sources of contamination, such as cesspools and landfills; the characteristics of the contaminants; and the length of time that the waste disposal practice has been in existence.

Groundwater quality is also extremely dependent upon hydrogeologic factors. Recharge to the Magothy from the water table or Upper Glacial aquifer occurs over a large area along the central east-west corridor of the Island. This region, where groundwater movement is generally vertically downward and unimpeded by intervening clays, is commonly referred to as the Magothy recharge area. Therefore, sources of contamination discharging to the water table can migrate downward to the underlying Magothy.

Deep flow also occurs in portions of the Upper Glacial deposits to the north of the limits of the Magothy recharge area in Nassau and western Suffolk.

Along the South Shore and parts of the North Shore groundwater movement is generally horizontal or upward, and intervening clays inhibit downward movement of groundwater, even where heavy pumping is taking place. This region is referred to as the Magothy discharge area. Groundwater quality is considerably more vulnerable to land use changes and sources of contamination in recharge areas than in discharge areas.

Another factor affecting groundwater quality over the long term is the slow movement of groundwater, especially in the vertical component. Under natural conditions, it takes about 100 years for water from the surface to reach the lower portion of the Magothy in the center of the Island. Heavy pumpage in the Magothy can reduce this time period to about twenty years. Thus, sources of contamination can be eliminated (for example septic tanks and cesspools replaced by sewers) but the effects on deeper aquifers may not be noticeable for many decades. In the Upper Glacial aquifer the effects of pollutants and of remedial measures are realized much faster.

Actual groundwater quality problems in the 208 Region have been characterized by a significant rise in nitrate concentrations in portions of the recharge area of the Magothy aquifer. Also of importance is the discovery of organic chemicals in sections of the two counties in both shallow and deep aquifers. Several independent analyses of nitrate trends in shallow groundwater and in the Upper Glacial aquifer were completed during the period in which the 208 Program was conducted. From this work, it is difficult to make clear-cut generalizations regarding statistically calculated trends, especially with respect to making distinctions between sewered and nonsewered areas. However, there is general agreement that nitrate concentrations are decreasing in many shallow wells in southwestern Nassau County where sewering took place in the 1950's and early 1960's. In unsewered eastern Nassau, one of the analyses also found generally decreasing nitrate trends, while another failed to find a trend. Water in shallow wells in southwestern Suffolk has generally increasing concentrations of nitrate. On the basis of limited data, it appears that the quality of the underlying Magothy has not improved. In Nassau County, the Magothy has apparently sustained an overall decline in water quality.

Individual sources of contamination, such as landfills and industrial waste recharge basins, have developed discrete bodies of contaminated groundwater. These plumes of contaminated water are isolated, but are of extreme importance locally. Analysis of organic chemicals is a new effort, and, thus far, no trends can be developed from the very limited data collected.

1.4.1.3 Contamination Sources and Identification of Control Needs. There are many sources and causes of contamination in the 208 area. Basically, these can be divided into four categores (Table 1–1). The first two categories include discharges of contaminants that are derived from solid and liquid wastes. The third category concerns discharges of contaminants that are not related to wastes, and the fourth category consists of those causes of groundwater contamination that are not discharges at all.

The variety and type of controls available for each category differ. For example, some Category I causes may require a discharge permit, whereas others may be controlled by restrictions on land use. Sources under Category II may require satisfaction of specified construction standards, such as the lining of landfills and the installation of leachate collection systems. Guidelines and manuals (*e.g.*, tons/lane-mile limits on highway deicing salts) may be the only tools available for dealing with Category III. Special types of regulatory controls are available for the causes of groundwater contamination listed under Category IV. An example is the current system of groundwater diversion applications and hearings employed to minimize saltwater encroachment. Another is the continued licensing of drilling contractors in order to upgrade waterwell construction practices.

The protection of groundwater quality involves both the elimination or mitigation of existing problems, and the prevention of new ones. Control needs will vary depending upon the nature and location of the source of pollutants, and upon the prevailing background or baseline conditions.

In the case of an established industrial source, the imposition of effluent controls and monitoring to assure compliance may be the best approach. Where the pollutant generating activity is a necessary one that is not readily controlled by traditional permitting systems, as in the case of landfills,

TABLE 1–1
CLASSIFICATION OF SOURCES AND CAUSES OF GROUNDWATER CONTAMINATION USED IN DETERMINING LEVEL AND TYPE OF CONTROL

Category I	Category II	Category III	Category IV
Systems, facilities or sources designed to discharge waste or wastewaters to the land and groundwaters.	Systems, facilities or sources not specifically designed to discharge wastes or wastewaters to the land and groundwaters.	Systems, facilities or sources that may discharge or cause a discharge of contaminants that are not wastes to the land and groundwaters.	Causes of groundwater contamination that are not discharges.
Domestic on-site waste dispoal systems	Sanitary sewers	Highway deicing and salt storage	Airborne pollution
Sewage treatment plant effluent	Landfills	Fertilizers and pesticides	Water well contruction and abandonment
Industrial waste discharges	Animal wastes	Product storage tanks and pipelines	Saltwater intrusion
Stormwater basin recharge	Cemeteries	Spills and incidental discharges	
Incinerator Quench water		Sand and gravel mining	
Diffusion wells (heat)			
Scavenger waste disposal			

relocation to an area where the aquifer is already degraded, and no longer used for water supply, may be appropriate. The prevention of degradation in relatively pristine areas may require a management program that employs a combination of land use and other non-point source controls to prohibit or severely restrict the development of potential pollutant sources.

1.4.2 Surface Water

1.4.2.1 Major Uses. Surface waters on Long Island provide a variety of beneficial uses. Fresh waters, including streams and lakes, are used for aesthetic enjoyment, swimming, fishing and boating. Marine waters, including bays and estuaries, are used for both commercial and recreational purposes. Shellfishing and finfishing are major commercial enterprises in bays and estuaries. Recreational use includes shellfishing, sportfishing, swimming and boating. In addition, the assimilation capacities of surface waters may allow their use as a major receiving system for waste disposal.

In recognition of the variety of, and sometimes competing, beneficial uses, Long Island marine waters have been classified by the New York State Department of Environmental Conservation as to their potential best usage in the public interest.

The New York State Department of Environmental Conservation classification of best usages for marine waters, in decreasing order of water quality requirements, comprises the following four classes:

SA Waters suitable for shellfishing for market purposes and primary[1] and secondary[2] contact recreation.

SB Waters suitable for primary and secondary contact recreation and any other use except shellfishing for market purposes.

SC Waters suitable for fishing and all other uses, except for primary contact recreation and shellfishing for market purposes.

SD Waters not primarily suitable for recreational purposes, shellfish culture, or development of fishlife and which cannot meet the requirements of these uses.

Notes 1 Primary contact recreation means activities where the body may come in direct contact with raw waters to the point of complete submergence (*e.g.*, swimming, diving, water skiing, skin diving and surfing).

2. Secondary contact recreation means activities where contact with the water is minimal and ingestion of water is not probable (*e.g.*, fishing and boating).

These specific uses are dependent upon naturally functioning marine ecosystems which are commonly characterized by a number of water quality parameters. Two major parameters are dissolved oxygen and coliform bacteria concentrations. Adequate dissolved oxygen is essential to the growth and reproduction of finfish and shellfish. Dissolved oxygen is also required in the natural decomposition of organic wastes. Current public health standards call for low coliform bacteria concentrations since the presence of such bacteria is regarded as an indication of potentially pathogenic contamination due to human or animal wastes.

1.4.2.2 Existing Quality. The tidal flushing of Long Island's North Shore bays is substantially greater than in the South Shore bays or the Peconic Estuary. Because of the greater tidal range in Long Island Sound, a parcel of fresh water or waste discharged to a North Shore bay will be flushed out within one to three days, whereas from one to three months may be required in eastern Great South Bay.

The dispersion and flushing of pollutants within any bay is generally maximum for discharges near the inlet and decreases with distance away from the inlet. Localized pollution problems generally exist where streams or municipal waste discharges enter a bay at a point well away from the inlet.

Within each bay, constituent concentrations are modified by biochemical processes. The parameters of primary concern, which reflect the net result of complex processes, are coliform bacteria and dissolved oxygen

concentrations. Levels of these constituents have been established for each bay system by the New York State Department of Environmental Conservation. In addition to these parameters, salinity levels, and the concentrations of non-point sources, are a major source of contaminants to the surrounding marine waters. The degree of contamination derived from a particular stream will depend upon the volume of streamflow, the rate and degree of pollutant input, and the degree of mixing of stream and bay waters. Other sources of marine surface water contamination include pointsource discharges from sewage treatment plants, subsurface inflow from groundwater, discharges from boats, and inputs from adjacent marine waters. In any particular bay, the degree of contamination attributable to those sources depends upon the rate of input of the pollutant and its rate of removal from the system by physical and biological processes.

1.4.3 Management Options

1.4.3.1 Introduction. There are many approaches that can be utilized to manage the ground and surface water quality problems of the Bi-county Region. The more traditional type of program has reacted to existing water quality problems by constructing facilities to ameliorate them. Less traditional approaches are to guide growth and to develop various types of programs which prevent water quantity or quality problems from occurring or to develop solutions which do not include facilities. The former approach can be defined as a structural set of solutions while the latter approach is non-structural in nature. The recommendations of the 208 include implementation of both types of programs.

The 208 has identified and evaluated numerous options and approaches. In some cases, only general evaluations could be performed while at other times, detailed studies were possible. However, the intent throughout has been to identify a viable set of options, both structural and non-structural, which should be studied in detail in more localized studies. This is the key to the relationship between 208 and the more detailed studies (*e.g.*, 201 Facilities Plans) in the Nassau-Suffolk area. The 208 must identify the structural and non-structural alternative approaches which are viable on a regional level. The more detailed local studies must start with the regionally satisfactory options and screen them as to their applicability at the local level.

1.4.3.2 Structural Approaches. The structural approach to wastewater management begins with collection of the waste. Water carriage has been and will continue to be the method of waste transportation in the Nassau-Suffolk Region for all wastes except certain special hazardous wastes. Sewers will be used whether the wastes are conveyed to large regional facilities or to smaller local or sub-regional plants. Modifications such as pressure or vacuum systems may be used in local situations.

The 208 Program has analyzed alternative collection concepts and has determined that vacuum and pressure collection systems should be evaluated in local studies. The comparison to traditional gravity collection should be made on the basis of construction cost, operation and maintenance costs and on operational reliability. A concern of the 208 is the energy consumption, on a continual basis, of pressure or vacuum systems. As energy costs continue to increase, and as energy resources become increasingly limited, vacuum or pressure collection systems become increasingly less attractive.

Structural treatment options are generally grouped according to the types of wastes that they process. Domestic sewage, for example, is one type of waste, industrial waste, another. A number of processes, both biological and physical/chemical, are available for the treatment of domestic sewage (activated sludge, activated carbon filtration, etc.) and other systems have been proposed or tried on an experimental basis (*e.g.*, spray irrigation, marsh-pond system, etc.). It is worth noting that all biological systems, including conventional biological treatment as well as spray irrigation and marsh-pond, are variations on a single theme, differing in design details such as scale, layout and treatment efficiency.

Industrial liquid wastes can be divided into two categories: toxic and non-toxic. The non-toxic wastes can be handled in the same manner as domestic sewage. The toxic wastes are almost exclusively handled by physical/chemical treatment processes.

Stormwater runoff is difficult to treat by structural approaches because of high and variable flow rates. Sedimentation and disinfection may be feasible options.

The 208 Program has investigated various treatment options and has determined that two of the newer concepts should be tested in a situation where the processes would receive no more than normal operating attention. The marsh-pond treatment process will be tested by Suffolk County at the Village of Greenport sewage treatment plant site (1978 funds approved). Although design procedures and criteria will be obtained during this test, normal operation by plant personnel rather than control by an engineering staff will be used. Similarly, improved septic tank systems, which de-nitrify the waste, should be tested in a small development. Once these systems have operated satisfactorily through all seasonal conditions, and procedures for design and implementation are obtained, their use as potential alternatives to conventional systems can be considered.

The treated effluent and sludge, which includes domestic industrial and hazardous wastes, must be disposed. The normal disposal methods for treated effluent are sea or bay disposal, recharge to the ground, stream augmentation or land surface application. The options available for sludge disposal include barging, various types of incineration and land disposal either on Long Island or outside the area. EPA regulations, however, call for the cessation of ocean dumping of sludge by 1981. The selection of any of these disposal techniques depends upon the toxicity of the waste, cost-effectiveness and the degree of desired protection of ground and surface water quality.

1.4.3.3 Non-Structural Management Options. Non-structural management options identified in this Program relate to the control of potential

sources of pollution. They may be categorized as follows:

a. Options to prevent the establishment of sources
b. Options to better manage existing sources
c. Options to eliminate existing sources.

Land use controls can be used to prevent new sources of pollution from arising. An activity may be prohibited, or it may be permitted to develop in a controlled manner consistent with environmental objectives.

Good management practices can minimize pollution discharges. For example, in areas of low soil permeability, septic systems may malfunction as a result of septage not being periodically pumped from the tank. Hence an appropriate management policy may be to require pumping according to a formally required procedure. Likewise, wastes from domestic animals on streets and highways may constitute a major source of contamination in storm drainage water. A non-structural option may be to prohibit littering or to require owners of dogs not to allow their dogs to defecate where water pollution might result. Regular sweeping of streets would also limit the amount of pollutants transported in stormwater.

Another management practice that may be particularly relevant to Long Island is to encourage the use of fertilizers and pesticides at levels not exceeding the requirements of cultivation. Thus householders could be encouraged to adopt "low maintenance" methods of cultivating lawns as opposed to growing species of grasses that demand high levels of water and chemicals for their maintenance.

If use of inorganic fertilizers by householders were to be banned outright, the ban would constitute an example of the total elimination of a potential source of contamination. Such bans are difficult to implement. However, Suffolk County's recent prohibition of the sale of non-biodegradable synthetic detergents is an example of a successful management attempt to eliminate an existing pollution source. Likewise the prohibition of chronically toxic and persistent pesticides such as DDT has begun to reduce the levels of these chemicals in the environment. Similarly, certain organic materials should also be controlled. The substitution of less harmful materials in place of such organic chemicals may provide a partial, non-structural solution.

1.4.3.4 Legal/Institutional. Another set of possible management options deals with the formulation of legal and institutional programs. These types of approaches might include:

—strengthening of existing laws or regulations
—enacting new laws or regulations
—restructuring of existing county and town level agencies
—establishment of new agencies
—elimination of existing agencies
—redefinition of responsibilties.

The thrust in these types of management options is to ensure that proper regulatory power exists, that regulation and operation of facilities do not conflict, and an adequate system of monitoring and control is available.

An institutional approach recognizes that improvements can be made in the administration and implementation of water quality management programs. It recognizes the need for improved communication between operating agencies and for a clear definition of responsibilties.

1.5 Summary

Nassau and Suffolk Counties together form a region of about 1,200 square miles, having a total of more than 1,000 miles of ocean and bay shoreline, lakefront and river edge. The area's subsoil is mostly sandy, and groundwater is the sole source of potable water. Precipitation averages 44 inches per year, of which approximately one-half is lost to the atmosphere and to the surface waters by evapo-transpiration and runoff.

Long Island's environment possesses a particular importance, because the area is an important place of resort for vacationers and sportsmen of all kinds. Its waters and marshes abound in shellfish and finfish of many varieties, and its coastline offers esthetic pleasure to many.

The quality of this environment, however, is beginning to suffer from problems due to growth. In areas of more intense development, marine water quality is deteriorating from the discharge of excessive quantities of nutrients. Beaches and shellfishing areas have been closed to the public because of bacterial contamination. In certain locations, heavy pumping of groundwater and the installation of sewers with disposal to marine surface waters have caused a permanent drop in the water table, with the resulting drying up of parts of streams. Groundwater quality, in parts of the Region, has been degraded by pollutants from excessive fertilizer application, the recharge of domestic and industrial wastes, landfill leachate and stormwater recharge.

The dangers of uncontrolled development have been recognized for a long time, and the Nassau-Suffolk Regional Planning Board issued a Comprehensive Land Use Plan in 1970. Since then, Congress has recognized the need for more detailed studies of water pollution problems in many areas, and, in 1972, passed the Federal Water Pollution Control Act Amendments. Under Section 208 of this act, funds have been made available to study the Region's waste disposal and water supply problems, and to devise a plan for their solution.

The plan will include a combination of many management options, which can be categorized under the following three headings:

a. Structural, *e.g.*, the installation of collection and treatment systems, etc.
b. Non-structural, *e.g.*, passing ordinances for the control of animal wastes, instituting special practices for minimizing runoff at construction sites, carrying out public education programs concerning the correct use of certain materials in agriculture and in the home, and so on.

c. Legal/Institutional, designed to improve the administration and implementation of water quality management programs.

Some of these options will have areawide applicability, others will be determined by the specific needs of each locality. In combination, they will protect the Bi-county Region's esthetic and recreational values, and ensure a healthy and adequate water supply for the foreseeable future.

Section 2 Assessment of Conditions

2.0 Introduction

Current land use patterns in the nearly 1,200 square mile Nassau-Suffolk Region have been influenced by the counties' geographic location within the New York Metropolitan Area and by the historic trends that that have affected the development of Long Island during the more than three centuries since the first colonial settlements were established in the east end towns of Southampton and Southold.

The earliest settlements clustered around the harbors since Long Islanders were dependent upon the sea for food and for the transport of farm products and wood to the New York City market. The construction of the railroad during the second quarter of the nineteenth century provided impetus for the expansion of farming and for the establishment of new settlements along its route. Decades later, vacationers, increasingly aware of the recreation resources of the Atlantic and Long Island Sound shores, began to come by train or boat to the older villages and to the new resort developments that preempted attractive and accessible shoreline sites in such places as Long Beach, Massapequa, Sea Cliff, Glen Cove, Cold Spring Harbor and Huntington. Soon suburban enclaves appeared in still semi-rural western Nassau County as hardy commuters took up residence in proximity to the railroad stations. Completion of an East River tunnel in the early twentieth century speeded rail travel between Manhattan and Long Island and further spurred development of the communities along the North Shore, main line and South Shore branches of the railroad throughout Nassau and into western Suffolk. Before World War I, and especially during the 1920's, wealthy people purchased large tracts of land and built the mansions, gardens and private clubs that gave rise to the characterization of the North Shore area from Great Neck to Huntington as the "Gold Coast." Others established similarly luxurious weekend or vacation retreats in scattered locations along the South Shore or built summer "cottages" in the seasonal "Gold Coast" colonies in the Hamptons. The less affluent acquired small parcels and built cabins or tiny cottages in the presumably healthful wooded areas around Lake Ronkonkoma and along the moraine or in such shorefront communities as Bayville, San Remo, Babylon, Lindenhurst and Mastic Beach

As early as the mid 1920's, increased mobility provided by the automobile permitted the expansion of older settlements. However, the Great Depression and, shortly thereafter, World War II brought new construction to a virtual standstill and set the stage for the explosive growth that was to follow the end of hostilities.

Commencing in the late 1940's, new household formations and a backlog of unsatisfied housing needs generated previously unknown levels of construction activity, first in central and eastern Nassau, then in western Suffolk. Increased population brought a need for vastly expanded services and provided a skilled labor force for Long Island's growing defense and high technology industries. Farms and woodlands, older homes and estates gave way to the schools and universities, the offices, stores and shopping centers that accompanied the eastward spread of residential development.

By 1975 growth had just about halted in Nassau and had slowed markedly in western Suffolk. According to the most recent estimates, less than two percent of the land area of Nassau and about 30% of the land area of Suffolk remains vacant. Approximately 95 percent of the vacant land in Suffolk is in Brookhaven and the five eastern towns. The Census Bureau's line indicating the eastern limit of the urbanized area was located in central Brookhaven in 1970, but has now been redrawn to include Long Island's most rapidly developing areas in central and eastern Brookhaven.

2.1 Land Use in the 208 Planning Region

2.1.1 Summary of Existing Land Use Patterns

2.1.1.1 General. The information on existing land use, which has been furnished to the 208 consultants in considerable area-specific detail, was obtained by updating older land use maps through the use of aerial photography, office records and, where necessary, field checks. Computerized tabulations of land use on a 1440 acre grid cell basis are available at the Planning Board. Table 2–1 presents a summary of the land use data, as of 1975.

More than three-fourths of the land area in the 208 Planning Region is built up or otherwise committed, with 44.5 percent in residential and 31.7 percent in non-residential uses. The latter category includes agricultural uses, which occupy about 5.8 percent of the bi-county acreage. Virtually all of the agricultural lands are located in Suffolk County, which has undertaken a multi-million dollar program to preserve at least two-thirds of the existing farmland through the purchase of development rights.

There is little, if any, opportunity to affect water quality or the need for sewer construction through changes in proposed land uses in Nassau

Table 2–1

THE NASSAU-SUFFOLK 208 AREA: PERCENTAGE OF LAND AREA IN VARIOUS USES, BY TOWN AND COUNTY, 1975

	RESIDENTIAL					NON-RESIDENTIAL							
Locality	High Density	5–10/D.U. per acre	2–4/D.U. per acre	0–1/D.U. per acre & Low Density	Total Residential	Industry	Commerce	Utility and Landfill	Agriculture	Institutional & Open Space	Total Non-Residential	Vacant	Total Land Area
Nassau													
N. Hempstead	4.6	20.5	19.5	25.5	70.1	2.6	6.3	0.3	–	17.8	27.0	2.9	32,828
Hempstead	4.1	56.1	1.0	1.0	62.2	0.9	6.7	0.4	–	28.4	36.4	1.4	77,413
Oyster Bay	1.4	19.5	14.4	30.4	65.7	2.8	3.9	0.4	–	25.4	32.5	1.8	69,275
County Total	**3.1**	**35.5**	**9.6**	**16.8**	**65.0**	**1.9**	**5.6**	**0.4**	**–**	**25.3**	**33.2**	**1.8**	**179,516**
Suffolk													
Huntington	0.3	7.0	21.8	42.5	71.6	1.2	3.3	0.7	–	17.7	22.9	5.5	59,227
Babylon	3.2	38.4	9.1	–	50.7	5.8	3.6	2.3	–	33.5	45.2	4.1	32,886
Smithtown	0.6	3.6	37.8	22.3	64.3	3.3	3.4	0.3	–	23.3	30.3	5.4	34,160
Islip	1.6	17.9	33.9	6.3	59.7	2.4	2.7	2.9	–	28.6	36.6	3.7	63,909
Brookhaven	0.8	2.7	26.6	11.4	41.5	0.9	1.4	2.1	1.8	18.3	24.5	34.0	163,366
Riverhead	0.3	0.5	4.2	5.6	10.6	0.3	1.0	12.4	45.7	12.8	72.2	17.2	41,462
Southampton	0.2	1.1	6.0	7.7	15.0	0.1	0.9	2.1	12.6	9.0	24.7	60.2	87,100
Southold	0.1	0.8	7.0	6.1	14.0	0.2	0.8	0.1	30.0	9.1	40.1	45.8	30,191
Shelter Island	–	0.9	3.5	5.7	10.1	–	0.8	0.3	0.4	4.3	5.7	84.1	7,603
East Hampton	–	0.3	8.0	4.7	13.0	0.2	0.5	1.8	3.4	17.0	22.9	64.1	46,416
County Total	**0.7**	**6.3**	**18.9**	**12.2**	**38.1**	**1.3**	**1.8**	**2.5**	**7.7**	**18.0**	**31.2**	**30.7**	**566,320**
The Nassau-Suffolk 208 Area	**1.3**	**13.3**	**16.6**	**13.3**	**44.5**	**1.4**	**2.7**	**2.0**	**5.8**	**19.7**	**31.7**	**23.8**	**745,836**

(Percentages may not total 100.0 due to rounding)

Source: Section C of the Areawide Waste Treatment Management Plan.

County. The townwide figures suggest a similar lack of opportunity in the western Suffolk towns of Huntington, Babylon, Smithtown and Islip. The remaining Suffolk towns, sensitive to real or assumed water supply problems and to other "quality of life" issues, have already moved to impose limits on growth through changes in zoning.

2.1.1.2 Residential Land Use. Gross residential densities generally decrease from west to east, with the highest densities in the Town of Hempstead and particularly in older Nassau communities such as the City of Long Beach and the Village of Hempstead. The next highest densities are found in portions of North Hempstead, southern Oyster Bay and southwestern Suffolk. Lower densities are found in much of northern Oyster Bay, Huntington, Smithtown and most of Brookhaven. The lowest densities are found in the remaining estate areas in northern Oyster Bay, in the extreme eastern part of Brookhaven and in the five east end towns of Riverhead, Southampton, East Hampton, Shelter Island and Southold. Residential densities vary greatly within relatively short distances, tending to be higher in the older harbor-related or rail-related communities, even in eastern Suffolk. According to the 1970 census, densities ranged from a high of 22.8 persons per acre in the City of Long Beach to 0.2 persons per acre in the Town of Shelter Island.

Most of the bi-county population resides in single family detached structures on plots of from 1/10 of an acre to several acres or more. The 1970 census revealed that 84.0 percent of the Region's inhabitants lived in single family dwellings, 15.7 percent in multi-family units and 0.3 percent in mobile homes. The percentage of the population residing in single family units was somewhat higher in Suffolk, while the percentage in multi-family units was somewhat higher in Nassau Mobile home dwellers were virtually non-existent in Nassau and were of local rather than county-wide significance in Suffolk.

Land use studies distinguish five categories of residential use. The first or most intensive category high density, includes all development at more than ten housing units per acre. In Nassau, the typical high density development averages about 25 housing units to the acre; in Suffolk, about fifteen. Highest densities were found in high rise apartment areas in Long Beach and Hempstead Village, where they reach 200 and 100 housing units per acre, respectively

The second category, five to ten housing units per acre, is essentially a single family detached or two family category although it occasionally includes apartments in some of the Nassau communities and a few recreation-related or senior citizen condominiums. Areas in the five to ten housing units per acre category account for well over half of the residential acreage in Nassau, and slightly less than one-sixth of that in Suffolk.

The third category, two to four housing units per acre, like the zero to one and the low density (estate or rural) categories, is a single family dwelling category. It is a predominant category in Suffolk where it accounts for almost half of the residential acreage. Much of the newer housing in this category has been built at two units to the acre. In many areas, sewers have already been provided through connections to existing systems or through the construction of a small collection system and treatment plant to serve a single large development or group of developments. In other areas sewers are needed at present or may eventually be required. There appear to be some locations where individual systems are functioning and may continue to function well enough to meet relevant public health criteria. In areas of low density, individual systems can be constructed so that regional groundwater quality will meet drinking water standards.

The zero to one housing unit per acre category and the low density category account for slightly more than one-fourth of all residential acreage in Nassau and slightly less than one-third of all residential acreage in Suffolk.

2.1.1.3 Non-Residential Land Use. The original tabulations, which were furnished to the consultants, listed eight non-residential land use categories: industrial, commercial, institutional, utility, open space, landfill, agriculture and duck farm. For purposes of the summary table, the acreage reported for landfills has been combined with that reported for utilities. The utilities category includes power plants, waste treatment and water supply facilities, radio and TV transmission sites and transportation facilities. The acreage reported for duck farms has been combined with that for all other agricultural uses; the acreage reported for institutional uses has been combined with that for open space uses. The latter category includes acreage for parks, conservation areas, private clubs or other recreation facilities, and cemeteries.

Industrial uses occupy only 1.4 percent of the land area in the Region; 1.9 percent of the land area in Nassau and 1.3 percent of the land area in Suffolk. Although some manufacturing operations are located in older mixed use areas, increasing numbers of them are concentrated in industrial parks or strip developments, close to the Long Island Expressway, or along several of the major north-south highways.

Commercial uses, among them retail and service establishments, offices, restaurants, marinas and warehouses, occupy nearly twice the area occupied by industrial uses in the Region as a whole; three and one-half times the area occupied by industrial uses in Suffolk. Commercial uses are found in a variety of locations—in older downtowns, in strip and mixed use roadside developments, and in neighborhood, community and regional shopping centers. The Garden City—Hempstead Village—Roosevelt Field area encompasses the greatest single concentration of commercial activity in Nassau County. Smaller concentrations are located along Northern Boulevard from Manhasset to Roslyn; along Sunrise Highway, east to Patchogue; and along Route 110 from the Walt Whitman Shopping Center south to the Long Island Expressway.

Utilities and landfills account for 2.0 percent of the acreage in the 208 area; 0.4 percent of the acreage in Nassau and 2.5 percent of that in Suffolk. Nearly all of the power plants and major sewage treatment facilities are located on shorefront sites in both counties, while water supply, communication and transportation facilities, and landfills are usually located on inland

parcels. Although most uses in this category are unevenly distributed throughout the Bi-county Region, there is at least one landfill in each of the thirteen towns. The larger land users in the utilities category, the communications transmission sites and the airports, are all located in Suffolk, which listed more than twenty times the Nassau acreage in this category.

Agricultural land use represents a shrinking, but nonetheless important, category in Suffolk County and in the Region. It accounts for 5.8 percent of the land area in the Region and 7.7 percent in Suffolk County. The few remaining agricultural enterprises in northeastern Nassau County are generally small scattered operations specializing in nursery crops or produce for local sale and consumption. Estimation techniques preclude separate identification of such uses.

Ninety percent of the farm acreage in Suffolk is located in three towns: Riverhead, Southold and Southampton. The major upland crops are potatoes, cauliflower, sod and nursery stock. Ducks are raised at waterfront locations in Brookhaven, Riverhead and Southampton.

The last non-residential category comprises two major groups of land uses: institutional uses and open space. The institutional uses include churches, schools, hospitals, governmental buildings and other public or quasi-public establishments. The open space uses include parks, parkways, preserves, private recreational facilties, and cemeteries. The combined institutional-open space category accounts for almost one-fifth of the land area in the Region as a whole; a somewhat higher proportion of that in Nassau and a somewhat lower proportion of that in Suffolk. Institutional uses occupy about one-fourth of the acreage in this category. Small institutional uses are dispersed throughout the two county area. Major educational facilities, many of them located on former estates, occupy large sites in northern Oyster Bay and northwest Brookhaven, while a research facility, the Brookhaven National Laboratory, and a nuclear generating plant, now under construction, occupy some areas in northeastern Brookhaven. New York State is gradually phasing out operations at three sizeable Department of Mental Hygiene hospitals in Suffolk: Kings Park, in Smithtown; and Pilgrim and Central Islip, in Islip. Some land has already been sold off or transferred to local government for other uses, and it is expected that eventually New York State will part with most or all of the remaining acreage.

Open space uses occupy about three-fourths of the acreage in the combined institutional-open space category. Although the greater part of the open space acreage is in Suffolk County, the more intensively used recreation areas are in Nassau County. For the most part, the larger Nassau sites are at inland locations; the larger Suffolk sites are on the shore or in stream corridors. In both counties public and private efforts to preserve wetlands and stream valleys have resulted in the commitment of extensive acreage to conservation and other open space use. (See Figure 2–1 in the Map Section.)

2.1.2 Projected Land Use Patterns. The Nassau-Suffolk Comprehensive Plan sets forth priorities for rational social and economic development of Long Island that are compatible with the existing natural environment. The Plan, which was originally completed in 1970, was amended, in part, during 1976 and 1977. The revisions reflect new environmental knowledge and concern. The 1976 and 1977 amendments affected the watershed of the Peconic River, eastern Great South Bay, and Moriches Bay. These are indicated in the 1995 Revised Land Use Plan. It is anticipated that further revisions will be made as increased knowledge and changed conditions dictate. The Plan is a regional one that relates the amount of land that is zoned for categories such as industry, housing and commerce to the amount of land that will be needed for these purposes. The primary goal of the Nassau-Suffolk Comprehensive Plan is to develop a series of corridors, clusters and centers throughout the Bi-county Region. The most valuable recreation land is at the waterfront, and the best location for housing is adjacent to this recreation land. The most logical location for industry and other development is along the central spine of the Island, which would put it in proximity to the major transportation facilities. The use of the corridor concept means that the highest intensity uses would be equidistant from the North and South Shores. The development of high intensity uses in this central corridor would minimize the need for such uses in coastal areas, thus affording some protection to the sensitive shore edge in Nassau and Suffolk Counties. The recommendations for industry include a stipulation that the use of accessible sites along major highways and railroads be reserved to meet the needs of both counties. The corridors along the shorefront would be primarily reserved for water related recreation and low density residential development and, on the eastern forks, for agriculture and fishing. The Plan makes a number of recommendations relating to residential densities. It provides for the lowest density along the shore, with an increase towards the central transportation corridor.

Land for parks and conservation has been accorded a first priority in the Regional Plan. There are many sites that must be preserved in order to provide adequate recreational opportunities for existing and future residents, or to protect the environmental resources from the degradation that could result from improper development.

The Plan recommends the use of clustering techniques, a most effective tool for open space preservation at minimal cost to the community. Clustering allows for the construction of a mix of town houses, apartments and single family detached houses, while maintaining the permitted density for the development as a whole. Through the use of clustering adjoining developments, extensive open space systems can be developed, thus retaining land that is best left in an undeveloped state. This land is valuable for watershed protection and preservation of sites of particular scenic beauty or ecological significance. It also provides sites for certain recreational uses. The clustering technique also allows a reduction in utility costs such as those for water lines and sewers, and a reduction in other public expenditures for road construction and maintenance.

The Plan recommendation for centers is a combination of preservation

and more intelligent use of developable land. There are proposals for new centers to be located only in the portions of the Island that are presently undeveloped and where it is not possible to expand existing small concentrations of non-residential uses. A significant part of the new economic activity should be concentrated in older central business districts that have extensive community facilities but are losing population and importance in their section of the Region. Other locations should be extensions of small business districts that have a nucleus of community services.

The Plan accords a high priority to land for apartments, since changing age patterns and family structure indicate a demand for this type of housing. It is recommended that many of the new apartments be located in older business districts where rebuilding and increased densities would stimulate revitalization, encourage greater use of mass transit and utilize existing services.

The Plan proposes to locate as much new commercial and office space as possible in the existing central business districts. Location of new business activity in the older downtowns would permit the use of existing infrastructure and would reduce some of the pressure on the remaining vacant land.

The 1995 Plan envisions a Region in which more than three-fifths of the acreage is used for residential purposes and less than two-fifths for non-residential purposes, including farming. It is assumed that, by 1995, all of Nassau-Suffolk will have been committed to one or another land use, and that there will be no vacant land. Such an assumption does not preclude further development, which may occur through the sub-division of large estates or non-residential holdings, through in-filling in established residential and commercial areas, and through clearing and redevelopment of older areas. Table 2–2 presents a summary of the proposed 1995 land uses.

Implementation of the Plan as revised will result in an increase in residential land use of slightly more than two percent in Nassau and of more than 59 percent in Suffolk, and an increase in non-residential land use of just over one percent in Nassau and of 26 percent in Suffolk.

In Nassau, almost all of the increase in residential acreage will be in the ten dwelling units or more per acre category, while in Suffolk, approximately two-thirds of the increase will be in the less than one housing unit per acre category and the low density category, and over one-fourth will be in the two to four housing units per acre category.

Of the very small increase in acreage devoted to non-residential uses in Nassau, about three-fifths will be in industrial, one-fifth in institutional and open space, and one-fifth in commercial uses. Of the much larger increase in non-residential acreage in Suffolk, just over four-fifths will be in institutional and open space, about three-twentieths in commercial, and less than one-twentieth in industrial uses. The number of acres in agricultural use will decline, but will still account for more than six percent of the total in Suffolk County and somewhat more than 37 percent and 25 percent of the total in Towns of Riverhead and Southampton respectively. (See Figure 2–2 in the Map Section.)

2.2 Pollutant Sources

2.2.1 Point Sources. Point sources include all discharges from domestic wastewater treatment plants and from those industries which do not discharge to a municipal system but operate their own treatment facility. The land, the ocean, and the intervening bays all receive waste discharges directly from point sources. Table 2–3 indicates the quantities of industrial and domestic wastes being discharged in Nassau and Suffolk Counties. Although the numbers of industrial and domestic plants are similar, domestic flows exceed industrial by a factor of 40.[1]

The major pattern of discharge differs markedly between Nassau and Suffolk. Nassau, being the more heavily sewered, and having all major treatment plants located near the shore, discharges 98 percent of its treated wastewaters to the surface water. Suffolk, however, discharges approximately the same amount to the land as to the bays. The quantity of wastes being treated also differs significantly, with Nassau treating a total of about 107 MGD compared to Suffolk's 16 MGD. It should be noted that operations of the Southwest District Sewage Treatment Plant are scheduled to commence in 1978. It is anticipated that flow from this plant will add 30 MGD to the Suffolk County surface water discharges by 1986.

Although greatly outweighed by domestic volumes, industrial wastes have created significant localized degradation, especially to the groundwater resource. Recent well pumping cutbacks in both Nassau and Suffolk have been related to organic industrial discharges (*e.g.*, halogenated hydrocarbons). Leachate from landfills, septic system cleaners and other home products have also been cited as possible sources of contamination. The lack of historical data on trace organic chemicals makes quantification of this problem extremely difficult.

Pollutants from point sources include oxygen-demanding substances (BOD, COD), micro-organisms, heavy metals, organics, suspended solids and nutrients. For discharges to groundwater, nitrogen compounds and organic chemicals receive the most attention, although localized problems may exist with any of the contaminants listed. Modeling and other studies of the reaction of the ground and surface water to these pollutants have indicated that, for discharges to bays, nitrogen and bacteriological parameters are of primary importance Analysis of marine water quality has shown that contravention of the dissolved oxygen standard is generally caused by the respiration of excess algae. The most feasible means of reducing dissolved oxygen standards contravention is to limit algal production through limitation of the nutrient element, nitrogen. Nitrogen is thus a key water quality parameter which is common to both groundwater and surface water and therefore is selected as a pollutant indicator.

The designation of nitrogen as the prime water quality indicator under consideration in this study is based upon the following:

1. The presence of nitrogen in all its forms, but particularly as nitrate, in both ground and marine waters correlates directly with the level of man's activities within the affected areas.

Table 2–2

THE NASSAU-SUFFOLK 208 AREA: PERCENTAGE OF LAND AREA IN VARIOUS USES, BY TOWN AND COUNTY, 1995

	RESIDENTIAL					NON-RESIDENTIAL							
Locality	High Density	5–10/D.U. per acre	2–4/D.U. per acre	0–1/D.U. per acre & Low Density	Total Residential	Industry	Commerce	Utility and Landfill	Agriculture	Institutional & Open Space	Total Non-Residential	Vacant	Total Land Area
Nassau													
N. Hempstead	6.0	20.9	19.5	25.5	71.9	2.7	6.9	0.1	–	18.4	28.1	–	32,828
Hempstead	5.5	55.9	1.0	1.1	63.5	1.1	6.8	0.3	–	28.3	36.5	–	77,413
Oyster Bay	2.6	19.7	14.4	30.4	67.1	3.1	4.0	0.3	–	25.5	32.9	–	69,275
County Total	**4.4**	**35.6**	**9.6**	**16.8**	**66.4**	**2.2**	**5.7**	**0.3**	**–**	**25.4**	**33.6**	–	**179,516**
Suffolk													
Huntington	1.6	7.1	21.8	43.4	73.9	3.9	3.6	0.5	–	18.1	26.1	–	59,227
Babylon	5.3	38.0	9.0	–	52.3	6.9	3.6	2.1	–	35.1	47.7	–	32,886
Smithtown	1.3	4.3	39.1	22.3	67.0	5.3	3.4	–	–	24.3	33.0	–	34,160
Islip	2.3	18.4	34.2	6.6	61.5	3.5	2.8	3.0	–	29.2	38.5	–	63,909
Brookhaven	1.8	5.1	36.7	23.4	67.0	3.1	1.9	1.5	0.5	26.0	33.0	–	163,367
Riverhead	0.7	1.0	9.3	13.0	24.0	1.5	1.5	12.3	37.3	23.4	76.0	–	41,462
Southampton	0.4	2.0	14.0	44.1	60.5	0.8	1.7	2.5	12.1	22.4	39.5	–	87,100
Southold	0.6	1.0	20.0	27.8	48.4	0.4	1.6	2.0	24.6	22.0	50.6	–	30,191
Shelter Island	–	1.2	8.1	52.0	61.3	–	1.5	0.1	0.4	36.7	38.7	–	7,603
East Hampton	0.1	0.3	15.0	46.3	61.7	0.6	1.4	1.6	3.4	31.3	38.3	–	46,416
County Total	**1.5**	**7.2**	**24.9**	**27.1**	**60.7**	**2.7**	**2.2**	**2.5**	**6.3**	**25.6**	**39.3**	–	**566,321**
The Nassau-Suffolk 208 Area	**2.2**	**14.0**	**21.2**	**24.6**	**62.0**	**2.6**	**3.1**	**2.0**	**4.8**	**25.5**	**38.0**	–	**745,837**

Source: Section C of the Areawide Waste Treatment Management Plan

2. A numerical standard not to exceed ten milligrams per liter as nitrate nitrogen must be met for all drinking waters supplied to the consumer
3. As noted above, the presence of excess nitrogen in the marine receiving waters is a cause of eutrophication and attendant contraventions of the dissolved oxygen standard.
4. The determination of nitrogen is an accurate and fairly rapid and straightforward analytical procedure.
5. A great deal of historical data exists relative to nitrogen concentrations in both ground and surface waters which can be used to assess trends.

The choice of this parameter, however, does not preclude the consideration of other contaminants, such as organic chemicals and bacteria, in the selection of wastewater management alternatives. This is more clearly exhibited in the following sections.

The distribution of point discharges is illustrated in Table 2–4. The bays of Nassau County currently receive the greatest amount of treated waste discharge, the highest being Hempstead Bay (Reynolds Channel). Suffolk County bays receive relatively little discharge, the highest quantities currently being discharged to Port Jefferson Harbor and Huntington Bay

Waste treatment plants generate sludge. Currently, Nassau County disposes of approximately 90 million gallons of sludge per year, predominantly

Table 2–3

TOTAL POINT SOURCES--FLOW SUMMARY (JANUARY, 1976)

		Discharge in MGD		
	No. of Plants	To Groundwater	To Surface Water	Total
Nassau	Domestic 23	1.21	104.42	105.63
	Industrial 20	0.79	0.41	1.20
Suffolk	Domestic 101	7.39	6.87	14.26
	Industrial 86	1.20	0.87	2.07

Source: Section C of the Areawide Waste Treatment Management Plan

Table 2–4

DOMESTIC WASTEWATER TREATMENT PLANT DISCHARGES TO BAYS*, 1976

Water Body	County	Flows (MGD)	Total Nitrogen Lbs/day	Total Coliform 10^{10} Organisms/day
Manhasset Bay	Nassau	7.18	1,600	93
Hempstead Harbor	Nassau	6.41	3,000	140
Oyster Bay	Nassau	1.90	390	9.1
Huntington Bay	Suffolk	2.03	360	16
Port Jefferson Harbor	Suffolk	1.44	160	6
Flanders Bay	Suffolk	1.82	840	2.8
East Great South Bay	Suffolk	0.47	130	10
West Great South Bay	Suffolk	0.06	10	<0.001
South Oyster Bay	Nassau	0.0	0	0
East Bay	Nassau	0.18	40	33
Middle Bay	Nassau	4.2	860	130
Hempstead Bay	Nassau	72.45	16,000	4,300
Little Neck Bay	Nassau	1.59	240	3
Total		99.73		

*These loadings do not include BOD or suspended solids, since these parameters are not a major concern of the 208 Program. They do not, in general, cause significant water quality problems. Nitrogen and coliforms, on the other hand, impact substantially on water quality in all the bays.

Source: Section C of the Areawide Waste Treatment Mangement Plan.

by barging to the Atlantic Ocean. Suffolk County treatment plants produce approximately twenty million gallons of sludge per year, disposed of almost entirely in landfills.

In the context of 208, landfills can be considered as either point sources or non-point sources. In the Bi-county Region, there are a total of 40 major operating and abandoned land disposal sites. The liquid waste generated at landfills is termed "leachate" and is formed by the interaction of rainfall with the buried wastes. Leachate constituents may include organics, heavy metals, nitrogen, chloride, iron and microorganisms. The volume of waste can be significant. Theoretically, given average Long Island rainfall and typical geologic conditions, 100 acres of landfill could generate 40 million gallons of leachate per year.

2.2.2 Non-Point Sources. Non-point sources of pollution are a major water quality management problem in the Nassau-Suffolk area. The sources are both wet-weather related as well as continuous. The pollutant loads are discharged to surface water bodies and to the ground. Non-point discharges have been found to contain a variety of pollutant parameters, ranging from relatively innocuous grit to complex organic compounds in trace (microgram/liter) concentrations, with organics of different formulations contained in the sources listed below.

The pollutant parameters of major concern in non-point sources of pollution are basically the same as those found in point sources: various forms of nitrogen, organic chemicals, coliform bacteria and heavy metals. There is, however, a basic difference in the patterns of occurrence for the two types of sources--pollutant loadings from non-point sources show greater variation over time than those from point sources. This makes accurate quantification difficult and control approaches most costly.

The 208 Program has identified the following non-point sources of pollution as contributing major pollutant loadings to the ground and surface waters of the study area:

1. Stormwater runoff from highways, medium and high density residential areas and commercial/industrial areas. The major contaminants in the runoff from these areas are coliform bacteria, organic chemicals, sediment, heavy metals and nitrogen. The loadings are discharged to surface waters and to the ground.[2]
2. Cesspools and septic systems. Contaminants from properly functioning systems include nitrogen and, to a lesser degree, organic chemicals. The loadings are almost entirely to the groundwater.[3]
3. Fertilizers and pesticides applied to crops, lawns and landscaping. Over-fertilization appears to occur in residential and recreational areas. The major contaminants from agricultural chemicals are nitrogen and organic compounds. The loadings are both to groundwater and to surface water.[4]
4. Groundwater underflow to marine waters. This can be a major source of nitrogen. (See Table 2–7.)

The literature or departmental experiences have also identified a number of other non-point sources of pollution, which may cause local or temporary water quality problems, but are not as pervasive as the sources described in the previous paragraph. These sources include runoff from construction sites, discharges from boats, runoff from oil storage depots, and sand and gravel mining sites, exfiltration from sewers, and leakage from product pipelines. Although these sources are not as regionally important as the four major sources listed in the previous paragraph, they can cause significant local water quality problems.[5]

Sub-surface oil and gasoline storage tanks constitute an additional non-point source that has an impact on groundwater quality The 208 Program has not been able to quantify the potential contamination from this source but has recognized that it could be substantial. Detailed studies and monitoring/regulatory programs for this non-point source should be continued and expanded.

Table 2–5 summarizes non-point source loadings of key parameters discharged to surface water bodies and Table 2–6 presents corresponding information for discharges to groundwater. The magnitude of the numbers, when compared to the point source loadings of the previous section, testifies to the severity of the non-point source problem. Areas contributing surface runoff directly to streams and salt water bodies are displayed in Figure 2–3.

Because of the magnitude of the loadings and the potential serious impacts on bay water quality, major efforts were made in the 208 Program to define the wet-weather loads to the bays. Studies of pollutant generation were conducted in a limited number of areas selected as representative of land uses or combinations of land uses found on Long Island. Data from

Table 2–5

ESTIMATED STORMWATER RUNOFF LOADINGS TO LONG ISLAND BAYS, 1976

Receiving Water Body	County	Total Nitrogen (Lbs/day)	Total Coliform 10^{12} Organisms/day
Manhasset Bay	Nassau	170	58
Hempstead Harbor	Nassau	220	74
Oyster Bay	Nassau	290	130
Huntington Bay	Suffolk	370	150
Port Jefferson Harbor	Suffolk	200	58
Flanders Bay	Suffolk	30	5
East Great South Bay	Suffolk	670	190
West Great South Bay	Suffolk	440	120
South Oyster Bay	Nassau	270	69
East Bay	Nassau	220	57
Middle Bay	Nassau	330	88
Hempstead Bay	Nassau	90	25

Source: Section L of the Areawide Waste Treatment Management Plan.

Table 2–6

ESTIMATED STORMWATER RUNOFF LOADINGS TO RECHARGE FACILITIES
(Based on 1975 land use data and sampling data)

		Pounds/day		
County	Drainage Basin	Total Nitrogen	Lead	Total Chromium
Nassau	N–1	720	75	14
	N–2	710	71	93
	Subtotal	1430	146	107
Suffolk	S–1	840	79	110
	S–2	790	81	81
	S–3A	610	58	43
	S–3B	30	3	6
	S–11B	170	19	118
	S–12C	10	1	1
	S–13B	20	1	1
	Subtotal	2470	242	360
	Bi-county Total	3900	388	467

Source: Section L of the Areawide Waste Treatment Management Plan.

these studies was then extrapolated to obtain estimates for the entire SMSA. In Nassau County, which is characterized by extensive urbanization and sewering, point sources contribute the major portion of the pollutant loads of BOD, total nitrogen and total phosphorus. Wet-weather non-point sources contribute the major loadings of suspended solids and fecal and total coliform bacteria, except in Hempstead Bay. In Suffolk County, pollutant loadings are dominated by non-point sources. This is true of all parameters studied for all major surface water bodies except Flanders Bay, which receives an estimated 76 percent of its total nitrogen loading from point sources.

Tables 2–7, 2–8 and 2–9 summarize the total loadings of nitrogen and total and fecal coliforms to the various bays from point and non-point sources.

Along the North Shore of the Bi-county Region, surface runoff patterns conform approximately to the natural contours. Much of the precipitation which falls on developed areas runs off directly to the bays and follows the natural drainage divides. The precipitation which falls on undeveloped land generally infiltrates directly to the groundwater.

Surface runoff patterns along the South Shore are more complex. In general, Sunrise Highway defines the approximate northern limit of direct runoff to the bays. Most of the area north of Sunrise Highway and south of

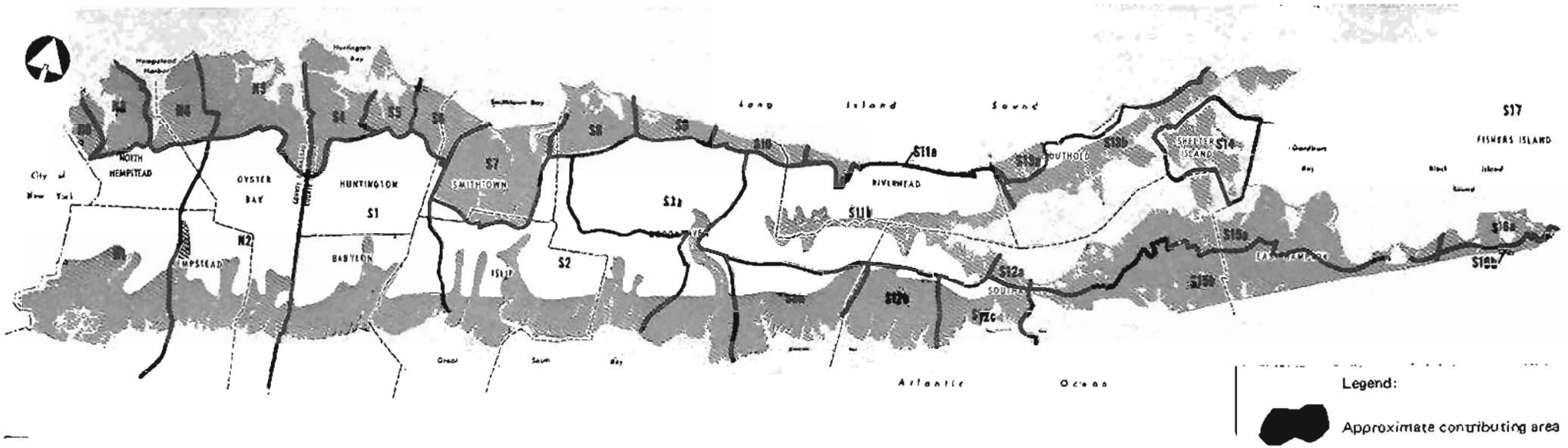


FIGURE 2–3 *Areas Contributing Surface Runoff Directly to Streams and Saltwater Bodies*

the moraine along the Long Island Expressway does not contribute surface runoff directly to the bays except for the drainage basins of certain streams. However, the storm related waste load contributed from these areas may be significant. The extent of these drainage basins was estimated in the course of the 208 Program.

The contribution to the groundwater regime occurs through precipitation infiltrating directly or being collected and recharged through recharge basins. Thus, a very large geographic area contributes substantial pollutant loads directly to the groundwater regime.

2.3 Transport Mechanisms of Potential Pollutants

The hydrologic cycle (precipitation, evapotranspiration, recharge to groundwater and runoff) provides a means of transporting contaminants on Long Island by flowing water. As fresh water flows through and over soil, it dissolves soluble materials. Overland flow suspends particulate matter.

Precipitation is the sole source of fresh water on Long Island. Generally, rainfall is distributed uniformly throughout the year and averages about 44 inches per year. Approximately eighteen inches, or about 40 percent of this annual amount, is returned to the atmosphere. Approximately 22 inches, or 50 percent, recharges to the groundwater by percolating down through the soil, and the remaining five to ten percent runs off. In addition, nearly 400 million gallons are pumped daily from the groundwater aquifer, and much of this also becomes a vehicle for contaminant transport.[6]

The major components of the hydrologic cycle may be represented in a highly simplified mass balance equation:

Recharge (fresh water restored to aquifers) = Precipitation – Runoff – Evapotranspiration – Change in Soil Storage

For the purpose of the 208 Program, the elements of this mass balance were computed for the whole Bi-county Region. The unit of time adopted for the calculations was one month, and the spatial units were defined by the 762 grid cells into which the Region was divided. These cells, each having an area of 2.25 square miles, were specified by a system defined by the Nassau-Suffolk Regional Planning Board (NSRPB) for land use planning purposes.

A brief description of the role of these components in transporting potential contaminants is presented in the following sections.

2.3.1 Precipitation. It can be seen in Figure 2–4 that precipitation averages just under four inches per month, and is quite evenly distributed throughout the year. Furthermore, the spatial distribution is also uniform. Precipitation is important, not only because it generates the flows of water that occur on the Island, but also because it is a direct contributor of pollutants. Residual materials that have become airborne over the northeastern

Table 2–7

COMPARISON OF TOTAL NITROGEN LOADINGS TO LONG ISLAND BAYS, BY SOURCE, 1976*

pounds/day
(percentage of total)

	Groundwater	Dry Weather Streams	Rainfall	Storm Runoff	Point Sources	Total
Manhasset Bay	280	140	110	170	1,600	2,300
	(12)	(6)	(5)	(7)	(70)	
Hempstead Harbor	500	340	120	220	3,000	4,180
	(12)	(8)	(3)	(5)	(72)	
Oyster Bay	790	70	170	290	390	1,710
	(46)	(4)	(10)	(17)	(23)	
Huntington Bay	760	130	200	370	360	1,820
	(42)	(7)	(11)	(21)	(20)	
Port Jefferson Harbor	250	70	110	200	160	790
	(32)	(9)	(14)	(25)	(20)	
Flanders Bay	–	120	120	30	840	1,110
		(11)	(11)	(2)	(76)	
Mecox Bay	150	70	30	60	–	310
	(49)	(21)	(9)	(21)		
Shinnecock Bay	180	40	250	60	–	530
	(33)	(7)	(48)	(12)		
Moriches Bay	700	640	290	190	300	2,120
	(33)	(30)	(14)	(9)	(14)	
Eastern Great South Bay	330	830	1,100	670	130	3,060
	(11)	(27)	(36)	(22)	(4)	
Western Great South Bay	720	1,800	640	440	10	3,610
	(20)	(50)	(18)	(12)	–	
South Oyster Bay	430	840	230	270	0	1,770
	(24)	(48)	(13)	(15)	–	
East Bay	270	630	90	220	40	1,250
	(21)	(52)	(7)	(17)	(3)	
Middle Bay	380	680	90	330	860	2,340
	(16)	(29)	(4)	(14)	(37)	
Hempstead Bay	590	80	80	90	16,000	16,840
	(3)	(1)	(1)	(1)	(94)	

**Loadings do not include nitrogen contributed by Long Island Sound or the Atlantic Ocean. See parts "B" and "D" of the Plan for discussion of estimated loadings.*

Table 2–8

TOTAL COLIFORM LOADINGS TO LONG ISLAND BAYS, 1976*

Organisms (MPN)/day
(percentage of total)

	Dry Weather Streamflow	Storm Runoff	Point Sources	Total
Manhasset Bay	2.4×10^{12}	5.8×10^{13}	9.3×10^{11}	6.1×10^{13}
	(4)	(95)	(1)	
Hempstead Harbor	6.4×10^{12}	7.4×10^{13}	1.4×10^{12}	8.2×10^{13}
	(8)	(90)	(2)	
Oyster Bay	5.6×10^{11}	1.3×10^{14}	9.1×10^{10}	1.3×10^{14}
	–	(99)	–	
Huntington Bay	2.7×10^{12}	1.5×10^{14}	1.6×10^{11}	1.5×10^{14}
	(2)	(98)	–	
Port Jefferson Harbor	1.7×10^{12}	5.8×10^{13}	6.0×10^{10}	6.0×10^{13}
	(93)	(97)	–	
Flanders Bay	1.0×10^{12}	5.1×10^{12}	1.9×10^{12}	8.0×10^{12}
	(13)	(64)	(24)	
Eastern Great South Bay	9.4×10^{12}	1.9×10^{14}	1.0×10^{11}	2.0×10^{14}
	(5)	(95)	–	
Western Great South Bay	2.6×10^{13}	1.2×10^{14}	8.6×10^{6}	1.4×10^{14}
	(18)	(82)	–	
South Oyster Bay	6.0×10^{11}	6.9×10^{13}	0	7.0×10^{13}
	(1)	(99)	–	
East Bay	6.7×10^{11}	5.7×10^{13}	3.3×10^{11}	5.8×10^{13}
	(1)	(98)	(1)	
Middle Bay	9.7×10^{11}	8.8×10^{13}	1.3×10^{12}	9.0×10^{13}
	(1)	(97)	(2)	
Hempstead Bay	1.5×10^{12}	2.5×10^{13}	4.3×10^{13}	6.9×10^{13}
	(2)	(36)	(62)	

**Loadings do not include coliform organisms transported to the bay from Long Island Sound or the Atlantic Ocean. See parts "B" and "D" of the Plan for discussion of estimated loadings. Total coliform loading estimates have not been made for Moriches, Shinnecock and Mecox Bays.*

portion of the United States are returned to earth in the precipitation. For example, the average concentrations of nitrogen in rainfall vary from about 1.0 milligrams per liter in Nassau County to 0.5 milligrams per liter in eastern Suffolk.[7] Thus precipitation deposits over 3000 tons of nitrogen on the two counties every year. This deposition is a significant source of the nutrient.

Table 2–9

FECAL COLIFORM LOADINGS TO LONG ISLAND BAYS, 1976*

Organisms (MPN)/day
(percentage of total)

	Dry Weather Streamflow	Storm Runoff	Point Sources	Total
Manhasset Bay	1.1×10^{11} (0.5)	2.1×10^{13} (99.5)	2.5×10^{9} (–)	2.1×10^{13}
Hempstead Harbor	3.3×10^{11} (1)	2.6×10^{13} (99)	4.1×10^{9} (–)	2.6×10^{13}
Oyster Bay	9.2×10^{10} (–)	6.6×10^{13} (99)	2.9×10^{8} (–)	6.6×10^{13}
Huntington Bay	2.5×10^{12} (4)	6.2×10^{13} (96)	0.3×10^{9} (–)	6.5×10^{13}
Port Jefferson Harbor	5.7×10^{11} (3)	1.6×10^{13} (97)	2×10^{10} (–)	1.7×10^{13}
Flanders Bay	1.0×10^{12} (14)	4.4×10^{12} (63)	1.6×10^{12} (23)	7.0×10^{12}
Eastern Great South Bay	2.9×10^{12} (5)	5.7×10^{13} (95)	1.6×10^{10} (–)	6.0×10^{13}
Western Great South Bay	8.2×10^{12} (27)	2.2×10^{13} (73)	8.6×10^{6} (–)	3.0×10^{13}
South Oyster Bay	5.7×10^{10} (1)	1.1×10^{13} (99)	0 (–)	1.1×10^{13}
East Bay	2.7×10^{11} (19)	0.9×10^{12} (63)	2.6×10^{11} (18)	1.4×10^{12}
Middle Bay	2.0×10^{11} (1)	1.6×10^{13} (97)	2.5×10^{11} (2)	1.6×10^{13}
Hempstead Bay	8.7×10^{9} (–)	4.5×10^{12} (85)	7.6×10^{11} (14)	5.3×10^{12}

**Loadings do not include coliform organisms transported to the bay from Long Island Sound or the Atlantic Ocean. See parts "B" and "D" of the Plan for discussion of estimated loadings. Total coliform loading estimates have not been made for Moriches, Shinnecock and Mecox Bays.*

2.3.2 Evapotranspiration. Figure 2–4 shows that evapotranspiration is markedly seasonal, being close to zero during winter months and almost equal to total precipitation during the summer. Evapotranspiration therefore indirectly affects the transport of contaminants, since it can reduce runoff and groundwater recharge to insignificant levels during much of the summer period. It can also affect contaminant transport directly because co-evaporation distillation of contaminants may occur in conjunction with evapotranspiration. For example, a class of pesticides, which includes DDT, is very immobile in soil. Yet quantities of these pesticides have been found in marine environments. It is believed that the primary mode of transport is co-distillation of the pesticides with water from the soil.[8]

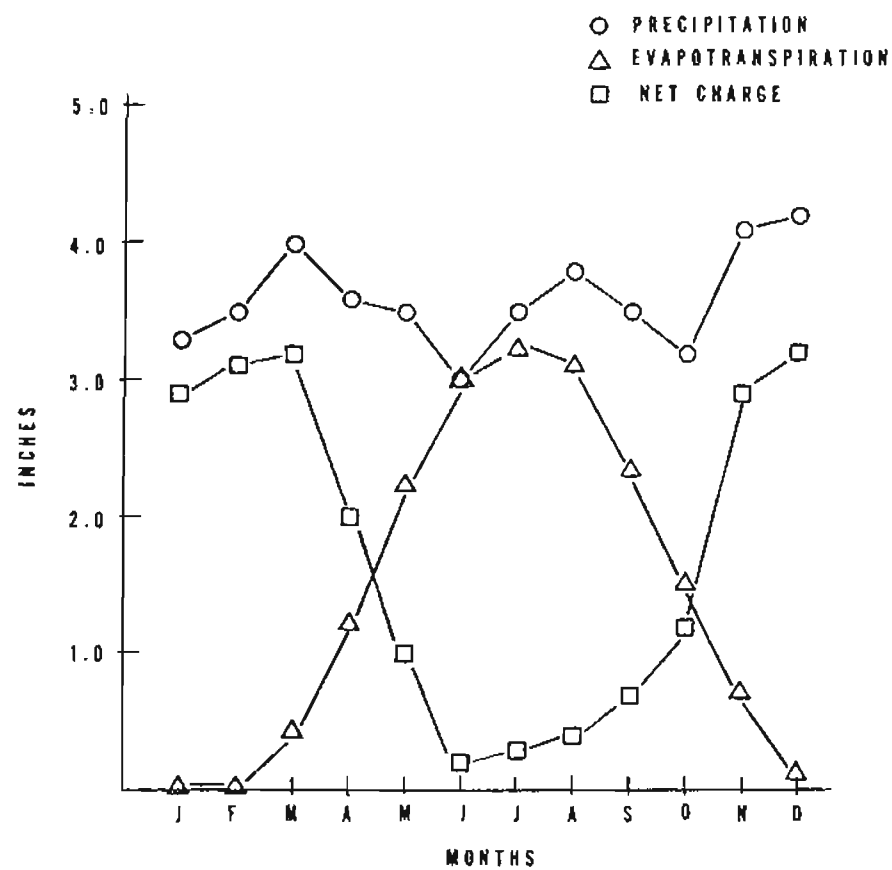


FIGURE 2–4 *Average Values for Hydrologic Components*

It may also be noted that urbanization, with its associated impervious areas (highways, rooftops and parking areas) effectively decreases evapotranspiration and augments runoff. On Long Island, much of this runoff is collected and allowed to percolate through the soil in excavated basins. Localities containing highly developed areas and recharge basins can thus provide greater quantities of groundwater recharge than rural and agricultural areas. However, the quality of water recharged in urban areas is substantially lower than rural recharge areas.

2.3.3 Recharge. Recharge water, prior to its passage through the soil, may be contaminated in many ways. Contaminants in the original precipitation and materials on the land surface, such as animal wastes or organic chemicals on highways, may affect the quality of the water before it begins to percolate through the soil. There is, in addition, a major source of contamination within the soil: cesspools and leaching fields are used for human waste disposal by 40 percent of the population of Nassau and 80 percent of the population of Suffolk.

Soil can, to a limited extent, remove organic pollutants, heavy metals and microorganisms, such as bacteria and viruses, from the groundwater by processes such as filtration, adsorption, precipitation and ion exchange. However, highly soluble salts, such as chlorides and nitrates, will generally not be removed Potential for desorption is an additional complication.

Thus groundwaters underlying Long Island's soils have acquired increasing amounts of inorganic materials as the Region has become urbanized. As shown in Table 2–10A, the estimated annual load of nitrogen carried down to groundwater by regional recharge is over 16,000 tons. This nitrogen is primarily in the nitrate form, and about 30 percent of it originates from human waste being discharged to groundwater. The 16,000 tons which appears in the groundwater is only about 50 percent of the original load. Runoff accounts for very little of the difference and it is believed that denitrification in the soil is a major factor. A very large portion of the nitrogen input to the Long Island system is believed to escape to the atmosphere in the gaseous form.[8]

The figures given in Table 2–10A represent gross averages for the entire Bi-county Region. It must be recognized that a great deal of variability will be encountered under specific conditions. Also, the relative average magnitudes of the various components will change from locality to locality within the Region. For example, Table 2–10B shows gross estimates of nitrogen produced in a residential area with medium density housing. As can be seen, the relative magnitudes of the loads differ from those for the whole Region.

The original total load of nitrogen for the acre, would produce a concentration of inorganic nitrogen of about 30 milligrams per liter, if it all leached. It is estimated however, based on work done during the 208 Program, that reductions in nitrogen levels during, or prior to, leaching to groundwater, would produce an actual concentration closer to fifteen milligrams per liter. This compares with ten milligrams per liter that would be

Table 2–10A

GROSS SUMMARY OF ESTIMATED SOURCES AND FATE OF NITROGEN IN THE BI-COUNTY REGION.
(Based on 1975 and 1976 data.)

Source	Nitrogen Initial Load	(tons/yr.) Load to Groundwater	Comment on Sink
Wastewater			
On-site systems	8500	4300	(Denitrification, etc.)
Sewers & sewage treatment			
Sewer leakage	500	200	(Denitrification, etc.)
Effluent discharge to ground	200	100	(Denitrification, etc.)
Effluent discharge to marine bays	4200	–	(Discharge to sea)
	13400	4100	
Fertilizers			
Farm (Inc. Sod farms)	4000	1000	(Crop removal)
Turf (Inc. households, golf courses, etc.)	9300	5600	(Volatilization & Denit.)
Animals (primarily dogs & cats)	1600	800	(Volatilization & Denit.)
Ducks	600	300	(Volatilization & Denit.)
	15500	7700	
Precipitation	4000	3700	(By difference from totals)
Totals	32900	16000*	(Totals estimated by water/nitrogen model)

**Assuming an annual recharge of about 500 billion gallons, the resulting concentrations in the leachate equals about 6.8 mg/l.*

Table 2–10B

ESTIMATED ANNUAL LOADS ORIGINATING ON AN ACRE OF RESIDENTIAL LAND, WITH THREE HOUSES.

Source	Lbs. of Nitrogen Initial Load	Approx. load to Groundwater	Assumption
10 Persons	100	50	(10 lbs. N/person)
15,000 sq ft. of turf	45	25	(average household income $16,000)
Pets	10	5	(0.82 lbs/person approx.)
Precipitation	10	6	(1 mg/l)

predicted by empirical relations based on groundwater data presented in Porter (1978).

As discussed by Porter, the estimate of ten milligrams per liter is probably an underestimate of the true level of nitrogen in the groundwater due to bias in the data.

2.3.4 Groundwater Flow. Once the recharge water enters the saturated zone, movement is controlled by the natural and artificial flow regimes operating in the system. Although groundwater moves very slowly, it can travel long distances. As a result, sources of contamination of human or natural origin, which are apparently remote, may have prolonged and wide-reaching groundwater impact at some time in the future.

Based on estimated flow rates in the Upper Glacial aquifer, many shallow wells in that aquifer now reflect the quality of water that entered the groundwater system since the late 1940's.[10] The exact age of water at these wells is probably quite variable, depending on depth, location, permeability of the sediments at the particular site, and the influence of pumping

In the central portion of Long Island, recharge to the Magothy from the water table aquifer occurs over a large area. The definition of this region is critical in trying to assess how chemical contaminants, introduced to the water table from the land surface, will tend to move in the groundwater system. Groundwater in the water-table aquifer near the groundwater divide is subject to hydraulic gradients which tend to carry some of the water vertically downward to the deepest part of the Magothy To the south and north of this zone, water from the shallow deposit flows with vertical and horizontal components that result in some water moving in the middle portion of the Magothy. Farther toward the coastlines, circulation becomes shallower until, at some point, flow is essentially horizontal in both the water-table and the Magothy aquifers. Beyond this area, water in the Magothy has a vertically upward component, while the water in the shallow deposits flows essentially horizontally until it discharges to streams or saltwater bodies. Under predevelopment conditions, it takes about 100 years for water from the surface to reach the lower portion of the Magothy in the center of the Island. The travel time to the barrier beach is about 800 years and, to the North Shore, about 400 years.[11] However, the travel time may be greatly reduced by pumping. Partial cross sections of Long Island, depicting typical patterns of groundwater flow, are shown in Figures 2–6 and 2–7 The location of these cross-sections is shown in Figure 2–5.

In general, the distribution of known contaminants follows the typical flow patterns shown above. It should be noted, however, that the flow patterns in reality are complicated by layers of different types of materials in the ground, such as clay lenses in otherwise sandy layers. However, groundwater flow into the bays constitutes a significant source of nitrogen to the surface waters. In some cases the nitrogen loads from groundwater inflow are more than one-third of the total input.[12]

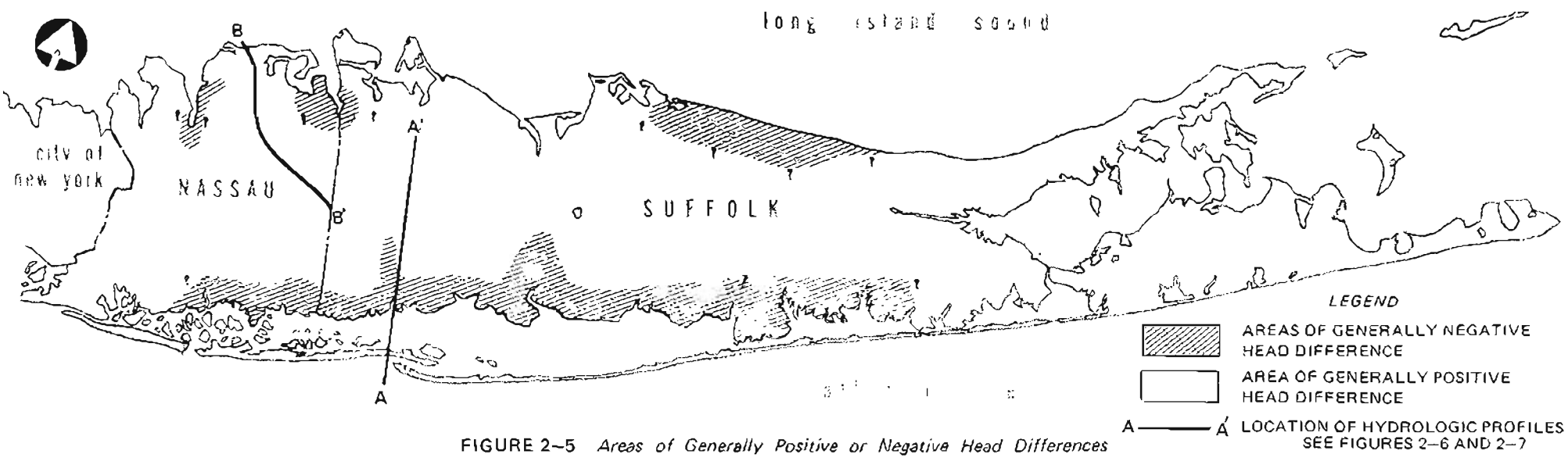
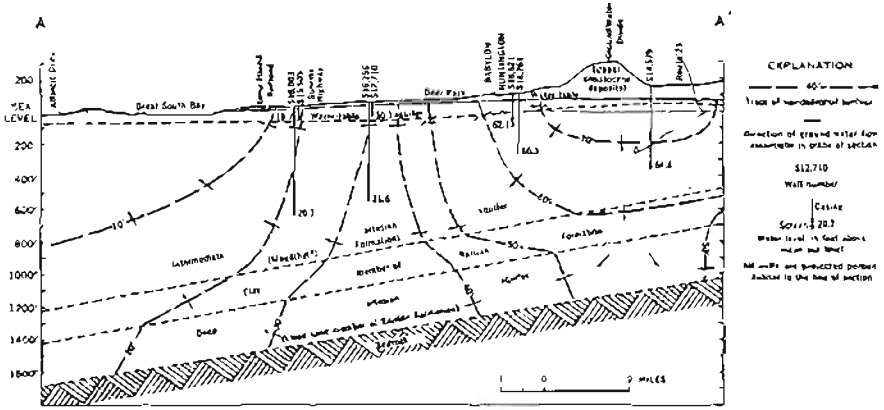


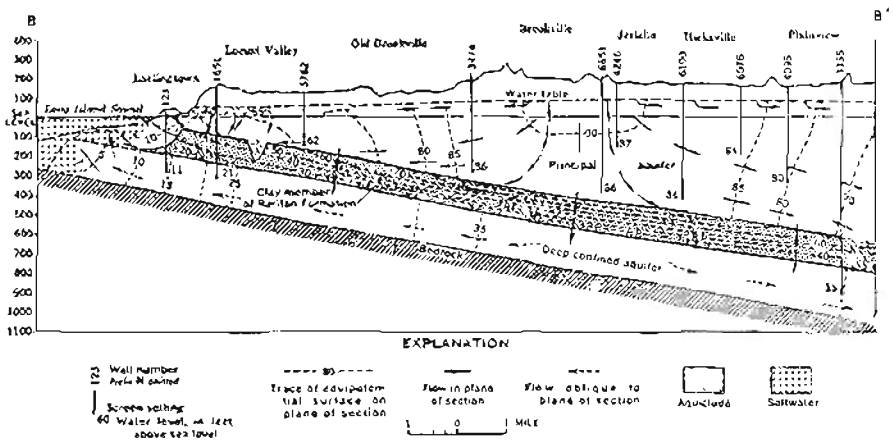
FIGURE 2–5 *Areas of Generally Positive or Negative Head Differences Between Wells Screened in the Water Table and Lower Magothy Aquifers, Based on USGS Maps for 1966, 1972, 1974 and 1975*

NOTE. POSITIVE HEAD DIFFERENCE MEANS THE WATER TABLE ELEVATION IS HIGHER THAN THE ELEVATION OF THE BASAL MAGOTHY POTENTIOMETRIC SURFACE AT A GIVEN POINT.



(from Pluhowski and Kantrowitz, 1964)

FIGURE 2–6 *Approximate Hydraulic Profile of the Groundwater Reservoirs Underlying the Babylon—Islip Area, October 1960*



(from Franke and Cohen, 1972)

FIGURE 2–7 *Hydraulic Section Through the Groundwater Reservoir from Lattingtown to Plainview, in March, 1961*

2.3.5 **Surface Runoff.** As already indicated, the volume of surface runoff from undeveloped land represents probably no more than five to ten percent of the original precipitation.

Measurements at twelve sites during the 208 Study produced an estimated average rate of infiltration of over seven inches per hour. This suggests that the soil is capable of infiltrating the precipitation of a 100 year storm, which delivers as much as four inches of precipitaion in one hour or eight inches in 24 hours. It should be noted that extremely heavy precipitation may impact the soil in a way that reduces natural infiltration.

Most runoff occurs as a result of precipitation falling on an impermeable area. It follows that the volume of runoff has been increased by urbanization. The proliferation of residential areas, shopping malls, highways and parking lots has required the provision of drainage system. Drains, and storm sewers all greatly augment the transfer of contaminants. Nitrogen, sediments, coliform bacteria and other pollutants may all be dissolved or suspended and conveyed to surface water. (See Table 2—11.)

Table 2—11

APPROXIMATE YEARLY LOADS TO SURFACE WATERS FROM WET-WEATHER RUNOFF, 1975

Drainage Basin	BOD lbs/yr	Suspended Solids lbs/yr	Total Nitrogen lbs/yr	Total Phosphorus lbs/yr	F. Coli organisms/yr	T. Coli organisms/yr
Nassau						
Subtotal	1,185,000	8,942,000	597,000	195,000	5.4×10^{16}	1.9×10^{17}
Suffolk						
Subtotal	2,307,000	16,911,000	1,137,000	368,000	1.1×10^{17}	3.5×10^{17}
Total	3,492,000	25,853,000	1,734,000	563,000	1.6×10^{17}	5.4×10^{17}

Source: Weston, R. F., 1977, "Wet-Weather, Non-Point Source Pollutant Loads in Nassau and Suffolk Counties," Prepared under contract to the 208 Program Study.

2.4 Groundwater Availability and Quality

A basic understanding of present groundwater conditions and trends is essential in evaluating various 208 plans for waste management. The following sections describe current knowledge of the overall availability of groundwater to meet water supply requirements. In addition, the status of water quality in the various aquifers underlying the 208 Region is discussed.

2.4.1 **Groundwater Availability.** The limit on the amount of groundwater available for development is termed the "safe" or "permissive" yield of the system. The concept of safe or permissive yield is normally defined as: "the amount of groundwater which can be withdrawn from the system and used consumptively on an annual basis without producing undesired results."[14] Over the years, several values have been proposed for this limiting yield on Long Island. The term "deficiency" refers to exceeding the permissive yield. For the Long Island 208 Region, water used "consumptively"

simply means that it is not returned to the groundwater system.

Domestic and industrial pumpage, that is eventually lost to the system following collection, treatment and bay or ocean discharge, constitutes the principal year-round consumptive use of fresh water on Long Island. Irrigation practices constitute the principal seasonal consumptive use. As consumptive use increases, groundwater is taken from storage, and underflow to streams and the sea is reduced. These stresses on the groundwater system result in water-level declines and saltwater encroachment.

Greeley and Hansen in 1971 estimated a mean permissive yield of 151 MGD for Nassau County. Holzmacher, McLendon and Murrell in 1970 computed a permissive yield of 466 MGD for Suffolk County. The Nassau County Department of Health computed the average consumptive loss in Nassau during the period of 1969 to 1973 to be 133 MGD. Average consumptive loss for Suffolk County was on the order of 40 to 50 MGD for the same period.

Both of the engineering studies estimated that large water-table declines would result from withdrawal at permissive yield rates if most areas were sewered and effluents were discharged by ocean outfall Greeley and Hansen predicted maximum declines of 30 feet, and Holzmacher, McLendon and Murrell estimated reductions up to 75 percent of present elevations above sea level before equilibrium occurs. The authors of both county investigations felt that, at the permissive yield, the saltwater interface off the South Shore would move landward to a new equilibrium position, perhaps a mile from its present position The water-level declines predicted for Nassau are significantly greater than those predicted in recent runs of the U.S. Geological Survey (USGS) analog model. A report[15] of the USGS for the 208 Study analyzed groundwater response to proposed sewerage programs and projected populations increases in Nassau and Suffolk Counties by 1995. The total modeled increase in withdrawal by 1995 was 9.54 MGD in Nassau County and 46.42 MGD in Suffolk County. The total modeled decrease in recharge by 1995 was 39.9 MGD and 42.67 MGD in Nassau and Suffolk Counties, respectively. It was concluded that by 1995, these stresses would result in a stabilized water table after declines of as much as sixteen feet in east-central Nassau County, and as much as six feet in central Suffolk County. Slightly smaller declines in the potentiometric head may occur in the Magothy aquifer

Declining water levels will significantly reduce streamflow and will also affect the amount of freshwater underflow to the bays. For instance, a run of the USGS analog model predicted reductions of streamflow of about 55 percent by 1995 in southeast Nassau County, based on present population and sewering projections. Reductions in streamflow may cause changes in the vegetation of certain freshwater wetlands. In addition, significant long-term reductions in groundwater outflow and streamflow to the various saltwater bodies surrounding Long Island may alter salinities. The environmental consequences of these changes are unknown at the present time. A decrease in freshwater discharge to the bays could be offset in part by shifting centers of pumping, stream augmentation or recharge with sewage effluent, importation or transfer of groundwater from surplus areas, or through planned water conservation programs.

A factor that adds some uncertainty to predictions of impacts in Nassau County is the future of the Jamaica Water Company in Queens. This supplier is pumping about 60 MGD, creating significant underflow from western Nassau to Queens. It is understood that, upon completion of New York City's third water tunnel, distribution of surface water to this area will be made possible. However the lack of additional supply sources upstate, or elsewhere, precludes complete replacement of the present Queens groundwater supply, especially during drought periods. If Jamaica Water Company pumpage is eliminated or reduced in the future, underflow will be reduced and significant recovery of water levels in western Nassau will occur

The Queens/Nassau common water-level decline illustrates the insignificance of political boundaries when dealing with the management of resources common to the entire Island. The present sub-surface flow from Nassau to Queens is estimated to be between ten and fifteen MGD. While some of this flow is due to natural conditions, a significant portion is undoubtedly due to heavy pumping in Queens. There have been a number of plans proposed for future groundwater development in the 208 area, that call for installing a regional well field in Suffolk County and pumping the water to Nassau County. At the present time, there is little natural exchange of groundwater between these two counties. However, if water levels are allowed to decline substantially in Nassau County, natural underflow of groundwater from Suffolk will occur.

If present patterns of use continue, groundwater outflow within the Magothy will be reduced along both the north and south shores of Nassau and Suffolk Counties. However, on the basis of past and present studies of saline groundwater on Long Island, including those on the North and South Forks, it is expected that the regional impact of saltwater intrusion will be small. The saltwater wedges in the upper and lower Magothy in the south-western and southern parts of Nassau, an area of historical saltwater contamination, will probably not advance much more than a mile locally, and less than a mile regionally, by the year 2000.[16] This would put the interface of the deep wedge in the vicinity of Sunrise Highway in Valley Stream and Lynbrook. Those few supply wells screened in the lower Magothy would be affected.

From the standpoint of water supply and wastewater management, it is essential that the potential threat of saltwater encroachment be viewed in its proper perspective and be fully understood. The loss of usable groundwater resources as a result of saltwater intrusion has been minor in comparison to the extensive fresh groundwater supplies that still remain in storage and untapped within the 208 Study area. Water-level declines due to increased pumpage, sewering, or temporary deficiencies in rainfall do not bring about

massive encroachment of saltwater bodies within the various aquifers. In only one area of the Bi-county Region (southwestern Nassau), has there been documented evidence that saltwater is actively intruding. Even here, the average rate of movement has been less than twenty feet per year, notwithstanding the fact that water levels in nearby areas have been below sea level for decades.

Many of the past studies infer that a critical shortage of water may be expected within the next few decades. Increased consumptive use and declining water levels have frequently been equated with running out of water. The fact is, that on a bi-county basis, there is sufficient available groundwater to supply Long Island for many years beyond the current 1995 population projection, provided that action is taken to solve problems in specific areas and proper management techniques are adopted.[17] In evaluating wastewater management options, *i.e.,* recharge and stream augmentation, under 208, emphasis must be placed on determining the impact of proposed plans on groundwater quality and the effects on other segments of the environment, such as streamflow and freshwater discharge to the surrounding saltwater bodies.

2.4.2 Groundwater Quality. A further constraint to water supply self-sufficiency is water quality Past and present waste disposal practices modify the purity of a significant portion of the available groundwater resource. The presence of nitrate, trace organic chemicals and heavy metals in some portions of the aquifer system may be much more important to long-term availability of usable water supply than short-term droughts and saltwater encroachment. In the following discussion, nitrate occurrence and trends are used to illustrate present conditions in the various aquifers. This constituent has been of great concern historically in the 208 Region, and data are available to reach some preliminary conclusions on how changes in land use and the presence of contamination sources have impacted groundwater quality on a regional basis. Other contaminants, such as heavy metals, organics in trace amounts and detergents have been of local importance. Chlorides, related to saltwater intrusion, have been discussed in the previous section on groundwater availability.

2.4.2.1 Water-Table Aquifer. The water-table or uppermost aquifer on Long Island receives most of the contaminants originating at the land surface. This aquifer consists primarily of Upper Glacial deposits and includes some sediments of the Magothy formation, the Manetto gravel and recent deposits. The aquifer has become contaminated to various degrees and is, in some places, unsuitable for use as a source of potable water supply The groundwater found in these sediments is of special importance because in many areas it supplies water to the deeper Magothy formation. In addition, streams in Nassau and Suffolk Counties are largely dependent on flow from shallow groundwater and closely reflect its quality. Significant input to the bays and most freshwater lakes is also derived from the water-table aquifer by underflow.

The normal background quality of groundwater in the shallow sediments of Nassau and Suffolk Counties is very good. In general, the water can be characterized as soft, mildly corrosive and, in some cases, somewhat high in iron and manganese.

Over the past few decades, widespread effects of urbanization have considerably altered the quality of groundwater in the water-table aquifer. Many studies have detailed the extent and magnitude of these effects, with particular attention paid to nitrate, detergent, chloride and, to a lesser extent, sulfate. These constituents are usually good indicators of contamination. Median concentrations of these parameters in Nassau and Suffolk for the period 1972–76 with the exception of detergents are given in Table 2–12.

Statistical analyses of nitrate concentrations in selected wells throughout Nassau and Suffolk Counties were performed as part of the 208 Program. Trends in nitrate are important not only in themselves, but also because associated contaminants may follow similar trends.

A recent study[18] found that, of 21 wells in Sewage Disposal District No. 2 in Nassau, thirteen show valid decreasing trends of nitrate. Four had increasing trends. The median change in nitrate per year for all of the seventeen wells that showed trends is –0.34 milligrams per liter. Eight of the wells

Table 2–12

CONCENTRATIONS OF SELECTED CONSTITUENTS IN THE UPPER GLACIAL AQUIFER, 1972–76

	Median		Mean	Range
Southwestern Nassau				
Nitrate	4.9	(159)	4.8	0.04 – 14
Chloride	28	(164)	43	6.6 – 950
Sulfate	44	(128)	47	5.0 – 120
Northern and Eastern Nassau				
Nitrate	3.0	(259)	4.3	0.00 – 36
Chloride*	19	(309)	83	1.3 – 14,000
Sulfate	30	(259)	30	0.00 – 450
Suffolk				
Nitrate	1.4	(1,273)	2.3	0.00 – 23
Chloride*	12	(2,047)	20	0.10 – 2,600
Sulfate	9.2		19	0.00 – 470

Note: The number in parenthesis indicates the number of analyses. Concentrations are in mg/l.

**High concentrations of chloride (i.e., 14,000 and 2,600) are due to contamination by salt water and are not representative of typical concentrations in fresh water.*

Source: Section B of the Areawide Waste Treatment Management Plan.

indicate a pattern of increasing and then decreasing concentrations. The time of inflection, or change from positive to negative slope, occurred during the late 1950's or early 1960's in most of these wells, and does not appear to be a drought-related phenomenon. The change corresponds to large scale sewer construction which started in the early 1950's and was completed in 1964.

In addition to the decreasing trends of nitrate in most of the water-table wells in Sewage Disposal District No. 2, the median nitrate concentration in streams sampled during the period 1972–1975 shows substantially lower levels in southwestern Nassau as compared with those in southeastern Nassau. The median values are shown in Table 2–13. Although it is not possible to identify trends on the basis of the limited data, it appears that sewering may have been responsible for reducing nitrate levels in the stream discharges, which generally represent the most recently recharged water in Sewage Disposal District No. 2.

Despite generally decreasing trends of nitrate in wells in Sewage Disposal District No. 2, the actual concentrations in some wells are still quite high. Possible explanations for this are (1) the sewers are leaking, (2) the use of home fertilizers is such an important input that removal of on-lot sewage disposal systems alone results in only a slow decrease in nitrate levels, or (3) insufficient time has elapsed for even shallow wells to be flushed of high nitrate water.

Applying the criteria used in the study, the number of wells in the unsewered portion of Nassau County (Sewage Disposal District No. 3) is found to be insufficient to permit any conclusions. Three wells show increasing trends in nitrogen concentration, while two show decreasing trends. Wells in northern Nassau County generally show either small increases or small decreases in nitrate concentration.

Twenty-one water-table wells in Suffolk that have nitrate-nitrogen concentrations above background levels show significant nitrate trends. Of eighteen wells in southwestern Suffolk (Babylon and Islip), sixteen show increasing trends, an indication of deteriorating water quality. The period of record for most of these wells started in the 1960's. Southwestern Suffolk is of interest because it is hydrologically similar to Nassau Sewage Disposal District No. 2. Recent land use is also similar, although development took place some years later. The median change per year in nitrate in the eighteen wells in this part of Suffolk is +0.13 milligrams per liter.

An indication of the effects of sewering on groundwater quality is provided by ongoing studies of the U.S. Geological Survey.[19] Preliminary findings of continued evaluation of the information obtained during the preparation of a U.S. Geological Survey report for the 208 Program[20] reveals significantly lower median concentrations of ammonia in shallow groundwater underlying Sewage Disposal District No.2 compared to shallow groundwater in Sewage Disposal District No. 3 in Nassau County. Again, sewering was undertaken in District No. 2 during the 1950's, whereas the installation of sewers in District No. 3 is still underway. In addition, an evaluation of water quality trends in only the very shallow glacial deposits in District No. 2 and District No. 3 indicates stronger decreasing trends of nitrate in the former. These preliminary findings are indications of the results of a reduction in nitrate loading, apparently due to sewering.

Table 2–13

QUALITY OF NASSAU AND SUFFOLK STREAMS

Stream	Median Nitrate-Nitrogen (mg/l) 1972–75		Median Specific Conductance (μmhos) 1972–75	
North Shore (Nassau and Suffolk)				
Glen Cove Creek	3.39	(11)	228	(14)
Mill Neck Creek	0.77	(26)	164	(35)
Cold Spring Brook	0.50	(12)	76	(13)
Nissequogue River	1.13	(8)	100	(12)
Southwestern Nassau				
Valley Stream	0.88	(6)	150	(9)
Pines Brook	2.03	(9)	340	(11)
Southeastern Nassau				
East Meadow Brook (tributary)	3.61	(28)	449	(38)
Bellmore Creek (tributary)	8.58	(10)	353	(14)
Bellmore Creek	5.87	(12)	340	(14)
Massapequa Creek	7.00	(31)	320	(36)
Southwestern Suffolk				
Santapogue Creek	2.26	(13)	290	(15)
Carlls River	2.93	(14)	215	(16)
Sampawams Creek	3.16	(15)	215	(17)
Penataquit Creek	3.61	(14)	313	(17)
Champlin Creek (Oakdale)	1.85	(14)	151	(16)
Connetquot River	0.93	(12)	80	(15)
Connetquot River (North Great River)	0.88	(12)	84	(14)
Southeastern and Eastern Suffolk				
Patchogue River	1.11	(10)	114	(4)
Swan River	1.20	(10)	90	(12)
Carmans River	0.74	(29)	101	(36)
Peconic River	0.25	(12)	92	(24)

Note: The number in parenthesis indicates the number of analyses.

Source: Section B of the Areawide Waste Treatment Management Plan.

2.4.2.2 Magothy Aquifer. The natural chemical quality of water within the Magothy is generally excellent and characterized by a very low dissolved solids content. Contamination of the Magothy is of great concern, since many public supply wells are screened in this formation. Past water-quality investigations have dealt primarily with the distribution and trends of nitrate. From these studies, it is well established that many wells within the Magothy are pumping chemically altered or contaminated water.

The 1972–76 median concentrations of nitrate, chloride and sulfate in the various portions of the study area illustrate the relative degree of alteration (Table 2–14). Differences in concentrations of these constituents between the two specified areas of Nassau are probably not due to sewering, except possibly at the shallower depths. Other factors, such as location of wells with respect to past land uses, are probably more important. Those water-quality trends now occurring in the water-table aquifer, as discussed in the previous section, will undoubtedly be reflected in some way in the Magothy in future years. In general, the levels of contaminants decrease with depth, until near-background concentrations are found in most wells greater than 600 feet deep. The apparent smaller value of nitrate for wells of the sewered area less than 200 feet deep may be due to insufficient sampling.

Table 2–14

MEDIAN WATER-QUALITY DATA IN THE MAGOTHY AQUIFER 1972-1976

Depth (feet)	Southwest Nassau		East and North Nassau		Suffolk	
Nitrate as N						
Less than 200	0.88	(18)	2.8	(104)	2.6	(4)
200 to 399	2.5	(130)	2.8	(443)	0.10	(263)
400 to 599	0.2	(526)	1.1	(515)	0.10	(391)
Greater than 600	0.01	(42)	0.13	(177)	0.01	(322)
Chloride						
Less than 200	18	(18)	13	(108)	14	(13)
200 to 399	12	(136)	10	(45)	5.0	(270)
400 to 599	6.4	(542)	5.8	(532)	4.5	(400)
Greater than 600	4.6	(42)	4.4	(179)	4.0	(355)
Sulfate						
Less than 200	32	(14)	22	(93)	2.6	(11)
200 to 399	13	(122)	7.0	(392)	3.2	(264)
400 to 599	5.0	(500)	2.0	(403)	3.2	(388)
Greater than 600	3.0	(39)	1.0	(159)	3.4	(399)

Note. Numbers in parentheses are the number of analyses. All concentrations in mg/l.
Source: Section B of the Areawide Waste Treatment Management Plan.

A recent U.S. Geological Survey study in southeast Nassau County provides an analysis of vertical and horizontal distributions of nitrate, chloride and dissolved solids.[22] The conclusions reached illustrate the typical history of heavily urbanized areas served by heavy pumpage from local, deep aquifer zones:

1. Downward movement of nitrate in the Magothy between the early 1950's and 1973 ranged from no significant movement in the area south of North Merrick and South Farmingdale to a maximum movement of a few hundred feet in the areas of Westbury, Hicksville and Plainview. There also seems to be a definite horizontal movement of equal nitrate concentration lines through the aquifer.
2. There has been a more rapid downward movement of nitrate in the eastern part of the study area than in the central and western parts. The rapid movement in the eastern part may be partly due to a large increase in pumpage in the Plainview area.
3. There is a zone of high-nitrate water in the Magothy aquifer in the area of Westbury, Hicksville and Plainview. Some of these increases may be attributable to past large-scale farming, and the associated use of fertilizers in the Hicksville and Levittown areas, and to subsurface domestic discharges and pumpage.
4. The downward movement of chloride covers a broader area than does that of nitrate.
5. There has been significant downward movement of higher than normal total solids concentrations between the 1950's and 1973. Overall downward movement ranges from a few feet to approximately 300 feet. A zone of high total solids concentrations of more than 200 milligrams per liter is found in the Hicksville and Plainview areas. The total solids concentration in groundwater in the Plainview area approximately doubled in twenty years.

It is also likely that reduction of pumpage from the Glacial formation and preferential or exclusive development of the Magothy formation has accelerated the downward movement of contaminated waters. A study completed in 1969 reviews the trends of nitrate in 373 public suppy wells in Nassau County.[23] Most of the wells analyzed were deep wells, screened in the Magothy. Eighty wells showed statistically significant increasing trends and nine were decreasing. A general upward trend of nitrate in most Magothy wells is also confirmed by a study presently under way by the U.S. Geological Survey.[24] In this investigation, trends of nitrate in most Magothy wells in Nassau County showed statistically significant increases. Studies in Suffolk County have not been as extensive as in Nassau, but the data indicates no significant change in water quality in the Magothy aquifer.

2.4.2.3 Lloyd Aquifer. The Lloyd aquifer is the least altered by human activities. This is due primarily to the thick confining bed of Raritan clay which overlies the Lloyd in most places and impedes the exchange of water with the Magothy. On the North Shore, however, the Raritan clay is discontinuous in places, and the aquifer is in lateral, and possibly vertical, hydraulic connection with Pleistocene deposits which have replaced the Magothy deposits. Regionally, the Lloyd is recharged through the clay over a broad area covering most of Nassau and Suffolk Counties. Discharge in the western part of the study area is primarily through wells, while in the eastern part discharge is mostly to the bays and to the ocean. (See Table 2—15 for Nassau water quality data.)

Table 2—15

THE MEDIAN CONCENTRATIONS OF SELECTED CONSTITUENTS IN THE LLOYD AQUIFER IN NASSAU COUNTY (1972—76)

	Southwest Nassau		North and East Nassau	
Nitrate as N	0.07	(13)	0.21	(100)
Chloride	5.1	(12)	5.2	(106)
Sulfate	6.0	(13)	3.0	(94)

Note: Concentrations in mg/l; numbers in parentheses are numbers of analyses.
Source: Section B of the Areawide Waste Treatment Management Plan.

Many of the wells in the north and east area are located in Manhasset, Great Neck and in the northern part of the Town of Oyster Bay. Some of the wells in these areas show elevated levels of nitrate, indicating contamination from the surface. This suggests some degree of hydraulic connection with overlying sediments, probably in areas where the Raritan clay has been eroded and replaced by more permeable deposits.

Uncontaminated water in the Lloyd is characterized by low dissolved solids (less than 50 milligrams per liter). Iron, however, commonly occurs at levels considerably above the recommended limit of 0.3 milligrams per liter.

2.4.2.4 Organic Chemicals. Several years ago, an incident of groundwater contamination was reported near an industrial complex in Nassau County. Subsequent sampling and analysis of water from wells within the complex indicated significant concentrations of vinyl chloride and industrial degreasers such as tri- and tetrachloroethylene. The wells yielding water containing these contaminants were removed from service as sources of potable water. An intensive survey of all public drinking water supply wells in both Nassau and Suffolk Counties has been underway for the past two years. As of October 1977, almost 650 analyses have been performed on samples collected from 475 public water supply wells in both counties. Fifteen wells have been removed from service because of the presence of volatile organic compounds.

The formation of chlorinated hydrocarbons in "finished" waters, as the result of chlorination practices, requires the presence of the precursor compounds. This is very rarely the case in Long Island groundwaters, especially Magothy waters, even though it has been the case in some surface waters.

The 208 Program responded to requests from its TAC and CAC, and initiated a program to analyze samples from groundwaters, stormwater, domestic waste discharges and landfill leachates for the presence of volatile and non-volatile organic compounds. The survey of non-volatile compounds resulted in the detection of substituted benzene compounds, napthalenes and various butylphthalates. Some of these compounds are common constituents of plasticizers, and some are on the list of those suspected of being carcinogenic to animals. Volatile organic compounds were also detected at parts per billion concentrations, with their sources yet to be determined or evaluated. Studies are continuing, and a full report will be forthcoming.[25]

2.5 Surface Water Quality

2.5.1 Introduction. As part of the 208 planning process, an extensive review of historical water quality data was made for selected bays. The bays were chosen for detailed investigation because of current water quality problems or the presence of existing or proposed major discharges. The data, which were collected between 1970 and 1975, were obtained from various sources. These programs were designed for a variety of purposes, not necessarily to characterize the water quality throughout the bay. To supplement this data base and to provide data for mathematical model calibration and verification, an additional data collection program was undertaken during 1976. All of these data, in conjunction with mathematical model results, provide a means to characterize the water quality of each bay. Presentation of data and detailed analysis is contained in a large number of technical reports. This section provides a summary water quality assessment for each bay for eight selected bay systems. A non-modeling water quality assessment was prepared for Moriches, Shinnecock and Mecox Bays, western Long Island Sound and the nearshore Atlantic Ocean.

It is important to note that, on the north shore of Long Island, water quality conditions within the bays are largely influenced by the quality of Long Island Sound water, which provides the boundary values for the bay models. Long Island Sound shows a definite gradient of improving quality from west to east. For example, total coliform bacteria concentrations ranged from approximately 2400 MPN per 100 milliliters near Manhasset Bay to less than twenty MPN per 100 milliliters near Huntington Harbor. Nitrogen shows a similar trend, with concentrations decreasing from approximately 0.8 milligrams nitrogen per liter at Manhasset Bay to approximately 0.3 milligrams nitrogen per liter at Port Jefferson Harbor.[26]

Conversely, if boundary conditions are low, waste loads can be relatively high, due to the rapid mixing and high flushing rates in the North Shore bays. The importance of these boundary values cannot be overemphasized, because no waste management plan for an individual bay would be able to reduce concentrations significantly below the boundary values.

The Peconic Estuary-Flanders Bay system, as well as the Great South Bay, have relatively long residence times and, although changes are slow to manifest, dilution and flushing are much less than in the North Shore bays. This characteristic causes water quality in these two systems to be highly sensitive to internal waste loads, and boundary effects to become minimal.

Unlike Long Island Sound's effect on water quality of the North Shore bays, the nearshore Atlantic Ocean water quality does not appear to significantly influence water quality of the South Shore bays. Available water quality data indicate that total nitrogen concentrations are consistently between 0.1 and 0.4 milligrams nitrogen per liter in nearshore Atlantic waters that represent the boundary conditions for the South Shore bays. Furthermore, bacterial water quality local to the Long Island South Shore is determined primarily by contaminant loads emitted by the bays themselves. A review of historical physical and water quality data in the New York Bight Apex indicates that the great majority of wastes emitted from New York Harbor travel south along the New Jersey coast, except during sustained periods of southerly winds. In addition, the sludge dumping practices in the Bight Apex do not, at present, appear to significantly affect water quality along the South Shore of Long Island. For these reasons, waste management plans for reducing waste loads within the South Shore bays should be effective in controlling water quality in these bays.[27]

The following subsections provide a description of observed water quality conditions in all of the bays, and attempt to indicate the amount of pollutants that result from different sources, based on data taken from Sections B and D of the Areawide Waste Treatment Management Plan. The last section provides a summary for all bays. Most of the discussion centers around coliform bacteria and nitrogen concentrations because they have been found to be key indicators of water quality conditions.

2.5.2 Manhasset Bay. Manhasset Bay, the most westerly of the North Shore bays that were studied, is largely influenced by Long Island Sound. Seventy percent of the total nitrogen contributed to the bay from internal loading is from point sources. The remainder (700 pounds per day) comes from non-point sources including groundwater inflow, stream base flow, stormwater runoff and direct rainfall. Storm-related nitrogen inputs are approximately twelve percent of the internal nitrogen loading to Manhasset Bay. Depending on location in the bay nine to 80 percent of the observed nitrogen is a result of internal sources. Concentrations of total nitrogen within the bay range from 0.1 to 3.4 milligrams nitrogen per liter. The high concentrations are found in the vicinity of discharges located in relatively poorly-flushed areas.

The nitrogen concentrations are sufficient to allow large phytoplankton blooms. The field data for 1976 showed chlorophyll a values to exceed 300 micrograms per liter on occasion.

Large masses of phytoplankton generally produce very high dissolved oxygen concentrations during the day through photosynthesis, and very low dissolved oxygen levels during the night due to respiration. While a normal value for dissolved oxygen would be between 7.5 and 9.0 milligrams per liter, the field data for 1976 showed values to reach nearly 20.0 milligrams per liter during the day. While nighttime measurements of dissolved oxygen were not made, some early morning measurements as low as 3.6 milligrams per liter suggest considerable dissolved oxygen depression at night.

Ninety-five percent of the total coliform bacteria contributed by sources within Manhasset Bay is from stormwater runoff. An additional four percent is contributed by stream base flow, while point sources generally contribute only one percent. These total coliform loadings, in conjunction with high boundary concentrations (2400 MPN per 100 milliliters), have resulted in the classification of Manhasset Bay as unfit for shellfishing and occasionally, after storm events, have resulted in the temporary contravention of the standards for swimming.

2.5.3 Hempstead Harbor. Hempstead Harbor, located just east of Manhasset Bay, is also largely influenced by Long Island Sound water quality. Approximately 72 percent of the internal nitrogen loading is from point sources.

The remainder (approximately 1200 pounds per day) comes from non-point sources, including groundwater inflow, stream base flow, stormwater runoff and direct rainfall. Storm-related nitrogen inputs are approximately five percent of the internal nitrogen loading. Concentrations of total nitrogen within the harbor ranged from 0.3 to 16.8 milligrams nitrogen per liter. Depending on location in the harbor, thirteen to 80 percent of the observed nitrogen is a result of internal sources. The high values are found in the vicinity of discharges that are located in relatively poorly flushed areas.

These nitrogen concentrations are sufficiently high to allow large phytoplankton blooms. The field data for 1976 showed chlorophyll a values up to 200 micrograms per liter on occasion. Such large chlorophyll a concentrations generally produce large amounts of oxygen by photosynthesis during the day, and consume larger amounts by respiration at night. Field data showed oxygen concentrations to range from two to seventeen milligrams per liter.

Ninety percent of the total coliform bacteria contributed by sources within the harbor is from storm runoff An additional eight percent is contributed by stream base flow and two percent by point sources. These total coliform loadings, along with high boundary concentrations, have resulted in the closing of shellfishing areas in Hempstead Harbor.

2.5.4 Oyster Bay. Oyster Bay receives a total nitrogen loading of approximately 1,700 pounds per day from all non-point sources within the

bay. About 46 percent of the loading is from groundwater underflow and 23 percent from point sources. The nitrogen contribution of Long Island Sound to Oyster Bay is substantially less than to Manhasset Bay and Hempstead Harbor. Concentrations range from a "worst case" boundary condition of 0.45 milligrams nitrogen per liter to an average of about 0.30 observed in August 1976.

Nitrogen concentrations in Oyster Bay observed in August 1976 ranged from 0.1 milligrams nitrogen per liter to 0.53 milligrams nitrogen per liter. The highest concentrations were observed in Mill Neck Creek and the south end of Cold Spring Harbor. In Mill Neck Creek, point sources account for about 34 percent of observed nitrogen concentration. In Cold Spring Harbor, 31 percent of the observed nitrogen concentration is due to point sources. In these areas the additional nitrogen was contributed by Long Island Sound.

Virtually one hundred percent of the total coliform loading to Oyster Bay is from stormwater runoff. Median coliform counts in Long Island Sound at the entrance to Oyster Bay/Cold Spring Harbor are below the maximum 70 MPN per 100 milliliters standard for shellfishing areas. Areas in the vicinity of the Cold Spring Harbor Treatment Plant outfall, the Oyster Bay Treatment Plant outfall, Mill Neck Creek and adjacent to Mill Pond are closed to shellfishing.

2.5.5 Huntington Bay. Approximately 42 percent of the total internal nitrogen loading (1800 pounds per day) to Huntington Bay is estimated to derive from groundwater inflow. An additional twenty percent comes from point sources, twenty-one percent from runoff, eleven percent from direct rainfall and seven percent from stream base flow. Concentrations of total nitrogen within the bay range from 0.1 to 1.4 milligrams nitrogen per liter. Depending on location in the bay, with a boundary nitrogen concentration of 0.32 milligrams nitrogen per liter, three to 50 percent of the observed nitrogen is a result of internal sources. The high values are in Centerport Harbor and Northport Harbor, where point sources discharge to poorly mixed areas. Huntington Harbor receives the Huntington Sewage Treatment Plant discharge.

The generally high nitrogen concentrations result in substantial algal production in those area that are poorly flushed. Chlorophyll a values up to 50 micrograms per liter have been found in Centerport Harbor and in Huntington Harbor. Dissolved oxygen concentrations ranged from 4.2 to 12.6 milligrams per liter.

Ninety-eight percent of total coliform bacteria loading contributed by sources within the bay are computed to derive from storm runoff. Stream base flow contributes most of the remaining two percent. Treatment plant discharges are minor sources. Total coliform bacteria concentrations within the Bay range from less than three to 1100 MPN per 100 milliliters. Typical coliform concentrations in Long Island Sound, near the entrance to Huntington Bay, are less than 70 MPN per 100 milliliters. As expected, the poorly flushed areas receiving treatment effluent and stream discharges (Northport Harbor, Centerport Harbor and Huntington Harbor) are closed to shellfishing.

2.5.6 Port Jefferson Harbor. Port Jefferson Harbor exhibits the best water quality of all the North Shore bays studied under the 208 Program. The total nitrogen loading from internal sources is approximately 800 pounds per day. Twenty percent of this total is contributed by point sources (Port Jefferson Treatment Plant). Total loads (wet and dry weather) indicate that groundwater inflow contributes 32 percent, stream base flow nine percent, direct rainfall fourteen percent and stormwater runoff 25 percent of the total nitrogen loading to the harbor.

The contribution of Long Island Sound to nitrogen concentrations in the harbor is relatively low Four observations in the Sound during June and July 1976 ranged from 0.20 milligrams nitrogen per liter to 0.41 milligrams nitrogen per liter with a mean of 0.30 milligrams nitrogen per liter.

Total nitrogen values ovserved in the harbor during June and July of 1976 ranged from 0.10 to 0.73 milligrams nitrogen per liter Highest concentrations were observed at the south end of Port Jefferson Harbor, in Little Bay, and in Conscience Bay. In July 1976, point sources and stream base flow accounted for 21 percent of the nitrogen at the south end of Port Jefferson Harbor. Non-point sources alone accounted for over twenty percent of the nitrogen in Little Bay and Conscience Bay The remaining nitrogen in all areas was contributed at the boundary

It is estimated that stormwater runoff is responsible for 97 percent of the total coliform input to Port Jefferson Harbor The remaining three percent is contributed mostly by stream base flow. The treatment plant discharge is only a minor source. This has resulted in the closing to shellfishing of areas near the mouths of the three streams discharging to the Port Jefferson Harbor system. Total coliform concentrations at the Long Island Sound boundary are below the maximum of 70 MPN per 100 milliliters allowable for shellfishing waters.

2.5.7 Peconic-Flanders. The Peconic Estuary-Flanders Bay system, located on the eastern end of Long Island, is characterized by long residence times. The total internal nitrogen loading was approximately 1100 pounds per day in 1976. Approximately 76 percent of this nitrogen loading was from point sources, which included duck farms and the Riverhead Sewage Treatment Plant. Stream flow and direct rainfall each account for an additional eleven percent of nitrogen loads. Bay water quality, under dry weather conditions, is impacted by sewage treatment effluent.

Concentrations of total nitrogen in the system range from 0.1 milligrams per liter to over 9.0 milligrams per liter. The higher concentrations are generally found in the Peconic Estuary and near Meetinghouse Creek. Very high chlorophyll a concentrations were observed in areas with high nitrogen levels. Chlorophyll a concentrations ranged from less than five micrograms per liter to over 370 micrograms per liter. Dissolved oxygen ranged from near zero to over fourteen milligrams per liter.

It was determined that 64 percent of total coliform loadings result from storm runoff Approximately thirteen percent is from stream base flow.

Total coliform bacteria concentrations in the Peconic/Flanders system ranged from five to 13,000 MPN per 100 milliliters. The Peconic Estuary is closed to shellfishing because of high bacterial concentrations.

2.5.8 **Great South Bay.** The Great South Bay is a large open estuary about 25 miles long and one to two miles wide. The average depth is near six feet. Water quality in the bay is largely affected by stream discharges, groundwater flow, two sewage treatment plants and tidal flushing.

Residence time in portions of Great South Bay is two to three months. This means that a parcel of wastewater requires about two or three months to be flushed out of the bay. It also means that, at any time, the bay contains nearly all the wastes and freshwater discharged to it over the last two or three months.

Total nitrogen loading to the Great South Bay is approximately 6,600 pounds per day. Of this total, approximately 39 percent is from base streamflow, sixteen percent from groundwater inflow, 26 percent from direct rainfall, seventeen percent from storm runoff and only two percent from point sources. Total nitrogen concentrations observed in November 1976 range from 0.12 to 1.72 milligrams nitrogen per liter The values generally increase from west to east, with highest concentrations found near Bellport Bay (Carmans River).

Chlorophyll a concentrations ranged from one to 90 micrograms per liter. Dissolved oxygen concentrations ranged from 0.2 to fourteen milligrams per liter. The lower values of dissolved oxygen are generally toward the western end of the bay and are not found in conjunction with the higher chlorophyll a levels.

The shallow nature of the Great South Bay, the abundance of macrophytes, and the benthic oxygen demand all contribute to the oxygen balance of the Great South Bay. As a result of the long residence time in the bay, phytoplankton abundance is often limited by nitrogen depletion.

Approximately 90 percent of the total coliform bacteria loadings to Great South Bay are from stormwater runoff. The remainder is primarily from base streamflow. Total coliform concentrations in Great South Bay ranged from less than two to greater than 35,000 MPN per 100 milliliters in the vicinity of Bayshore Cove. Portions of the Great South Bay near stream discharges are closed to shellfishing as a result of high bacterial concentrations.

2.5.9 **Western South Shore Bays.** The western South Shore bays include Hempstead, East, Middle and South Oyster Bay. These bays comprise a series of interconnecting channels, marshes, tidal flats and islands. Hydraulic residence times are relatively small compared to Great South Bay, and flushing is good. However, there are a number of large pollutant sources.

Total nitrogen loading is approximately 22,400 pounds per day, 75 percent of which is from point sources. Groundwater inflow and stream base flow contribute an additional seven and ten percent, respectively. Storm runoff contributes only four percent, and direct rainfall two percent of total nitrogen loading. Total nitrogen concentrations within the bays ranged from 0.03 to 2.4 milligrams nitrogen per liter. Areas in the vicintiy of discharges, particularly the Bay Park Sewage Treatment Plant, showed the highest concentrations.

Chlorophyll a concentrations ranged from less than one to 130 micrograms per liter, illustrating the potential for large phytoplankton production. Dissolved oxygen concentrations ranged from 0.04 to fourteen milligrams per liter. The oxygen concentrations are primarily a result of organic matter oxidation, algal respiration and benthic oxygen demand.

Approximately 83 percent of total coliform loadings to the western South Shore bays result from storm runoff. Point sources account for approximately fifteen percent. Specifically, in Hempstead Bay, point sources contribute approximately 62 percent of total coliform; 36 percent comes from nonpoint sources. Total coliform bacteria concentrations in the bays ranged from less than two to greater than 24,000 MPN per 100 milliliters. Virtually all of the western South Shore bays are closed to shellfishing because total coliform concentrations exceed the standard. It should be noted, however, that the contribution of fecal coliform loadings is less evenly distributed between runoff and point sources with the former accounting for roughly 96 percent, and the latter for four percent.

2.5.10 **Moriches Bay.** Moriches Bay lies to the east of Great South Bay on Long Island's South Shore. An estimated 2100 pounds per day of nitrogen are discharged to the bay, mainly from groundwater underflow (33 percent) and stream base flow (30 percent). Point sources of discharges from duck farms account for fourteen percent of the nitrogen loading, while direct rainfall and runoff together contribute 23 percent. There are no known measurements of nitrogen input from duck sludge deposits, and it is therefore nearly impossible to estimate any present day nutrient loadings.

Virtually 100 percent of total and fecal coliform loadings to Moriches Bay are from stormwater runoff. Total coliform concentrations commonly exceed 70 MPN per 100 milliliters in tributaries of Moriches Bay, with an observed range from less than three to greater than 2,400 MPN per 100 milliliters. Several tributaries and their mouths are closed to shellfishing due to total coliform concentrations in excess of the standard.

The status of Moriches Inlet is a major influence on water quality. The inlet is at present open, providing more tidal flushing than at any other time in the past 40 years. Total nitrogen concentrations in Moriches Bay average around 0.6 milligrams nitrogen per liter. Water quality in the bay has been steadily improving due to stabilization and natural enlargement of the inlet and recent reductions of point source loadings.

2.5.11 **Shinnecock Bay.** Shinnecock Bay lies to the east of Moriches Bay and receives a relatively small nitrogen loading (500 pounds per day). The largest single source of nitrogen to the bay (48 percent) is direct rainfall, There are no point sources. Coliform loadings to Shinnecock Bay are due solely to stormwater runoff. Observed coliform concentrations throughout

Shinnecock Bay are typically below ten MPN per 100 milliliters. As a result, there are presently no areas closed to shellfishing in Shinnecock Bay. Also, as a result of the small nitrogen loading, Shinnecock exhibits excellent water quality. The average total nitrogen concentration in the bay is approximately 0.32 milligrams nitrogen per liter.

2.5.12 Mecox Bay. Mecox Bay is a shallow coastal embayment located east of Shinnecock Bay on Long Island's South Shore. Mecox Bay receives an estimated 310 pounds per day of nitrogen of which groundwater underflow contributes 49 percent, stream base flow 21 percent, stormwater runoff 21 percent and rainfall nine percent. There are presently no point sources to Mecox Bay. In addition, there is no clear evidence to suggest that duck sludge deposits created by the past operation of the Mecox Bay Duck Farm do or do not contribute nitrogen to the bay. Coliform contamination in excess of the State standard occurs in Mecox Bay due mainly to stormwater runoff. As a result, most of Mecox Bay is closed to shellfishing.

Despite this small loading to the system, Mecox Bay has exhibited water quality problems, especially in its side embayments. Total dissolved inorganic nitrogen concentrations have average 0.77 milligrams per liter in Hayground Cove. Coliform concentrations frequently contravene standards in Hayground Cove and Mill Creek, probably as a result of stormwater runoff loads. The only outlet for the bay is an ephemeral channel connecting it to the Atlantic Ocean. This inlet provides limited flushing and drainage to Mecox Bay approximately 50 percent of the time.

2.5.13 Comparison of Bay Water Quality. Any evaluation of surface water quality necessarily requires a consideration of physical, chemical and biological processes. Unfortunately, existing governmental regulations set standards for only two parameters normally considered in marine water quality assessments. Dissolved oxygen and coliform bacteria levels have traditionally been measured for most of the waters on Long Island, and are used by the State as the basis for the classification of areas as to their "best use." Table 2–16 presents data on both dissolved oxygen and total coliforms for each bay system, and the frequency with which State standards for these parameters have been contravened. In addition, data on total nitrogen and chlorophyll a levels are presented. These parameters have been shown to be highly useful in determining the general biological state of the marine waters of Long Island. Analyses of historical and newly acquired 208 data have indicated that total nitrogen values of approximately 0.4 milligrams nitrogen per liter and chlorophyll a levels of about twenty micrograms per liter can be used as guidelines for evaluating the overall biological state of each system.[28]

Table 2–16

SUMMARY OF WATER QUALITY DATA AND FREQUENCY OF STANDARDS CONTRAVENTION FOR LONG ISLAND MARINE WATERS

	Manhasset Bay	Hempstead Harbor	Oyster Bay	Huntington-Northport Complex	Port Jefferson Harbor	Peconic-Flanders Complex	Hempstead Bay	Middle Bay	East Bay	S. Oyster Bay	W. Great South Bay	C. Great South Bay	E. Great South Bay	Moriches Bay	Shinnecock Bay
Diss. O_2+ (ppm)	2–19	2–17	3–18	4–15	4–10	0.2–12	1.2–14.1	0.4–14.0	3.8–15	1–15	0.2–15	2–15	3.6–10	–	–
T Coli.+ (MPN/100 ml)	4–11000	3–11000	2–11000	2–11000	2–1600	2–15000	3–24000	3–11000	2–24000	2–11000	2–35000	2–1600	2–24000	<3–2400	<3–1100
T Nit.+ (mgN/l)	0.1–3.4	0.3–16.8	0.1–0.5	0.1–1.4	01.–0.7	0.1–11.8	0.03–2.38	0.08–1.62	0.09–0.63	0.12–0.76	0.13–1.24	0.12–1.65	0.51–1.72	0.1–1.6	0.1–0.6
Chl a+ (mg/l)	2–308	4–220	10–35	1–49	1–18	1–372	<1–130	<1–40	3–50	3–14	1–50	1–90	1–46	–	–
T. Col. % exceed 70 MPN/100 ml	11*	11*	24	26	33	55	16	8	6	33	46	38	40	27	10
Diss. O_2 % below 5.0 ppm	17	46	5	36	4†	60	20	24	3	6	45	16	8	–	–
Chl a % above 20 mg/l	59†	60†	57†	21†	<1†	15	14	10	8	<1	61	42	62	–	–

\+ *range includes historical and newly acquired 208 data.*

† *indicates frequency of contravention calculated based on average of 208 data only—all other frequencies based on historical data.*

* *criteria is based on 2400 MPN/100 ml—therefore % contravention of 70 MPN/100 ml would be significantly higher.*

Source: Tetra Tech Inc. 1977, "Water Quality Evaluation—Western Long Island Sound," Prepared under contract to the Nassau-Suffolk 208 Program Study.

Several general conclusions can be drawn from the data presented in Table 2–15.

1. All bays exhibit ranges of dissolved oxygen concentrations that periodically contravene the five milligrams per liter standard. Hempstead Harbor and western Great South Bay show the highest frequency of depressed oxygen values, whereas Oyster Bay and Port Jefferson Harbor on the North Shore, and East Bay and South Oyster Bay on the South Shore, exhibit the lowest frequency of low oxygen levels. (Moriches and Shinnecock Bays were not evaluated for this parameter.)
2. All areas studied show total coliform concentrations above the 70 MPN per 100 milliliters standard set for shellfish areas. Historically, sampling locations are not uniformly distributed, but rather concentrated in areas where contravention of the standard is expected to occur, in order to determine the necessity for closing shellfishing areas. Consequently, the record is biased toward high bacterial values. The percent frequency of contravention seems to indicate that the Peconic-Flanders and Great South Bay systems exhibit the most persistently elevated coliform values. Unfortunately, the only historical data available for Manhasset Bay and Hempstead Harbor were analyzed with respect to the swimming water standard of 2400 MPN per 100 milliliters. Had available data for these areas been based on the 70 MPN per 100 milliliters criterion, both areas would have shown significantly higher frequencies of coliform contamination. The majority of the open water areas of Great South Bay are free of coliform contamination, and indeed, almost all open water areas are certified for commercial shellfishing. Areas closed to shellfishing in August 1977 are shown in Figure 2–8.
3. There are large regional variations in total nitrogen concentrations. North Shore bays generally exhibit slightly lower values than the South Shore bay systems. The influence of treatment plant locations can be seen in Manhasset Bay, Hempstead Harbor, Peconic-Flanders and the Hempstead Bay system.

   In the Nassau County South Shore systems, values decrease from west to east, reflecting increased flushing and the distance from the Bay Park Sewage Treatment Plant outfall. Values in Great South Bay generally increase from west to east, reflecting the inputs from Carmans River and the decrease in flushing with increasing distance from Fire Island Inlet. All bays periodically exceed 0.4 milligrams nitrogen per liter This has been suggested as the concentration below which abnormally high fluctuations in dissolved oxygen levels would not be expected. Indeed, all bays exhibit phytoplankton "bloom" conditions from time to time, with concommitant fluctuations in dissolved oxygen levels.
4. Chlorophyll a concentrations are used as an indicator of the standing crop of phytoplankton.[29] Larger fluctuations in this parameter often indicate the probability of associated fluctuations in nitrogen and dissolved oxygen. This is readily apparent in Manhasset Bay, Hempstead Harbor, Peconic-Flanders and the Great South Bay systems. Oyster Bay and Port Jefferson Harbor on the North Shore, and South Oyster Bay on the South Shore, exhibit the narrowest range of chlorophyll a values.

2.6 The Long Island Ecosystem

The following discussion on the Long Island ecosystem is based on information taken from a report prepared by Energy Resources Company Inc.,[30] and contained in Section P of the Areawide Waste Treatment Mangement Plan.

2.6.1 Ecological Processes on Long Island. The functioning of the Long Island ecosystem is governed by several processes that integrate the biological elements and cycle and transport material. The major processes affecting the food web include nitrogen cycles, phosphorus cycles, organic matter cycling, land-water interactions and surface-groundwater interactions. The nature of one of these processes on Long Island is indicated in Figure 2–9. Present stresses on the Long Island ecosystem include accumulations of trace contaminants, modification of wetland habitats by point and non-point source inputs, and various chemical discharges. The reduction in shoreline wetlands has eliminated much of the capability of the bays to easily assimilate sediment, and organic and nutrient material loadings. Groundwater-surface water relationships have also been alterd by development, that is, the substitution of impermeable surfaces for natural vegetation, and sewering.

2.6.2 Existing Ecological Communitites. The Nassau-Suffolk Region is characterized by complex ecological systems, of which the chief components are offshore water, bays and estuaries, streams and lakes, wetlands, land, and groundwater. A number of significant types of interactions tie together the six subsystems with respect to the environmental processes affected by waste treatment (nutrient cycles, organic cycles, food web). Most treated and untreated wastes are discharged to offshore areas, bays and land some are discharged to streams and lakes.

The present conditions and areal extent of the various subsystems can be assessed. In the following discussion, offshore water, bay and estuary, stream and lake, wetland and land systems are discussed in order. Finally, the processes occurring in these systems are considered. A discussion of groundwater has been provided in Section 2.4.

Each of the subsystems presented below can be further divided into smaller systems, which are termed "habitats." Diverse habitats generally permit a variety of life forms to flourish, and provide many predator-prey relationships, which promote system resiliency. Easy access to food sources often allows the development of productive fisheries. The edges of bays

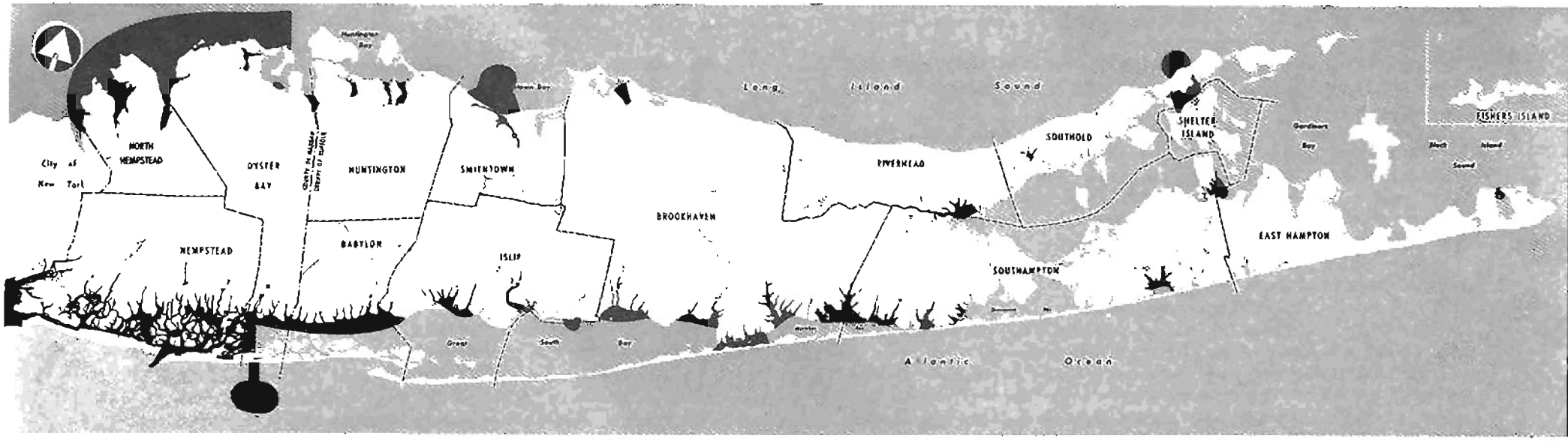


FIGURE 2–8 *Areas Closed to Shellfishing in August 1977*

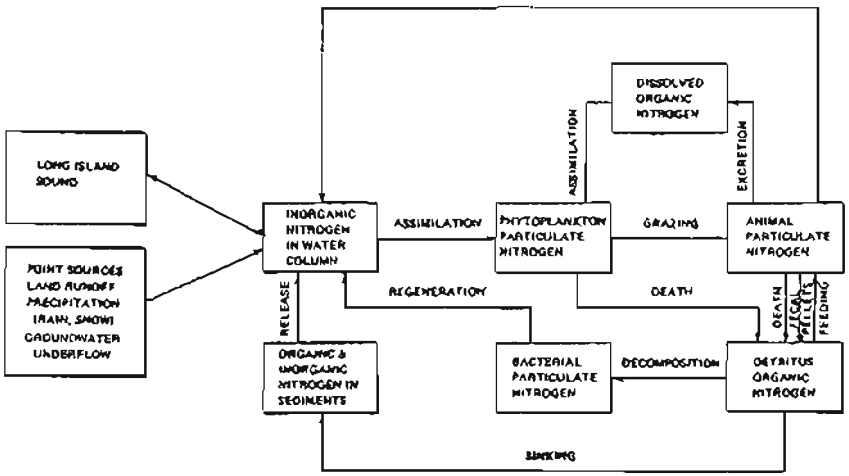


FIGURE 2–9 *Typical Nitrogen Cycle for a Bay Ecosystem*

Source: Energy Resources, Inc., 1977, "Environmental Tradeoffs on Long Island with Respect to Areawide Waste Management," Prepared under Contract to the Nassau-Suffolk 208 Program Study.

provide a simple example of the importance of habitat diversity. The various natural "edge" habitats include *Spartina alterniflora* marshes, *Spartina patens* marshes, sandy beaches, gravel and boulder beaches, bluffs, mudflats, and stream mouths. In many bays, large areas of such habitats have been replaced with uniform, bulkheaded shoreline. These altered areas are generally less ecologically productive except, perhaps, for phytoplankton blooms. Oyster Bay, with a diversity of shoreline habitats, supports a productive community of shoreline uses: waterfowl, sea birds and mammals; Manhasset Bay and Hempstead Harbor, with less diversity of habitat and a great proportion of altered shoreline, mainly support bottom and water column users such as shellfish and finfish.

2.6.2.1 **Offshore Subsystems.** The offshore ecosystem is composed of several ecological habitats, commonly termed marine zones. These are: the surface film, where ultraviolet radiation inhibits productivity; the near-surface layer, which is highly productive; the water column, which is sparsely inhabited; the near-bottom layer, which is productive; and the benthic zone, which is organized around processing of detritus. The offshore waters of Long Island include Block Island Sound, Long Island Sound and New York Bight.

Open waters are characterized by significant local and regional horizontal and vertical circulation patterns. Thus, materials introduced in a dissolved or suspended state tend to be rapidly dispersed. Despite rapid

dispersion, western Long Island Sound has high pollutant concentrations that are attributable to East River discharges.

2.6.2.2 Bay and Estuarine Subsystems. Bay subsystems include a variety of habitats. Each of the six bays studied in detail has its own particular ecological characteristics.

Manhasset Bay and Hempstead Harbor are the closest to New York City. Hence, they have a relatively developed shoreline, and adjoining Long Island Sound waters tend to be of low quality. The two bays are long and narrow, and are well flushed by tidal action. They are generally characterized by few wetlands, high levels of water pollutants, shellfish populations contaminated by coliform bacteria, and minor fish kills.

Farther east, Oyster Bay has a well protected shoreline, large areas of wetlands, and low pollutant levels, except in a few highly localized problem areas. The bottom substrate is generally suitable for oyster production, and an active oyster mariculture program is carried out. The wetland, creek and pond habitats are suitable for invertebrate and fish spawning.

Huntington Bay is a complicated bay system containing well-flushed bay areas and less well-flushed harbors and creeks. The northeast sections contain shallows and mudflats. The harbors are presently subjected to significant pollutant loads, while the open bay areas exhibit generally low pollutant levels. Wetlands are limited.

Port Jefferson Harbor is the cleanest of the six North Shore bays. This may be attributable to its easterly position on the North Shore. It is a small harbor with limited diversity of habitats. However, the adjoining Conscience and Little Bays are relatively undeveloped, with extensive wetland areas.

Peconic-Flanders is a large bay-estuarine system, which grades from deep and well-flushed in Little Peconic Bay to shallow and poorly-flushed in the Peconic estuary. Many of the creeks tributary to Flanders Bay have been dredged and display eutrophic conditions. Some of these creeks support extensive wetlands. The shallows and wetlands are key fish spawning areas.

The eastern part of the South Shore bay system tends to be very shallow and poorly flushed. The western bays are better flushed. Essentially all of the Nassau County South Shore bays have been closed to shellfishing due to elevated coliform concentrations. On the other hand, in Great South Bay, in Suffolk, the only areas closed to shellfishing are located along the northern shore, at the river mouths. Both systems support a great diversity of estuarine forms and are prime spawning areas for shellfish. Great South Bay provides a suitable habitat for bottom dwellers such as hard clams and flounder.

Phytoplankton are a major primary producer in bay systems. They can be sensitive to changes in water quality, particularly with respect to nitrogen levels, nitrogen/phosphorus ratios and turbidity. It is generally agreed that nitrogen/phosphorus ratios of 10:1 or higher are usually correlated with high phytoplankton species diversity, whereas values below 10:1 are generally found in areas associated with elevated algal biomass and low species diversity. Water quality can give an indication of what flora and fauna may be present in a body of water, and conversely, phytoplankton biomass and diversity can give an indication of water quality. Highly turbid waters have a reduced phytoplankton mass. Polluted waters generally have very small diversity. Excess nitrogen can stimulate algal production with the attendant problems associated with eutrophication. Algal blooms shift productivity and species distribution at the lowest level of production. Phytoplankton blooms have been observed in most Long Island bays.

The bays, estuaries and Long Island Sound support large fish populations, many of which have great commercial value. These populations are sensitive to changes in salinity, phytoplankton, and zooplankton levels, and also to the abundance of shellfish and other finfish upon which they feed. The life cycles of some species are dependent upon both the bay and wetland habitats, while some species depend on wetlands mainly as spawning or nursery areas. The important finfish species of Long Island can be conveniently divided into two categories. resident and migratory populations.

Among commercially valuable finfish inhabiting the bays are the winter flounder, menhaden and blackfish; the latter two species, however, move offshore to spawn. Northern pipefish, mummichug and Atlantic silversides are the most important resident forage species in several bay systems, especially Great South Bay.

Bluefish and striped bass are the most abundant of the migratory species that spend a portion of their life cycle in Long Island waters. Northern porgy and weakfish, somewhat less abundant migratory species, spawn in shallow bays and estuaries where the larvae remain for one season.

Shellfish and invertebrates are plentiful; however, the shellfish industry is affected by sewage disposal and non-point runoff since shellfish are generally found in shallow waters close to the shore or in bays. In 1975, 214,000 acres or eighteen percent of the Long Island shellfish beds were closed because of coliform bacteria contamination.

Commercially significant shellfish species include lobster, oyster, many species of clams, blue mussel, bay scallop and, in some years, blue claw crab. Hard clams are particularly abundant in Great South Bay, while oysters are found in large quantities in Oyster Bay

The bays adjoining wetlands on Long Island serve as wintering grounds for some birds, breeding grounds for others, resting stops for many birds migrating on the Atlantic flyway, and permanent homes for other species. Scoters, black ducks, scaup, mergansers, goldeneye and brant overwinter in many wetlands on Long Island. Black ducks, Canada geese, mallards, gadwalls and wood ducks also breed there. Other species commonly seen in the wetlands of the region include old-squaws, canvasbacks, ringedneck ducks, buffleheads, pintail ducks, baldpates, teal, ruddy ducks and coots. These populations are affected by bay water quality, by changes in wetland areas, and by alterations of beaches and other bird habitats.

2.6.2.3 Streams, Lake and Freshwater Wetlands. Although streams,

lakes and freshwater wetlands are of minor areal importance in the Long Island system, these water bodies are significant. Detailed information concerning the ecology of many Long Island freshwater bodies is minimal. The streams are generally edged with a narrow band of wetlands. These wetlands, together with epibenthic plants, are nutrient cyclers. In those areas where the streams have been channeled or the wetlands have been filled, nutrient and organic cycles are curtailed and pollutants are transported downstream.

The scattered lakes are generally small and shallow. Many are impoundments, formed by damming of streams. Whereas stream water usually exhibits a significant flow, water in impoundments has a high residence time and thus is susceptible to nutrient and coliform inputs. Residence time is related to the rate of stream inflow and outflow. Past sewering and pumping, particularly in Nassau County, have lowered the water table, and hence streamflow in a number areas, and have thus increased residence time in some impoundments. Many Long Island lakes and streams display eutrophic conditions and high coliform counts as a result of wild and semi-wild waterfowl pollution and runoff. In addition, coliform die-off rates are extended due to the warmer water temperatures, thus maintaining high levels for longer periods. Swimming is only allowed where an average value of total coliform is below a specified standard, and adequate sanitary and safety facilities are provided.

2.6.2.4 Marine Wetland Subsystem. Wetlands serve as nurseries and spawning grounds for many commercially important fishes and shellfishes. They also protect the shoreline from the intensive erosion that might otherwise occur during storms, and they serve to attenuate many harmful effects of such pollutants as human and animal wastes and wet-weather runoff by assimilating nutrients into a diverse food web. Wetlands and tidal marshes cover 545 square kilometers of Long Island, and their continued viability is a major environmental concern in regional wastewater management.

Immediately above the mean high water line in wetlands, there is a low marshy area characterized by infrequent inundation and soft, peaty, often saline soils. This zone is usually dominanted by either of two plants, salt marsh hay *(Spartina patens)*, or spike grass *(Distichlis spicata)*, or by a combination of the two. The saltworts are less abundant but still common. A variety of marsh plants that are less tolerant of saltwater inundation grow at somewhat greater elevations above the high tide level. One of the most notable among these is the marsh reed, *Phragmites communis*. Phragmites thrive in a wide range of soil types, including very saline soils. As a result, it frequently dominantes spoil banks created during dredging operations or landfilling. Other marsh species include the cattails, black grass, groundsel bush and marsh elder.

The greater part of Long Island's tidal marshes and wetlands, 314 square kilometers, are in Suffolk County. The remaining 231 square kilometers are in Nassau County, where large areas of salt marsh are located in the sheltered South Shore bays in the Towns of Hempstead and Oyster Bay.

2.6.2.5 The Inland Environment. Five major types of plant cover existed on Long Island prior to development: (1) the red oak forest; (2) pine-oak and pine-dune forest; (3) scarlet oak/black oak forest; (4) Hempstead Plains (grasslands); and (5) downs grassland and dune heath. The extensive red oak forest of the western third of the Island has virtually disappeared and very little remains, even in Suffolk County. The Hempstead Plains have been almost totally destroyed, splinter fragments remain only in the vicinity of Mitchel Field. The pine-oak and pine-dune forest and the scarlet oak/black oak forest still survive in large tracts. Small areas of the downs grasslands and dune heath remain.

Although many other tree and plant species are found scattered, or even in local abundance, at various sites, and although many areas have been cleared and the indigenous vegetation removed, the historically dominant communities still exist in certain areas.

The major types of altered habitats that exist on Long Island include (1) urban or suburban residential and commercial areas, (2) agricultural lands, (3) old fields, and (4) recharge basins. Each of these plays a role in the terrestrial subsystem.

The terrestrial subsystem includes both natural and man-induced habitats. Generally, Long Island vegetation is a product of the Island's geologic setting. The sandy, glacial soil supports such scrub growth as pitch pine, black pine and black oak. Long Island's chief agricultural activity is the growing of potatoes, which do well in sandy areas. The sandy soil column allows rapid assimilation of precipitation. The leaching of fertilizer tends to be rapid, although vegetative cover slows the process.

There are specific settings in which maintenance of vegetation is of particular ecological importance. As discussed in 2.6.1, a diversity of habitats is generally desirable. This is particularly true of the land/water interface, since aquatic species need the protection of the upland vegetation. The preservation of forested or shrub buffers at the edge of wetlands and ponds, and along streams, is critical.

2.7 Summary

Pollution enters the ground and surface waters of Long Island from both point and non-point sources. Point sources include such discharges as municipal waste treatment plant effluents and industrial wastes, both treated and untreated. Nassau County treats about 107 MGD of domestic and industrial wastes, and discharges all except two MGD to surface waters. The two MGD is recharged and, of this, 40 percent is of industrial origin. In contrast, only 0.4 percent of the flow discharged to surface waters is of industrial origin. Suffolk County currently treats sixteen MGD, although, by 1986, when the Southwest Sewer District plant is operating at capacity, this quantity will rise to 46 MGD. At the present, Suffolk's treated effluent, of which ten to fifteen percent is of industrial origin, is discharged to ground and surface waters in roughly equal amounts. Nassau also generates 90 million

gallons per year of waste treatment sludge, mostly disposed of in the Atlantic Ocean. Suffolk generates twenty million, mostly disposed of in landfills.

Non-point sources of pollution comprise stormwater runoff from impervious surfaces, cesspools and septic systems, fertilizers and pesticides and groundwater underflow to streams and bays. Stormwater finds its way into both ground and surface waters. Effluents from domestic on-site waste disposal systems enter the groundwater. Fertilizers and pesticides are applied to the ground surface, and rainfall washes them down into the groundwater. In certain areas, contaminated groundwater carries pollutants into streams and marine waters by underflow.

The concept of "safe" or "permissive" yield is defined as the volume of groundwater that can be withdrawn from the aquifer and used consumptively on an annual basis without producing undesirable results. The safe yield for Nassau County has been estimated at 151 MGD, and that for Suffolk County at 466 MGD. In contrast, although current withdrawal rates are considerably higher, consumptive losses are estimated at 133 MGD for Nassau and 30 MGD in Suffolk. Daily pumpages in Suffolk are well over 110 MGD, and peak days pumpages over 300 MGD, but a substantial portion is returned to the system and not consumed, or is discharged to the ocean.

Chlorophyll a is an indicator of the standing crop of phytoplankton, and if large fluctuations of chlorophyll a occur, then large fluctuations occur in total nitrogen and dissolved oxygen levels. Such changes are observed frequently in Manhasset Bay, Hempstead Harbor, Peconic Bay and Great South Bay

Because of pollution in western Long Island Sound, the water quality and marine environment in the North Shore bays show steady improvement with distance from New York City. Superimposed on this pattern are local variations due to runoff and poor flushing in certain creeks and harbors. The amount of development falls off from west to east, so that the easterly bays have better water quality and more extensive wetlands. Most of the South Shore bays in Nassau County are closed to shellfishing. However, in the Great South Bay, in Suffolk County, such closures are confined to river mouths. In the Peconic Estuary-Flanders Bay system, tidal flushing diminishes going from the bay into the estuary. There are extensive wetlands on the tributary creeks, and eutrophication is frequently observed.

All bays support large and valuable fish populations, which are sensitive to changes in salinity and plankton levels. Shellfish and invertebrates are also plentiful. Shellfish are particularly sensitive to sewage disposal and non-point pollution runoff. Marine wetlands and tidal marshes cover 545 square kilometers, and provide habitats and wintering areas for many bird species.

The total surface area of streams and lakes, and their associated wetlands is small. The lakes are generally shallow, and suffer from eutrophication due to waterfowl pollution and surface runoff.

Long Island's sandy glacial soil supports scrub growth, such as pitch pine, black pine and black oak. Much of the original tree cover has been lost to development. The sandy soil allows the rapid seepage of rainfall, which, in turn, carries contaminants rapidly into the groundwater. Vegetative cover helps to slow this process.

In sum, Nassau and Suffolk Counties present a picture of rapid growth and development, in the course of which the area's great natural resources have been seriously impacted. Those that remain are still of the highest quality. Section 3.0 addresses the alternatives for the protection of these resources.

Long Island's geologic system is characterized by three geologic formations, stratified and generally hydraulically connected. The uppermost aquifer usually contains the water table surface, and is most susceptible to contamintion as a result of activities on the land surface. Water quality in the uppermost aquifer is somewhat variable, at times containing objectionable concentrations of iron and manganese, and at times, evidence of the leaching of domestic wastes. Water quality variability in shallower wells is more related to population density and land use. Concentrations of most contaminants are somewhat lower in Suffolk than in Nassau. For example, Nassau County wells show an average nitrate level of 4.5 milligrams per liter compared to 2.3 milligrams per liter in Suffolk. Similarly, Nassau County shallow wells range in chloride concentration from nineteen to 83 milligrams per liter, whereas Suffolk County averages twelve milligrams per liter.

The next deeper aquifer is the Magothy formation. Its background water quality is excellent, having very low dissolved solids. In the deep recharge area, the Magothy formation is affected by seepage of contaminants from the water table aquifer, as evidenced by nitrates detected deep in the Magothy in the center of Nassau County.

The deepest aquifer is the Lloyd, and this too has excellent background quality, with low dissolved solids. In some locations, the iron content can exceed the drinking water standard. The Lloyd aquifer has not yet been greatly developed for water supply.

Organic chemicals have been appearing in the groundwater in recent years. Their concentrations have been very low, but their presence is a cause for public concern. Fifteen wells have been removed from service because of trace amounts, mostly in industrial areas.

In the marine waters of Long Island, all bays have shown dissolved oxygen concentrations which periodically fall below the standard of five milligrams per liter. Hempstead Bay and western Great South Bay show this periodic drop most frequently. Similarly, all bays show high total coliform counts periodically, at least in some locations. North Shore bay waters generally contain lower total nitrogen concentrations than South Shore bays. Nassau County South Shore bays show a decrease in total nitrogen level from west to east, attributable to the improved tidal flushing as one moves east. In contrast, Great South Bay waters show a decrease in total nitrogen from east to west. Again, this is probably due to improved tidal flushing, in this case as one approaches Fire Island Inlet.

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Section 3 Alternative Wastewater Management Programs

3.0 Introduction

This section outlines alternative wastewater management programs in terms of:

1. objectives
2. source control alternatives (both point and non-point), and
3. methods by which objectives may be met, using a combination of traditional and innovative structural and non-structural alternatives.

3.1 Objectives

The various alternative wastewater management programs all have as their general objective the development of a comprehensive management plan for the treatment and disposal of waste to protect the public health and natural resources of the Long Island 208 Region.

3.1.1 Public Health Objectives. The major public health objectives may be met by (a) the continued protection and restoration of the quality of the water-table aquifer, and the deeper aquifers, in order to assure the availability of potable water, and (b) the maintenance and/or improvement of water quality of both fresh and marine surface waters so as to ensure their use for swimming, fishing and other recreational and commercial purposes.

A. Protection of Groundwater. There is a wide range in the types and locations of the sources of groundwater contaminants. Landfills, industrial discharges, sewage treatment plant recharge basins, accidental spills, process and incinerator wastewater, cesspools, rainwater and stormwater recharge are important sources of pollutants for Long Island groundwater.

Just as the sources of contamination vary widely, the materials contributed by each source also vary. Inorganic and organic nitrogen, halogenated hydrocarbons, heavy metals, pesticides, deicing salts, coliform bacteria and viruses are all contributed by these sources. Nitrate and organic chemical contamination are of particular concern in the Long Island area.

Within this category, items that impact the public health include failing cesspools, leakage from faulty or failing sewer collection systems, overloaded treatment systems, physical breakdown of wastewater treatment facilities and inactivation of treatment systems by plant upset. These conditions result in the contamination of ground and surface waters with nitrogen, coliform bacteria, viruses, inorganic ions, heavy metals and organic compounds.

B. Maintenance of Surface Water Quality. Shoreline development places the source of contamination due to human activities immediately adjacent to vital water resources. The erosion of stream banks and the destruction of marsh edges increase surface water contamination from fertilizers, silt, animal wastes and other pollutants. The location of sewage treatment plant outfalls may cause localized degradation of surface waters to levels that prevent their utilization for shellfishing and water-intensive recreational activities. In general, non-point sources contribute the greater part of the pollutant loading that endangers public health.

3.1.2 Natural Resources Objectives. The natural resource objectives include: (a) the protection of critical environmental zones such as primary recharge areas, marine and freshwater wetlands, and unique wildlife habitats; (b) the protection of biological resources, especially fin and shellfish populations, in the marine environment; and (c) the protection of biological diversity

A. Protection of Critical Environments. While public health aspects that relate directly to human diseases are obvious concerns to be addressed in a wastewater management plan, the protection of unique environmental zones has often been overlooked, or its importance underestimated. Development or loss of natural recharge areas increases non-point source contaminants in groundwater, such as nitrates, metals and organic chemicals. It also reduces the partial removal of nitrates in rainwater, which normally occurs in naturally vegetated areas. The loss of wetlands such as marshes, swamps and lowlying areas adjacent to streams increases erosion, siltation and the

runoff of nutrients and coliform bacteria to surface waters. Furthermore, these areas are highly productive and of the greatest importance in the food chain. The protection of these unique habitats is required by several Federal and State regulations.

Beyond the effects of the physical dislocation of these critical areas, their degradation due to quality changes resulting from adopted management philosophies must be considered. Strategies that result in the maintenance of public health but allow wholesale changes in the physical or chemical characteristics of surface waters can easily lead to loss or changes in unique natural resources. For example, decreases in groundwater levels can result in changes or losses of marshes, swamps and bottomland zones, with the resulting problem of erosion and runoff. Decreases in the streamflow may affect salinity regimes in the tidal portion of streams and the receiving waters of bays, possibly resulting in changes in spawning and nursery areas for marine organisms.

B. Protection of Biological Resources. The loss or change of existing populations of marine and freshwater organisms, while not necessarily directly affecting man's use of the marine zone, or impacting public health, could indicate a severe alteration in the physical and chemical properties of these waters. Any loss of these resources would also have serious economic consequences affecting the shellfish, sportfish and tourist industries. It must be remembered that, while the natural population of a marine organism such as the hard clam may be maintained, if it cannot be utilized because of contamination by coliform bacteria or viruses, then the population is effectively "lost" to commerce.

The maintenance of existing biological resources implies the prevention of any changes that will affect the normal functioning of the ecosystem. Furthermore, changes in phytoplankton density will result in alterations in dissolved oxygen levels, with subsequent effects on all animal populations in the area. These algal populations are highly dependent upon nutrients such as nitrogen and phosphorus. Any significant increases in nutrient levels may result in large scale changes in phytoplankton.

Decreases in streamflow may result in salinity changes, affecting the growth and reproduction of many marine organisms. Included here are dislocations of finfish populations due to the shifting of optimal salinities in nursery areas. Mid-bay outfalls may give rise to local salinity changes and increases in coliform bacteria levels, which may affect the health and marketability of shellfish. Stormwater runoff contributes coliform bacteria, heavy metals, pesticides, nitrogen and other contaminants to surface bays, and may severely impact the biological resources of these areas.

3.2 Identification of Wastewater Management Needs

Table 3–1 lists the main sources of contaminants and the wastewater management objectives that they impact. Table 3–2 lists the major types of pollutants they contribute to the environment, and the possible types of control options available. A number of conclusions can be drawn from these tables. It is obvious that a number of sources impact both public health and natural resource objectives. It is also apparent that the contaminants that are of major concern are common to a wide variety of sources. State and Federal standards exist for coliform bacteria, certain organics and heavy metals in drinking water. There exists a Federal drinking water standard of ten milligrams NO_3–N per liter. Nitrogen is the only parameter common to almost all public health and natural resource concerns for which total loadings can be calculated. Control of this contaminant from each source will in many cases lead to reduction or elimination of other pollutants. (There are, of course, some specific exceptions to this, as in the case of coliform bacteria,

Table 3–1

CONTAMINANT SOURCES AND IMPACTS ON PUBLIC HEALTH AND NATURAL RESOURCES

	Impacted Factors			
	Health		Resources	
Contaminant Source	Ground Water	Surface Water	Critical Environments	Biological
Animal wastes	X	X		X
Cesspools	X	X		X
Stormwater runoff	X	X	X	X
Rainwater	X			X
Leakage from sewer systems	X	X		X
Shoreline development		X	X	X
Development of recharge areas	X		X	X
Loss of wetlands		X	X	X
Changes in streamflow		X	X	X
Landfills	X	X	X	X
Recharge basins	X			
Industrial process water	X	X	X	X
Spills	X	X	X	X
STP operation*	X	X		
Siting of STP		X	X	X
Siting of outfalls		X	X	X
Siting of collection systems			X	
Residuals	X		X	X
Hazardous wastes	X	X	X	X

X – adverse impact *STP = sewage treatment plant

Table 3–2

WATER CONTAMINANTS, BY SOURCE AND TYPE OF CONTROL

	Contaminant					Control		
Contaminant Source	Coliform Bacteria	Nutrients (Nitrogen)	Organic Chemicals	Metals	Other	Structural	Non-Structural	None
Animal Wastes	X	X			Viruses	X	X	
Cesspools	X	X	X		Viruses	X		
Stormwater runoff	X	X	X	X	Viruses	X	X	
Rainwater		X		X	Acids			X
Leakage from sewer systems	X	X	X	X	Viruses	X		
Shoreline development	X	X	X		Sediments		X	
Development of recharge areas		X	X	X	Viruses	X	X	
Loss of wetlands	X	X	X	X	Sediments		X	
Changes in streamflow					Sediments	X	X	
Landfills	X	X	X	X		X	X	
Recharge basins		X	X	X			X	
Industrial process water	X	X	X	X	Variable	X	X	
Spills					Variable		X	
STP operation	X	X	X	X			X	
Siting of STP	X	X			Viruses	X		
Siting of outfalls	X	X			Viruses	X		
Siting of collection systems					Sediments	X		
Residuals	X	X	X	X		X		
Hazardous wastes			X	X	Variable	X	X	

organic chemicals and viruses.) It is for this reason that nitrogen has been selected as the primary parameter upon which the following treatment alternatives have been developed. However, it should be understood that other treatment may be required to remove specific contaminants not directly affected by nitrogen removal processes. In addition, the impacts of parameters not historically monitored, and therefore not specifically treated, require further evaluation.

A primary question is what levels of nitrate-nitrogen are consistent with both the public health and water resource objectives? As described previously, groundwater is the sole source of drinking water on Long Island. Therefore, if the public health standard is to be satisfied, the nitrate-nitrogen concentration in groundwater should not exceed ten milligrams per liter. Regulations require that, if a water supply reaches this concentration, the purveyor must immediately notify all customers.

Groundwater quality on Long Island is highly variable both in time and from place to place. In order, therefore, to satisfy the drinking water standard, this variation should be accomodated. A statistical analysis of groundwater data, obtained from wells in Nassau County, indicated that, if the *mean* nitrate-nitrogen concentrations in the Upper Glacial aquifer was six milligrams per liter, then there is a 90 percent chance that well samples will contain levels of nitrate-nitrogen less than ten milligrams per liter.

Although this result is preliminary, it is a useful criterion for managing the Region's nitrogen sources in a manner that ensures that the drinking water standard of ten milligrams per liter will probably not be violated in the Upper Glacial aquifer.

Surface water quality analyses, undertaken within the 208 Program, have demonstrated that levels of oxygen are largely determined by algal respiration and photosynthesis, and by the utilization of oxygen in the bacterial decomposition of dead algal material and other detritus. Large diurnal fluctuations of oxygen are highly undesirable. In particular, larvae of shellfish and other juvenile fish are vulnerable to low levels of oxygen. Given the dependence of algal production on nitrogen, it follows that controls that limit nitrogen will in turn reduce the range of oxygen fluctuations.

From data obtained during the 208 Program, an approximate relationship between nitrogen, chlorophyll a and levels of oxygen was computed, and a nitrogen guideline for the determination of waste load allocations for

marine receiving water was developed. An outline of the method of calculation is given in Section 8 of the Areawide Waste Treatment Management Plan. The results show that a total nitrogen concentration of 0.4 milligrams per liter or less will generally maintain chlorophyll a levels below 40 micrograms per liter, and will minimize diurnal fluctuations in dissolved oxygen levels. Although this recommended standard can only be regarded as preliminary, the limited data available supports the hypothesis that accelerated eutrophication will not occur where this concentration of chlorophyll a is not exceeded.

3.2.1 The Hydrogeologic Zones. As previously indicated, there are two broad public health objectives, one dealing with groundwater and the other with surface water. The primary objective in protecting the quality of groundwater is to maintain the resource as the regional water supply.

The major patterns of groundwater flow are such that the Region's deep groundwater reservoirs are mainly replenished over a broad area in the central part of the Bi-county Region, as shown in Figure 3—1. Recharge water entering this central area affects the quality of the middle and lower supply. The area outside the central area may be less critical in terms of water supply. On this basis, and considering the use of the groundwater, wastewater management zones can be defined in the Bi-county Region (Table 3—3 and Figure 3—2). It should be recognized that deep flow also occurs to the north of the northern limit of the Magothy in both Nassau and Suffolk. This flow occurs in the deeper portion of the Upper Glacial deposits which are the hydrologic equivalent of the Magothy in this area. In addition, the Upper Glacial aquifer is still utilized as a source of drinking water. Therefore, precautions should be taken to preserve or restore this aquifer as a source of potable water.

One approach to wastewater management is that of identification and protection of critical watersheds. In the Bi-county Region, the greater part of the Magothy aquifer may be identified as the prime source of future water supply. Those areas contributing to this aquifer should be subjected to the strictest management controls.

Zone I covers areas characterized by a deep flow system, which generally contribute water to the middle and lower portions of the Magothy. This zone is a primary source of drinking water in both counties. Shore areas of this zone require control of non-point sources of pollution in order to protect surface waters. Point and non-point source controls should be implemented in this zone to protect the public health.

Zone II has experienced serious groundwater quality problems in the Magothy in recent years, primarily due to organic chemicals. Most of the zone is included in Nassau County Sewage Disposal District Three, it is already highly developed, and is presently being sewered. Until the extent of the contamination is determined, all sources of groundwater pollution should be controlled in a manner similar to those in Zone I. Control of non-point

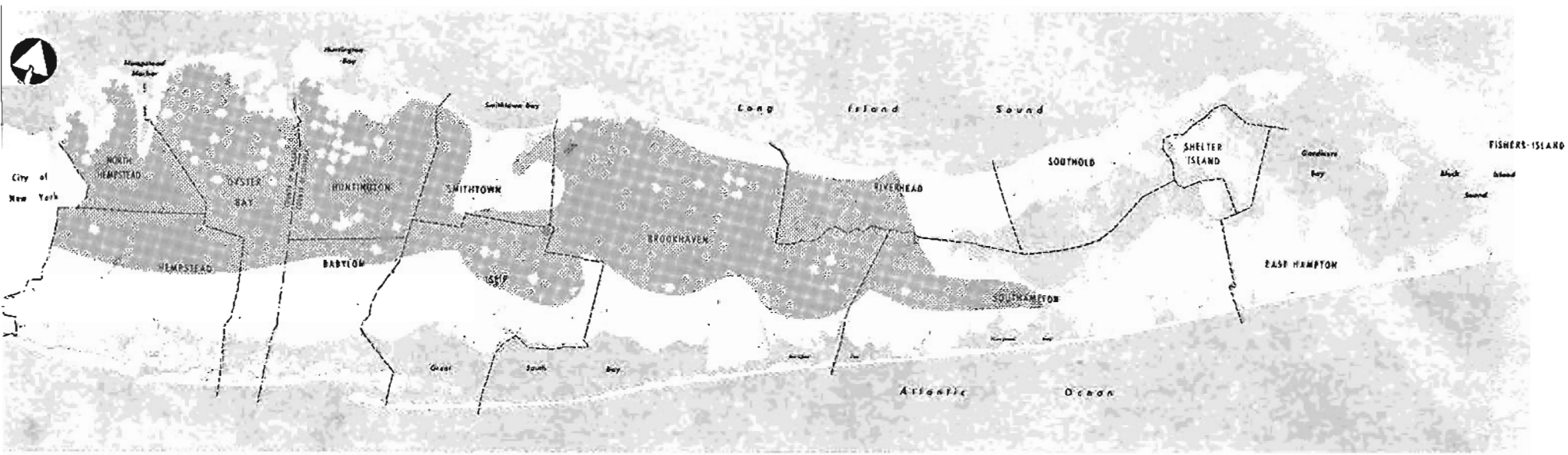


FIGURE 3—1 *Deep Flow Recharge Area*

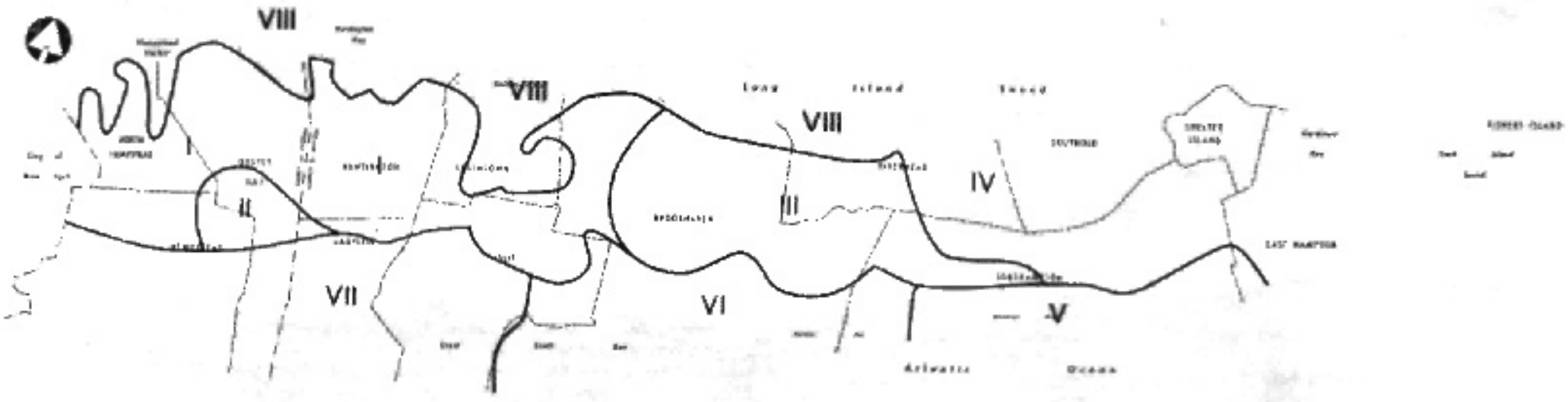


FIGURE 3–2 *Water Management Zones in the Nassau Suffolk 208 Study Area*

sources of pollution will be necessary for reasons of public health.

Zone III is an area of low density, primarily non-agricultural land use, which still has good quality groundwater in both the Upper Glacial and Magothy aquifers. Median nitrate-nitrogen concentrations in water from wells in this area have always been low. Moreover, since the hydraulic conductivities of both aquifers are high, there is considerable potential for water supply development in this zone. This zone should be protected by applying land use restrictions, as well as strict pollution source controls. In this zone, control of non-point sources is necessary for the protection of the resource itself, and the entire zone should be governed by non-degradation regulations.

Zone IV comprises the North Fork and the eastern part of the South Fork. This area has unique groundwater conditions, and special management alternatives apply to it. Intensive agricultural activities have resulted in nitrate-nitrogen concentrations in wells located in agricultural areas that are above six milligrams per liter, with many observations exceeding ten milligrams per liter. Although groundwater underlying agricultural areas shows definite signs of nitrogen-related contamination, the residential areas still have good quality water, and statistical examination of over 300 analyses from domestic wells located on the North Fork indicates that almost all have nitrate-nitrogen concentrations of less than three milligrams per liter. High chloride concentrations (over 250 milligrams per liter) have been found in a few areas on the North Fork, in New Suffolk, and along both shores of Great Hog Neck and Little Hog Neck. Public supply wells in the Greenport area have experienced saltwater upconing where pumpage was concentrated at one site. While there are many areas with acceptable water quality, any expansion of farming, without the adoption of proper fertilizer management procedures, will lead to increased nitrate contamination of groundwater. However, reduction or elimination of farm acreage and subsequent residential development may result in water supply problems, because most groundwater beneath these agricultural areas already contains very high nitrate concentrations. Based on assessments of the groundwater development potential in each of these areas, there appears to be sufficient available groundwater to support projected land uses, if pumpage is properly developed and managed. This conclusion is supported by the results of a detailed hydrologic model study of the South Fork, conducted as part of the 208 Program. However, because of the limited depth of fresh water on the forks, wastewater management controls must protect those areas that still have acceptable groundwater quality if the areas are to remain self-sufficient in water supply. Failing this, alternative engineering solutions based on water importation or large-scale renovation, will be extremely expensive. Public health questions in Zone IV are related to nitrate concentrations in groundwater. The protection of resources, both natural and recreational, is related to the quality of marine waters. Non-point source controls are relevant to both.

Zone V comprises the southwestern portion of the South Fork not

Table 3–3

WATER MANAGEMENT ZONES IN NASSAU AND SUFFOLK

Zone No.	Type of Location of System	System Characteristics
I	Deep Flow (Magothy recharge area)	Deep recharge with vertical flow.
II	Deep Flow (Magothy recharge area)	Area of substantially impaired groundwater quality.
III	Deep Flow (Magothy recharge area)	Higher grade reservoir Exceptionally high quality water with high potential yield.
IV	North Fork and Eastern South Fork	Local water quality problems, but with potential for development, particularly on South Fork.
V	Western South Fork	As previous, but little agricultural input.
VI	Surface Water Impact Area	Polluted groundwater has major impact on surface water, due to long residence time in bays.
VII	South Shore Shallow Flow System	Generally shallow and horizontal flow.
VIII	North Shore Shallow Flow System Shelter Island and Fishers Island*	Generally shallow and horizontal flow.

**Shelter Island and Fishers Island were considered separately.*

included in Zone IV. It differs from Zone IV in having less agricultural activity and, consequently, less of a fertilizer runoff and leaching problem. In all other respects, Zone V shares the characteristics of Zone IV.

Zone VI is that portion of the groundwater system that discharges to Moriches Bay and the eastern portion of Great South Bay. Because the flushing rate in eastern Great South Bay is so low contaminant concentrations are not sufficiently dispersed and diluted.

The shoreline of Zone VI has valuable recreational resources, and the adjacent bay has important shellfish resources. This zone should be covered by non-degradation regulations.

Zone VII and VIII are areas which are likely to contribute water only to the shallow groundwater flow system. This flow system discharges to streams and saltwater bays, and hence will affect the quality of the surface water Zone VII groundwater flows into the Nassau County South Shore bays, and has a more significant impact on marine water quality than the groundwater from the areas marked Zone VIII. The latter enters North Shore bays, whose water quality is more dependent on Long Island Sound.

Zones VII and VIII differ geologically. In Zone VIII areas, the Magothy formation has been completely eroded away and replaced by a deep glacial aquifer. The zones are also differentiated on the basis of sewering options. Zone VII is predominantly committed to comprehensive sewering, whereas Zone VIII areas are generally not. Possible exceptions to the shallow flow concept discussed here include those areas of heavy pumping such as in southwestern Nassau, where local reversals of gradient occur. Areas immediately surrounding high capacity supply wells situated in the shallow flow region could also act as local recharge zones. In addition, abandoned wells or wells with faulty construction can serve as conduits for contaminated water and allow movement from shallow to deep systems.

In the matter of nitrates, one may allow mean concentrations in shallow well water to reach six milligrams per liter in Zone I areas, whereas levels in Zone VIII might be allowed to approach ten milligrams per liter, without contravening surface water standards. In Zone VII, the eastern portion of the zone presently has low groundwater nitrogen concentrations. Increases in groundwater nitrogen in this area will increase the nitrogen loading to eastern Great South Bay. Nitrogen loadings from the western portion of Zone VII do not have as large an effect on eastern Great South Bay, due to the proximity of Fire Island Inlet. The boundary lines separating Zone I and Zones VII and VIII are not meant to be definitive, because there is a lack of data in some areas. The northern boundary of Zones V, VI and VII corresponds roughly to the limit of the Gardiners Clay or equivalent clays. These zones also are areas where available head data between the Magothy and the Upper Glacial indicate essentially horizontal flow in the Upper Glacial aquifer. The southern boundary of Zone VIII on the North Shore was determined using existing information on head distribution near the coastline and interpolating between these points. Flow in the upper aquifer in Zone VIII is, again, essentially horizontal. The area in Zone VIII near Smithtown coincides with the extent of the Smithtown Clay. Further investigation is required to evaluate the flow relationships in most areas before specific management schemes can be implemented. These especially include the Smithtown and Shoreham areas, as well as the southeast portion of Suffolk County.

In some localities, Zones VII and VIII are similar, in that they have a high water table and soils of low permeability.

3.2.2 **Surface Waters.** Fresh waters in the Nassau-Suffolk Region include several lakes, four major streams and numerous ponds and minor streams. Freshwater quality is a function both of groundwater quality and of the nature and volume of the pollutants carried in runoff originating in the immediate watershed. Freshwater streams contribute locally significant amounts of nitrogen and coliform bacteria to the bays.

These pollutants affect not only public health but also environmental resources. Abnormal changes in the volume of streamflow, such as might be expected to result from sewage collection and discharge of effluent to marine

waters, can be expected to produce changes in stream corridor and bay ecosystems. In the first instance, the changes will occur because of lowered water levels or disappearance of the streams; in the second, because of increased salinities resulting from reduced quantities of fresh water reaching the bays as streamflow and underflow.

In order to protect the marine surface waters and biological resources of Nassau and Suffolk Counties, nitrogen and coliform bacteria have been selected as the two key pollutants to be controlled. Nitrogen is contributed to the bays by point sources (principally municipal treatment plant discharges) and non-point sources. The non-point sources include groundwater underflow, stream base flow, stormwater runoff and direct rainfall. For each Long Island bay, the relative loading of each source varies. The response of each bay to a given loading also varies due to the different flushing rates of each bay. It is also true that the effect of a nitrogen loading to a bay varies, depending on the exact location of the discharge. The individual bays are discussed below, in Section 2.5 of this report and in Section B of the Areawide Waste Treatment Management Plan. Figure 3–3 indicates the areas considered in the natural resource planning alternatives.

Great South Bay. Over 50 percent of the present total nitrogen loading to Great South Bay is from groundwater—sixteen percent from groundwater underflow, and 40 percent from stream base flow. (See Table 2–7 in Section 2.5.) Since nearly 100 percent of stream base flow is derived from groundwater, both sources can be considered together. Groundwater underflow to Great South Bay is approximately 78 cubic feet per second (cfs). This compares to the average stream base flow of 260 cfs.* Nitrogen concentrations in groundwater underflow and stream base flow show similar concentrations. In western Great South Bay (west of the Connetquot River), groundwater nitrogen concentrations average about five milligrams nitrogen per liter. The resulting nitrogen loadings to western Great South Bay are 720 pounds per day from groundwater and 1800 pounds per day from stream base flow.

In eastern Great South Bay (east of the Connetquot River) nitrogen loading is 330 pounds per day from groundwater underflow and 830 pounds per day from stream base flow. The lower loadings are primarily due to lower nitrogen concentrations of 1.4 milligrams nitrogen per liter for streams and one milligram nitrogen per liter for groundwater. Although the nitrogen loadings to eastern Great South Bay are smaller than the loadings to the western Great South Bay, the long residence time (the average length of time for which a parcel of water remains in the bay) of eastern Great South Bay makes it the most critical half of the system. Current nitrogen loading from stream base flow and groundwater underflow in eastern Great South Bay

*Includes groundwater inflow to streams below gauging stations.

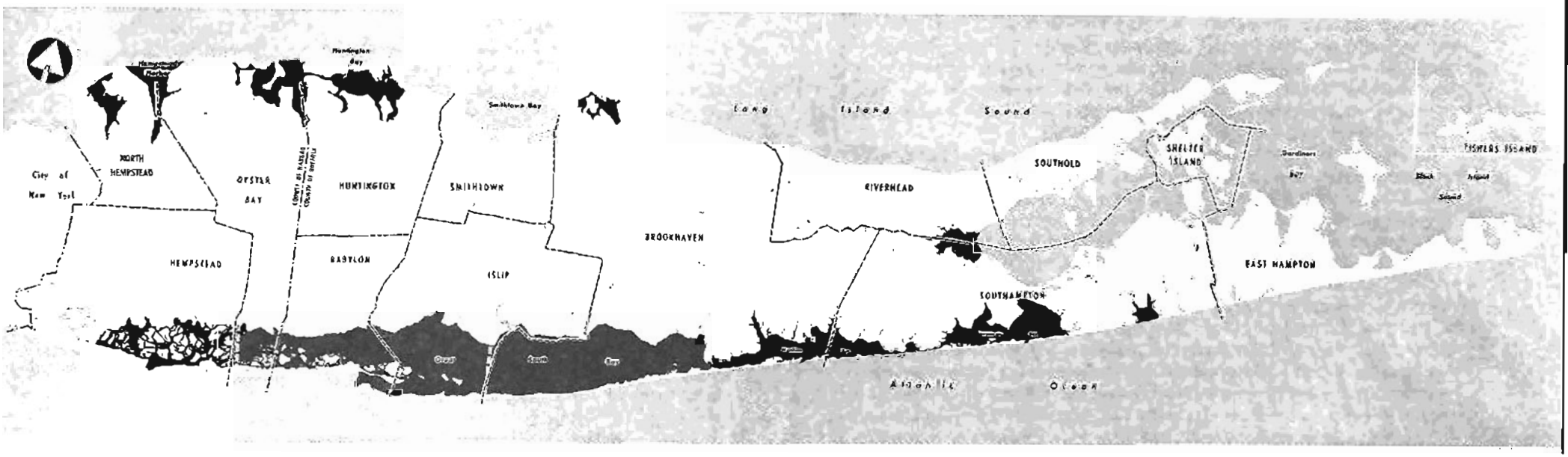


FIGURE 3–3 *Areas of the Nassau-Suffolk 208 Study Area Considered for Natural Resource Planning Alternatives*

produces average receiving water nitrogen concentrations over one milligram nitrogen per liter.

Additional increases in groundwater nitrogen discharging to eastern Great South Bay must be avoided if serious degradation to the bay is to be prevented. If groundwater nitrogen concentrations increase to two milligrams nitrogen per liter or more, nitrogen concentrations in eastern Great South Bay will exceed two milligrams nitrogen per liter.

In western Great South Bay, the residence time is lower and the flushing considerably better than eastern Great South Bay, except in some canals, where the low flushing rate is a very real problem. Although the loadings are greater, receiving water nitrogen concentrations are currently near acceptable levels. Sewering programs with ocean outfall, currently planned for southwestern Suffolk County, should result in lower groundwater nitrogen concentrations within ten to twenty years.

The two remaining major non-point sources are direct rainfall and stormwater runoff. There are no options available for controlling nitrogen loading from direct rainfall. However, storm runoff into eastern Great South Bay should be controlled. Point sources account for only two percent of the total nitrogen loading to Great South Bay. The major point source, the Patchogue treatment plant, discharges to eastern Great South Bay This discharge should be removed, or receive denitrification.

Western South Shore Bays. Point source discharges are the major internal source (76 percent) of nitrogen to the western South Shore bays of Nassau County. The point sources are concentrated in Hempstead Bay with an additional source at the Jones Beach Sewage Treatment Plant outfall located to the east of Jones Inlet, and the Freeport Sewage Treatment Plant (scheduled for diversion to Cedar Creek in 1979). Receiving water nitrogen concentrations are excessive in Hempstead Bay and Middle Bay, and near acceptable levels in East Bay and South Oyster Bay.

The Bay Park Sewage Treatment Plant contributes about 85 percent of the total point source nitrogen loading to the Nassau County South Shore bays. If this outfall were moved to an offshore location, there would be a reduction of the total nitrogen loading (to the western South Shore bays) by 66 percent and the total coliform loading by eleven percent.

Moriches Bay. Moriches Bay has experienced high nutrient and coliform loadings, particularly in the form of wastewater from duck farms in the vicinity of its tributary streams. Point sources account for fourteen percent of the total nitrogen loadings. There are no estimates of the amount of nitrogen trapped in duck waste sludges deposited during past years. However, they are not considered to be significant nitrogen sources at present. Groundwater underflow and streams contribute significant inputs of nitrogen to the system. In order to attain surface water quality goals of 0.4 milligrams nitrogen per liter and 5.0 milligrams per liter dissolved oxygen, these sources must be reduced. Point sources, although only fourteen percent of the total loads, cause localized problems in the poorly flushed streams on which they are located. Any pollutant loads to the Narrows area will affect both Moriches Bay and eastern Great South Bay. Large areas of Moriches Bay are presently closed to shellfishing because of elevated coliform concentrations.

Nitrogen and coliform loads do not occur to the same extent in all the sources. It will be necessary to reduce pollutant contributions from a number of sources in order to attain the required water quality objectives.

Mecox Bay. The inlet from this bay to the Atlantic Ocean is closed approximately half the time. There are several duck farms discharging into the bay or its tributary streams.

Shinnecock Bay. Flushing rates, surrounding land use and the absence of point sources have allowed maintenance of high water quality in Shinnecock Bay. For this reason, wastewater management should ensure non-degradation of this resource.

Manhasset Bay. Seventy percent of the nitrogen loading from sources within the bay is discharged from point sources. High nitrogen concentrations in Long Island Sound water are an even larger influence. A waste management plan to maintain recommended nitrogen levels in Manhasset Bay must, therefore, consider control of sources within the bay and possibilities for control of sources outside of the bay (Long Island Sound) and beyond the boundaries of the Nassau-Suffolk study area.

The high nitrogen concentration in Long Island Sound impacts water quality in Manhasset Bay (and Hempstead Harbor). The recommended nitrogen loading to Manhasset Bay assumes future reduction in the concentration of nitrogen in the Sound. This assumption is valid only if New York City ceases its nitrogen discharges to the upper East River. If Long Island Sound water quality does not improve, the attainment of water quality standards in Manhasset Bay (and Hempstead Harbor) cannot be assured even with nitrogen removal or mid-bay discharge. It is therefore very important that the New York State DEC or EPA plan and implement waste controls required to improve water quality in western Long Island Sound.

Hempstead Harbor. Hempstead Harbor, like Manhasset Bay, is subject to high nitrogen loadings from Long Island Sound. Approximately seventy percent of the nitrogen loading from sources within the harbor is from point sources. These point source nitrogen loadings are concentrated in Glen Cove Creek, which receives approximately 1600 pounds per day from the Glen Cove Municipal Treatment Plant and an average of 400 pounds per day from the Powers Chemco plant. (Powers is preparing to treat their wastewater for nitrogen removal.) Although not normally regarded as a point source, the semi-wild duck population on Roslyn Park Pond constitutes one. (The pond discharge frequently requires chlorination because of high bacteria levels.) To avoid localized water quality degradation, the recommended total nitrogen loading to the harbor has been established at 417 pounds per day. At the south end of Hempstead Harbor, the Roslyn Sewage Treatment Plant discharges an average nitrogen loading equal to the total recommended for the entire harbor.

Oyster Bay. Stormwater runoff and stream base flow are currently responsible for contravention of coliform bacteria standards and elevated nitrogen loadings.

Current nitrogen loadings from the Oyster Bay Treatment Plant are well below the maximum recommended loading.

Huntington Bay. Within this embayment, 75 percent of the point source loadings discharged to Northport Harbor and Huntington Harbor originate from sewage treatment plants. Loadings to both harbors exceed the recommended loadings. Therefore, reduction of nitrogen concentrations is required. Stormwater runoff contributes 98 percent of the coliform loading to the bay and requires control.

Port Jefferson Harbor. The Port Jefferson Sewage Treatment Plant is the major nitrogen point source to the harbor. Current loadings are within the recommended maximum of 500 pounds per day. Future loadings greater than 500 pounds per day will result in unacceptable concentrations if the outfall remains in its present location.

Stormwater runoff and stream base flow are currently responsible for violations of shellfish standards in Conscience Bay and Setauket Harbor/Little Bay; they also contribute to violations in southern Port Jefferson Harbor.

Flanders Bay. Flanders Bay and the Peconic Estuary receive point source nitrogen loadings from duck farms located on tributaries, including the Peconic River, and from the Riverhead Sewage Treatment Plant. Over 50 percent of the present loading is from duck farms. The approximate loading to Flanders Bay from Meetinghouse Creek and the Crescent Duck Farm was 600 pounds per day during the 208 sampling period. The recommended discharge is 464 pounds per day. Thus nitrogen removal would be indicated for the Crescent Duck Farm. However, significant treatment system improvements were made subsequent to the 208 sampling period. These have resulted in no surface discharge from this farm for most of the period beginning February 1977. A re-evaluation of the impact of this discharge point should therefore be made.

The Peconic Estuary receives most of its nitrogen loading from the Riverhead Treatment Plant and the Peconic River. The nitrogen loading of the Peconic River is variable because of the variation of river discharge. From four observations between July 1976 and April 1977, the total nitrogen loading to the Peconic Estuary from the river ranged from 133 pounds per day to 414 pounds per day. In addition to the Peconic River discharge, the Riverhead Treatment Plant discharges an average of 148 pounds per day of total nitrogen.

The maximum allowable nitrogen loading to the estuary is 182 pounds per day. To meet this allowable discharge, the two duck farms on the Peconic River must either institute effluent nitrogen removal, or go to zero discharge. This will reduce the nitrogen loadings of the Peconic River by 40 to 50 percent. No additional nitrogen loading should be allowed from the Brookhaven or Grumman treatment plants. With these controls on the Peconic River, the river loading may still periodically exceed the maximum allowable loading.

3.3 Point Source and Residual Controls

The previous parts of Section Three have described the objectives of the Program and have developed a series of waste management options for different geographic areas. These are general in nature and are meant to provide decisionmakers with an overview of existing problems, their probable causes, and general courses of action for addressing the problems.

This section discusses in more detail structural alternatives to wastewater management. It presents information on various treatment approaches that may be used in the bi-county area, evaluates new technological concepts, and discusses alternative programs for residuals (solid waste, sludges, hazardous wastes) management.

The term "cost-effectiveness" is used throughout this report. It is defined in traditional engineering terminology as those measures that are economically feasible in terms of tangible benefits that accrue from monies spent. Cost-effectiveness, as defined in USEPA "208" Guidelines, refers to the solution, chosen as a result of the systematic comparison of alternatives, that minimizes total costs to society over time, while meeting specified goals and objectives. The total costs should include resource, social, environmental and dollar costs. Effectiveness refers to meeting the 1983 goals of the ACT (PL92–500), while providing for the highest practical degree of technical reliability in the pollution control alternative that is chosen. This national goal states, in Section 101–a–(2), that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water be achieved by July 1, 1983.

3.3.1 Point Source Controls

3.3.1.1 Introduction: Traditional Collection and Treatment Approach Alternatives. This section describes the alternative treatment approaches that have been developed in the 208 Program for Nassau and Suffolk Counties. Because of differences in the degree of development in the two counties, and the inherently fixed nature of the existing Nassau system, treatment emphasis differs not only by the hydrogeologic zone but also by administrative area. In Nassau, the major options concern treatment plant locations and effluent disposal, in Suffolk, the major options concern an identification of those areas that should be sewered as well as the siting of treatment facilities and effluent discharges.

In addition, Nassau and Suffolk are discussed separately because their municipal wastewater treatment needs differ. Nassau County is highly developed; according to the 208 population estimates, the county population is approximately 96 percent of saturation or zoned capacity, and is projected to reach 98 percent by the year 1995. Suffolk's population, on the other hand,

is currently at 52 percent of saturation and is expected to increase to 71 percent by 1995. Nassau County has 23 existing domestic wastewater treatment facilities, and major new construction is not anticipated except where expansion and upgrading of existing facilities is necessary. Suffolk County has 105 small domestic treatment facilities in operation, and one major facility (30 MGD) under construction. Nassau's domestic treatment facilities are generally large scale, treating up to 60 million gallons per day (MGD), but a typical Suffolk County domestic wastewater treatment plant treats less than one MGD, with the largest treating only approximately two MGD.

Surface water quality considerations also dictate different approaches in the Bi-county Region. Marine water quality in Nassau County and western Suffolk is influenced by the effects of New York City discharge. In eastern Suffolk, agricultural uses impact river and bay quality. A final reason for separate consideration of the two counties concerns their degree of urbanization: Nassau and western Suffolk Counties are highly urbanized, while eastern Suffolk is essentially rural and agricultural in nature.

In order to assist in the establishment of potential future sewer service areas and to estimate future domestic wastewater loads for traditional sewering alternatives, an attempt was made to correlate population density with nitrate-nitrogen (NO_3—N) concentrations in the Upper Glacial aquifer. Although the results were not statistically conclusive, they indicated that population density was an important factor that had to be considered in establishing sewer service areas. Several population density criteria were applied in those geographic areas that recharge to the Magothy aquifer to develop alternative geographic limits for potential sewer service areas.

A second reason for establishing areas to be sewered concerns high groundwater tables or low soil permeability, both of which would result in pervasive septic tank/cesspool failures and consequent health hazard. Concern for the protection of surface water quality was a final consideration in delineating potential future sewer service areas.

These criteria—protection of the Magothy, potential for on-lot systems failure and protection of surface waters—were combined to develop the various sewering alternatives. In Suffolk County, these alternatives ranged from the maintenance of the status quo, or no additional sewering, to sewering at a population density of one dwelling unit per acre. The greater part of the Suffolk area is currently unsewered and potential future sewer service areas could be extensive. For this reason, a wide range of alternatives had to be examined in order to delineate these areas, and to develop flow and cost estimates. Potential future service areas were developed for each of the following assumptions:

a. No new sewering; utilize existing service areas only (1975 populations)
b. Include land with two dwelling units (D.U.) per acre in high groundwater table areas; five D.U. per acre in the Magothy recharge area (1995 population)
c. Include two D.U. per acre in high groundwater table areas; five D.U. per acre everywhere else (1995 population)
d. Include two D.U. per acre in high groundwater table areas; two D.U. per acre in the Magothy recharge (1995 population)
e. Include two D.U. per acre in high groundwater table areas; two D.U. per acre in the Magothy recharge area (1975 population)
f. Include two D.U. per acre in high groundwater table areas; two D.U. per acre everywhere else (1995 population)
g. Include a density of one D.U. per acre everywhere (1995 population).

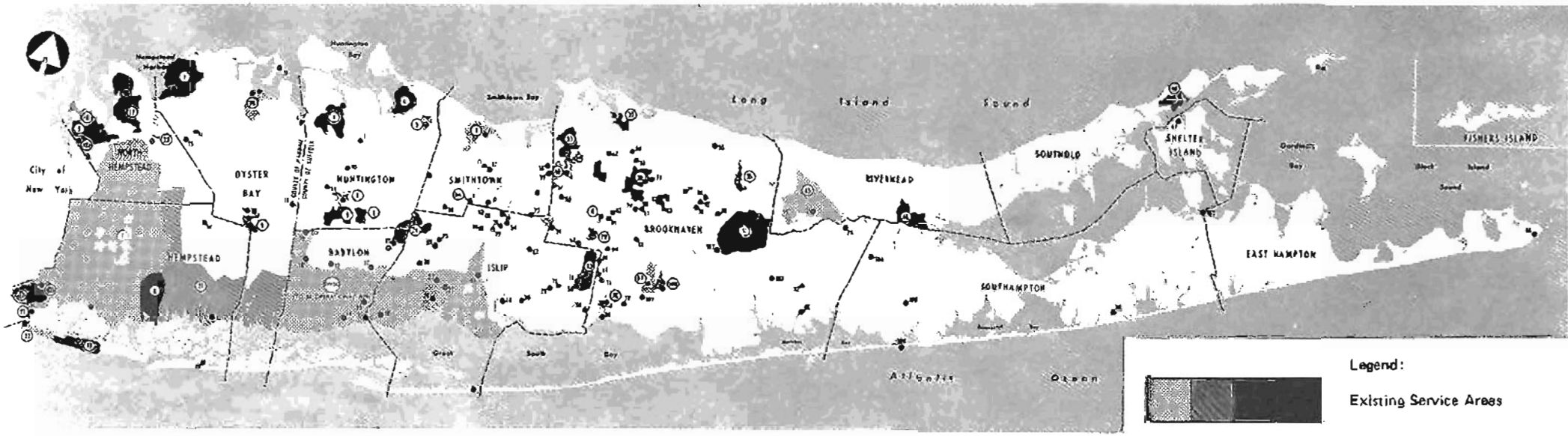
Figures 3—4 through 3—10 indicate the approximate geographic extent of the areas that would be sewered for each alternative. The areas do not include separate commercial/industrial areas because of scale, but they would be included in sewering approaches. Flows from these land uses are included in subsequent estimates.

Two dwelling units per acre was selected as the sewering criterion in areas of high groundwater or low soil permeability because, at lower densities, individual homeowners will normally have sufficient acreage to permit the installation, expansion or construction of new leaching facilities on other parts of the lot. At densities of two or more dwelling units per acre, those options are not as readily available and sewer systems may be the only viable solution.

Five dwelling units per acre was selected as representative of high density land use because, at this density and at higher levels, there is a clear threat to groundwater contamination from individual on-lot systems.

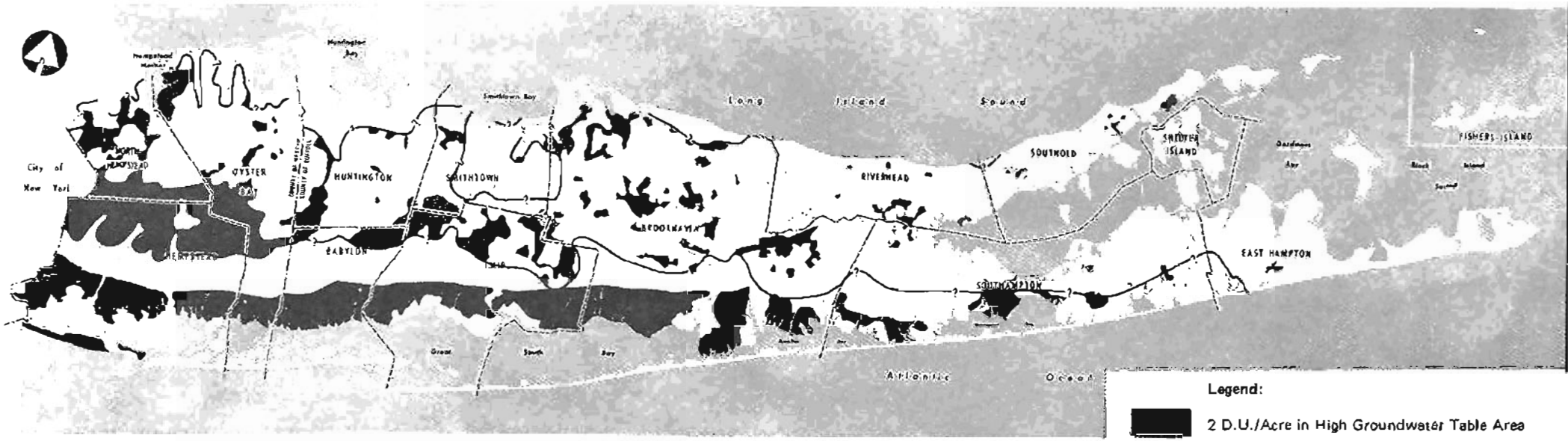
Although protecting groundwater quality provides a major justification for establishing an allowable population density, the geographic limits of the Magothy aquifer recharge area are not precisely defined. It should be recognized that deep flow also occurs to the north of the northern limit of the Magothy in both Nassau and Suffolk. This flow occurs in the deeper portion of the Upper Glacial deposits, which are the hydrologic equivalent of the Magothy in this area. Since this part of the aquifer is also used for water supply, it may be necessary to consider sewering here even in the minimum sewering alternatives. Therefore, criteria for sewering were applied on an Island-wide basis for some of the alternatives. Definition of those areas contributing subsurface flow to the bays was also uncertain, and provided further reason to examine sewering in all areas for some alternatives.

In considering sewering alternatives it should be noted that even the most comprehensive sewering plan will not address all water quality problems. Sewering does not reduce the nitrogen input from fertilizer, which appears to be a major source of elevated nitrate concentrations in groundwater In addition, sewering an area can lead to land use changes that may actually increase contaminant loading, by encouraging more intense development. This results from more lawn fertilizing, greater volumes of stormwater



NOTE: FOR IDENTIFYING NUMBERS, REFER TO APPENDIX A, ELEMENT H.

FIGURE 3–4 *1975 Existing Service Areas*



(potential service areas on the Forks are based on population densities only)

FIGURE 3–5 *1995 Potential Service Areas*
2 D.U./Acre in High Groundwater Areas
5 D.U./Acre in Deep Flow Recharge Area

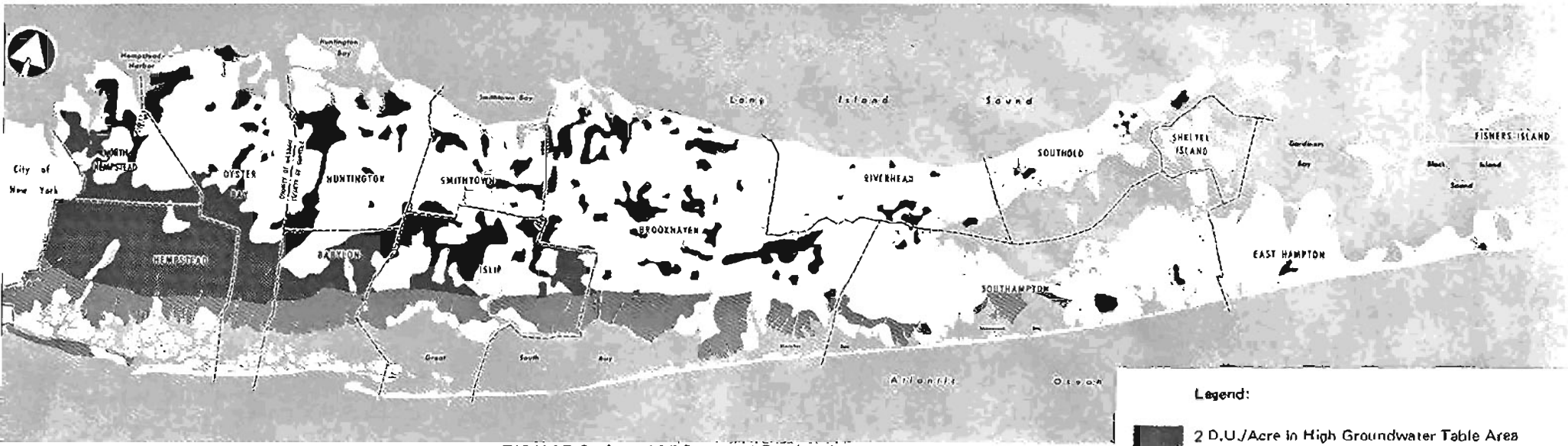


FIGURE 3–6 *1995 Potential Service Areas*
2 D.U./Acre in High Groundwater Areas
5 D.U./Acre Everywhere Else

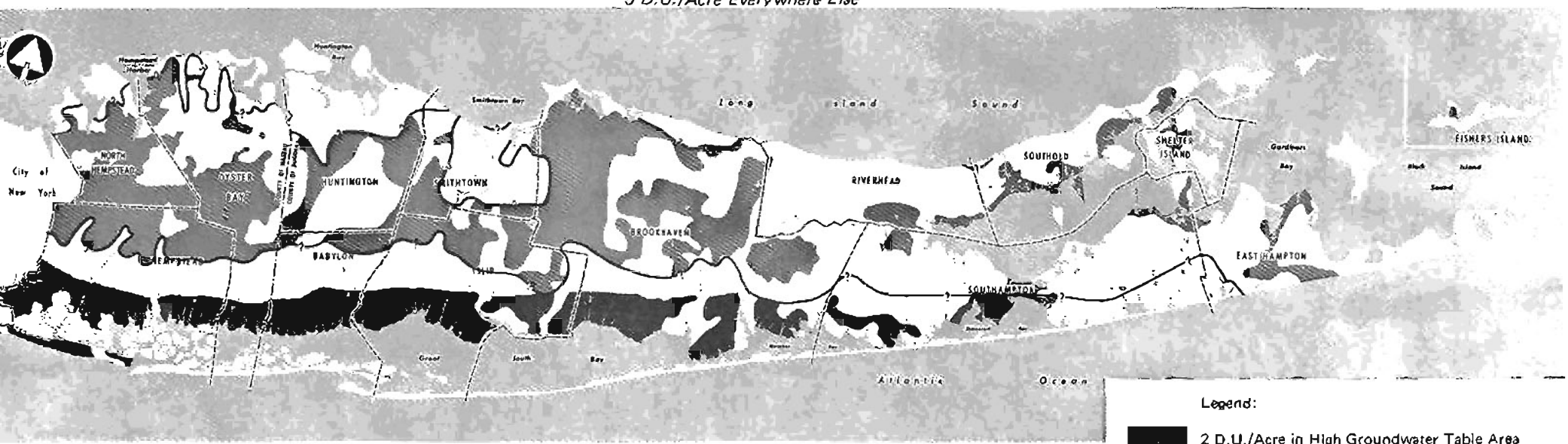
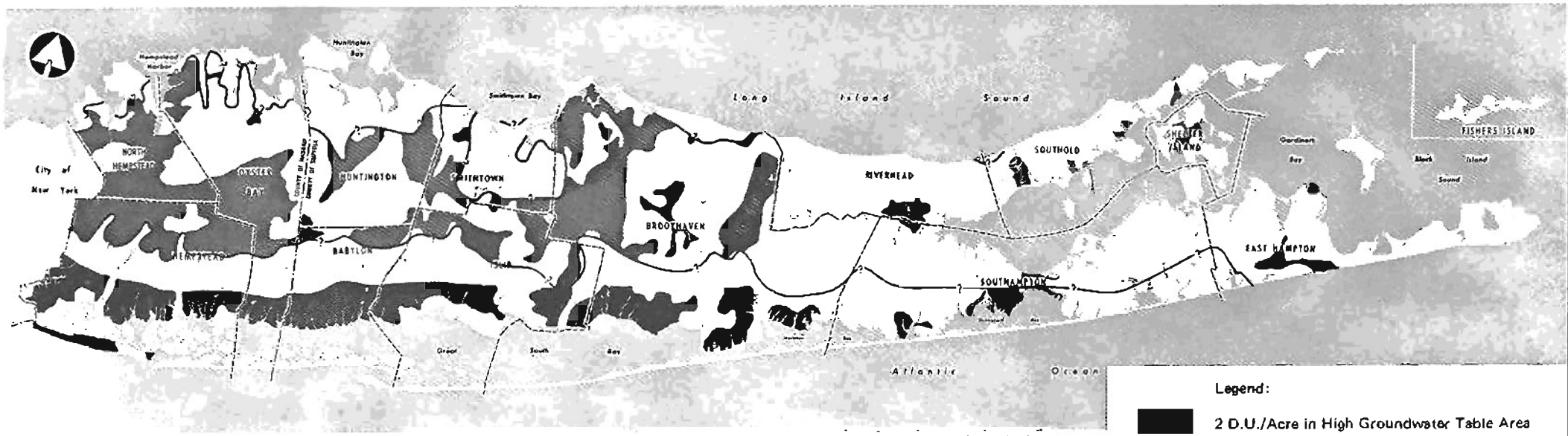


FIGURE 3–7 *1995 Potential Service Areas*
2 D.U./Acre in High Groundwater Areas
2 D.U./Acre in Deep Flow Recharge Area

(potential service areas on the Forks are based on population densities only)



(potential service areas on the Forks are based on population densities only)

FIGURE 3–8 *Potential Service Areas—Based on 1975 Population*
2 D.U./Acre in High Groundwater Areas
2 D.U./Acre in Deep Flow Recharge Area

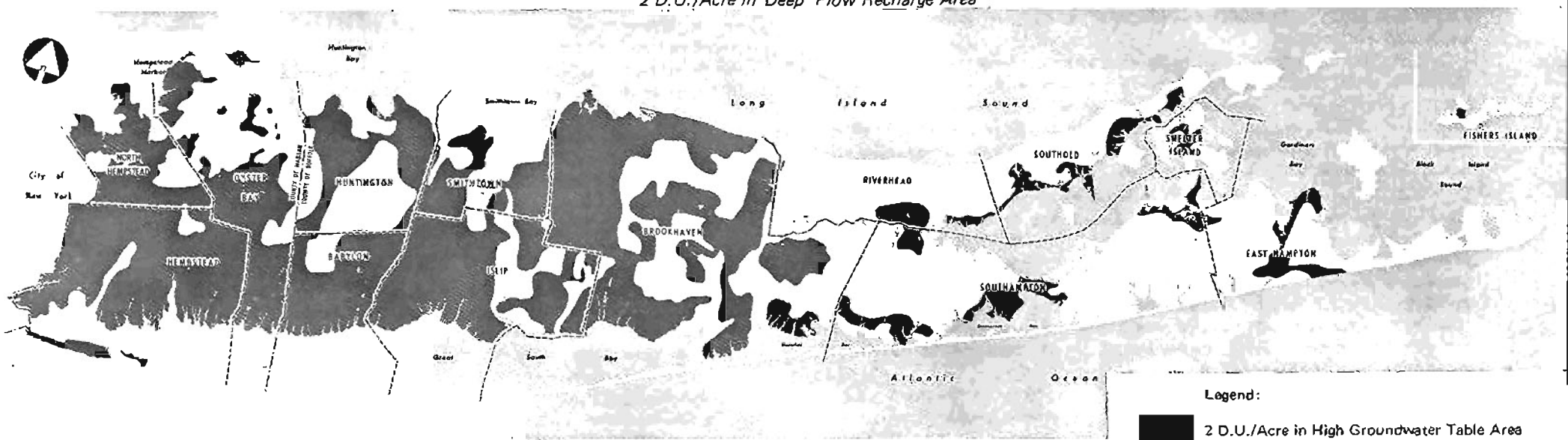


FIGURE 3–9 *1995 Potential Service Areas*
2 D.U./Acre in High Groundwater Areas
2 D.U./Acre Everywhere Else

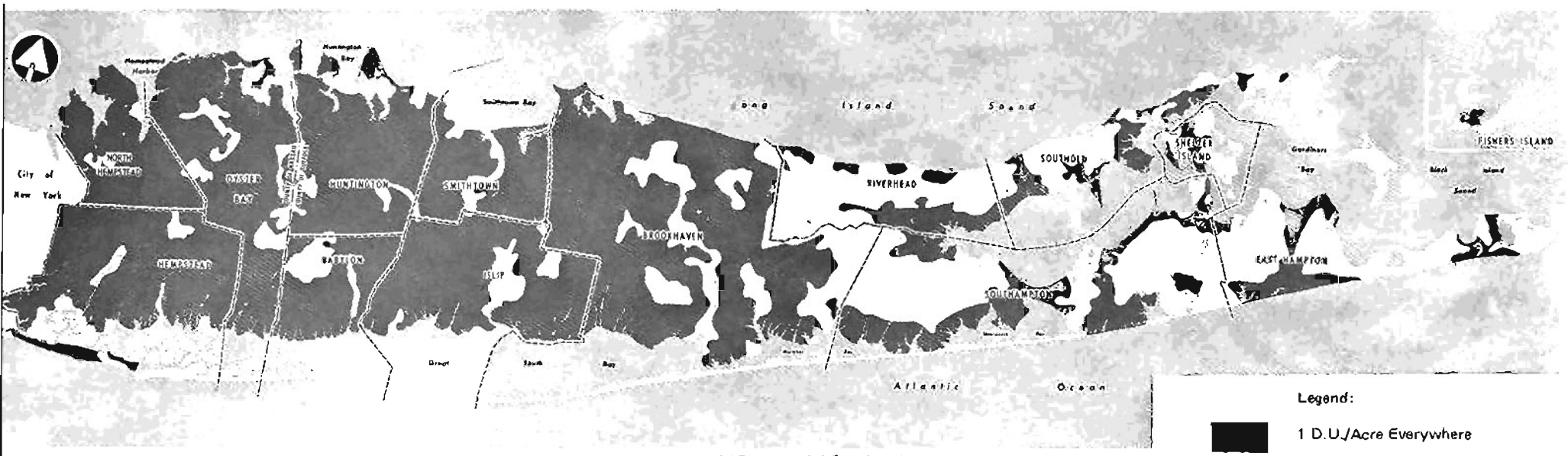


FIGURE 3–10 *1995 Potential Service Areas*
1 D.U./Acre Everywhere

runoff from roads, and increased commercial activity with attendant spills and accidental discharges.

The NSRPB projected 1995 population estimates were used to delineate future service areas. In order to study sewerage needs under no-growth policy, alternative (e) was mapped using the same density criteria but substituting the 1975 population for the 1995 population. Figures 3–4 to 3–10 illustrate potential future service areas for those alternatives identified above, including alternative (e) which utilized 1975 population figures.

3.3.1.2 Discussion of Various Sewering Alternatives. Each of the seven sewering alternatives listed in the previous section was developed to test the sensitivity of the study area (particularly Suffolk County) to various degrees of sewering. The first alternative (a) assumes that no new sewering will occur beyond the present sewer service areas (assuming Nassau County District III and Suffolk County Southwest Sewer District are complete). It implies that other technologies or non-structural measures will be employed and will be sufficient to handle the wastewaters of the area. It reflects a no-action alternative in terms of the traditional sewering approach.

As a first approach, it is assumed that sewering is not the most cost effective method for protecting public health and ground and surface water quality. Either water quality will be allowed to degrade and public health threatened, or alternatives will be found to protect public health and water quality that do not require sewers. The major potential problem areas in the first approach will be south of Sunrise Highway, where groundwater elevations are high and on-lot systems fail, and in the Magothy recharge area, where nitrates, organic chemicals and other contaminants from on-lot systems discharge to the Magothy aquifer.

The second sewering alternative (b) attempts to alleviate the major problems cited in the no sewering approach. It provides for sewers in the areas of high groundwater since it assumes that other options are not viable for that area; the alternative would provide sewers in areas of high groundwater when population densities are equal to or greater than two dwelling units per acre. In areas of lower density, septic tanks with additional leaching fields are recommended.

This second approach also assumes that sewers are necessary in the Magothy recharge area to protect the water supply from contamination from on-lot home systems. It reflects a policy that is quite different from past practice in that it assumes sewering at high densities equal to or greater than five dwelling units per acre. Past practice in Suffolk County has required the provision of sewers whenever an area is developed at a density equal to or greater than one dwelling unit per 40,000 square feet. The county currently does not require sewering at lot sizes of 20,000 square feet or more, providing public water supply is available. It is important to note that none of the sewering alternatives assumes that sewers will solve all public health, and surface and groundwater quality problems. Rather, they attack the problems

of domestic sewage and industrial wastewater disposal by traditional means and assume that other pollutant sources (*e.g.,* fertilized areas, stormwater runoff) will also be controlled.

Because the specific Magothy recharge area is difficult to define with accuracy, alternative (c) has been included. It would sewer at densities equal to or greater than two D.U.s per acre in areas of high groundwater and is similar to (b). However, everywhere else, it would sewer at densities of five D.U.s per acre or greater. This approach is included to ensure that the total water supply is protected from wastewater generated by high density areas.

Alternatives (b) and (c) rely on sewering to protect the ground and surface waters and public health only from human and industrial waste. Both the (b) and (c) must be combined with waste management programs for fertilizers, stormwater runoff, landfills and other pollutant sources. Sewering alone cannot be used as a management tool to control all pollutant sources.

Alternatives (d) and (f) are similar to each other and differ from (b) and (c) only in that more protection is given to the Magothy recharge area by sewering at population densities of two D.U.s per acre or greater. In (d) and (f) areas of high groundwater table are sewered at two D.U.s per acre. In (d), areas in the Magothy recharge area are sewered at two D.U.s per acre or more. In (f), all areas of two D.U.s per acre or more are sewered because of the uncertainty of the recharge boundary lines.

In adopting alternatives (d) or (f), it must be emphasized again that other major sources of pollution must be attacked concurrently as was described in the alternatives (b) and (c).

Alternative (e) has been developed for comparative purposes. It utilizes 1975 population distributions, not 1995 data, and assumes sewering wherever population densities are equal to or greater than two D.U.s per acre. It is similar to alternative (f), except 1975 population is used. Alternative (e) expresses the sewering consequences of a no-growth policy. In other words, if land use and population were controlled to the point where no growth was allowed, a sewering scenario similar to alternative (e) would result. The results of (e) can be visually and statistically compared to the other options, allowing decisionmakers to opt for future growth or no-growth policies.

Alternative (g) is the final traditional sewering approach that has been studied. It assumes that sewers would be provided in all areas where population densities are equal to or greater than one D.U. per acre. Thus, it might be considered the opposite of alternative (a) in that the first alternative assumed all sewering would cease at the present service area boundaries, while (g) assumes sewering will occur wherever subdivision development might occur. Later on in this section, flow estimates are presented for the various alternatives that indicate numerically the relative degree of sewering for each of the alternatives. Cost estimates are also presented.

The study areas used for the development of traditional sewering alternatives represent existing sewer service areas, 201 areas and disposal districts identified in earlier studies. The use of these areas, which are based on surface drainage, does not imply a conflict with the hydrogeologic approach to the selection of wastewater management options.

3.3.1.3 **Development of Traditional Sewering Alternatives.** In the detailed development of the structural sewering approaches, Nassau County was subdivided into four study areas approximately coinciding with existing or proposed disposal district boundaries as designated by the Nassau County Department of Public Works (NCDPW). In general, Suffolk County was subdivided into the five western towns and five eastern towns. The five western towns are considerably more urbanized and are similar to Nassau County in respect to land use and water quality problems. The five eastern towns are more rural and have extensive agricultural land use and lower population densities. The five western towns were subdivided into seven study areas, which approximate the boundaries of seven 201 planning areas as designated by the Suffolk County Department of Environmental Control (SCDEC). With the exception of those areas in or adjacent to the hamlet of Riverhead and the Village of Greenport, and on Fishers Island, the five eastern towns cannot be conveniently subdivided into proposed 201 study areas and were therefore divided into study areas coinciding with the SCDEC proposed disposal districts as identified by the 1966 Suffolk County Comprehensive Sewerage Disposal Plan (Disposal Districts No. 11 through No. 17). The seven study areas for the five western towns are the Southwest Sewer District (SWSD), West Central excluding the SWSD, Huntington-Northport, Kings Park, South Central, Port Jefferson and Yaphank.

Nassau County treatment alternatives consist of combining a variety of feasible components, including sewage flow diversions and/or the expanssion of particular treatment facilities. Since there are 23 existing domestic facilities in Nassau County, the number of possible permutations is too great to permit examination of all possible diversions between facilities. Instead, only viable options, as determined on the basis of an initial screening, were selected for examination.

In Suffolk County, sewering and treatment alternatives were more numerous than Nassau because many more options were available. Various potential future service areas were delineated utilizing different population density criteria; regional, sub-regional and small plant approaches were analyzed. A regional facility was defined as one treatment plant serving an entire study area such as the SWSD or the Huntington-Northport study area. A sub-regional approach was defined as two to six wastewater treatment facilities serving a study area, and the small plant approach was defined as a proliferation of treatment facilities of approximately one MGD in size, serving localized growth within a study area.

Table 3–4 summarizes the flow projection figures for each of the study areas of the five western towns in Suffolk County. The flows are presented for each of the various sewering criteria and include both domestic and industrial flows for the different scale systems (regional to small plants). Table 3–5 presents similar information for the five eastern towns of the

Table 3—4

SEWAGE FLOW BY STUDY AREA FOR VARIOUS SEWERING CRITERIA (MGD)
FIVE WESTERN TOWNS[4]

Study Area	Alternative	Approach	Sewering Criteria					
			2 DU/A high GW [2] 5 DU/A Mag [3] 1995	2 DU/A high GW 5 DU/A everywhere 1995	2 DU/A high GW 2 DU/A Mag. 1975	2 DU/A high GW 2 DU/A Mag. 1995	2 DU/A everywhere 1995	1 DU/A everywhere 1995
SWSD								
	I-1	Regional	19.5	28.0	17.0	19.5	30.0	30.0
	I-2	Regional	33.5	52.5	31.5	36.5	54.0	61.0
West Central								
	II-2	Sub-Regional	6.00	7.50	10.5	13.3	17.0	21.0
	II-3	Sub-Regional	11.0	24.0	20.0	24.5	41.0	42.5
	II-4	Small Plants	11.0	24.0	20.0	24.5	41.0	42.5
Huntington-Northport								
	III-2	Regional	0.25	10.5	1.50	2.25	13.0	20.0
	III-3	Regional	0.25	10.5	1.50	2.25	13.0	20.0
	III-4	Sub-Regional	0.25	10.5	1.50	2.25	13.0	20.0
	III-5	Small Plants	0.25	10.5	1.50	2.25	13.0	20.0
Kings Park								
	IV-2	Regional	2.50	7.00	4.00	6.00	14.0	16.0
	IV-3	Sub-Regional	2.50	7.00	4.00	6.00	14.0	16.0
	IV-4	Small Plants	2.50	7.00	4.00	6.00	14.0	16.0
South Central								
	V-2	Regional	19.0	21.5	18.0	25.5	31.0	32.0
	V-3	Sub-Regional	19.0	21.5	18.0	25.5	31.0	32.0
	V-4	Sub-Regional	19.0	21.5	18.5	26.0	32.0	33.0
	V-5	Small Plants	19.0	21.5	18.5	26.0	32.0	33.0
Port Jefferson								
	VI-2	Regional	5.00	4.75	5.00	8.50	8.50	9.00
	VI-3	Regional	5.00	4.75	5.00	8.50	8.50	9.00
	VI-4	Sub-Regional	5.00	4.75	5.00	8.50	8.50	9.00
	VI-5	Sub-Regional	5.00	4.75	5.00	8.50	8.50	9.00
	VI-6	Small Plants	5.00	4.75	5.00	8.50	8.50	9.00
Yaphank								
	VII-2	Sub-Regional	20.5	23.0	15.0	31.0	37.5	38.5
	VII-3	Sub-Regional	20.5	23.0	15.0	31.0	37.5	38.5
	VII-4	Small Plants	20.5	23.0	15.0	31.0	37.5	38.5

(1) Where more than one regional or sub-regional option is listed, different configurations of regional or sub-regional systems were studied. These are discussed in detail in other study reports.

(2) Two dwelling units per acre in high groundwater table areas.

(3) Five dwelling units per acre in the Magothy recharge area.

(4) Refer to Section C of the Areawide Waste Treatment Management Plan. Numbers include industrial waste flow allocations. Nassau flows are not included since most of the County is currently sewered or will be sewered under existing plans. Therefore, the flows for the Nassau alternatives are essentially the same as those presented for existing Nassau treatment plants.

Table 3–5

SEWAGE FLOW BY STUDY AREA FOR VARIOUS SEWERING CRITERIA (MGD)
FIVE EASTERN TOWNS

Study Area	Approach	Sewering Criteria					
		2 DU/A high GW [1] 5 DU/A Mag. [2] 1995	2 DU/A high GW 5 DU/A everywhere 1995	2 DU/A high GW 2 DU/A Mag. 1976	2 DU/A high GW 2 DU/A Mag. 1995	2 DU/A everywhere 1995	1 DU/A everywhere 1995
D.D. No. 11							
	Regional	6.00	5.50	2.50	7.50	8.00	9.75
	Sub-Regional	6.00	5.50	2.50	7.50	8.00	9.75
	Small Plants	6.00	5.50	2.50	7.50	8.00	9.75
D.D. Nos. 12, 15, 16							
(Sag Harbor)		0.00	0.00	–	0.75	0.75	0.75
(Amagansett)		0.35	0.35	–	1.50	1.50	1.50
(Hampton Bay)		1.60	1.65	–	2.00	2.00	2.00
(East Quogue)		1.70	1.70	–	1.75	1.75	1.75
D.D. No. 13							
(Greenport)		1.00	1.00	–	2.00	2.00	2.00
(Mattituck)		0.30	0.30	–	1.50	1.50	1.50
D.D. No. 14							
(Shelter Island)		0.33	0.33	–	1.00	1.00	1.00
D.D. No. 17							
(Fishers Island)		0.00	0.00	–	0.25	0.25	0.25

(1) Two dwelling units per acre in high groundwater table areas
(2) Five dwelling units per acre in the Magothy recharge area
(3) A more detailed definition of the alternatives for Suffolk County can be found in Section H of the Areawide Waste Treatment Management Plan, Appendix D–Suffolk County Point Source Alternatives.

County.

Capital, operating and maintenance costs were calculated for the various point source sewering alternatives. Present worth—that is, the current value of all costs incurred over the planning period as the result of the selection of a specific option—was determined for all sewering alternatives to facilitate comparison between them. Present worth includes the total capital cost, plus all of the annual operation and maintenance costs discounted back to the present time. For the various sewering alternative components in Nassau County, a least-cost optimization model was utilized to identify the combination of components that would result in the lowest total cost to Nassau County. A series of possible diversions and/or upgradings was screened based upon engineering feasibility and environmental impacts. In Nassau County, the fourteen exising domestic treatment plants (with one proposed new plant at Bayville) were examined for expansion and/or upgrading to accept additional service area or to be phased out with diversion to a regional facility. To permit selection of the most promising combination, a cost was developed for each component and computer techniques were utilized. (See Section H of the Areawide Waste Treatment Management Plan.)

The optimization results for the north shore plants of Nassau County are dependent upon treatment requirements. If the plants are to continue to discharge at the shorelines or bulkheads, it appears most economical to maintain the individual plants as they presently exist. If, however, the modeling runs indicate that AWT or mid-bay discharges are required to meet bay water quality standards, the cost-effective solution for meeting waste load allocations for the North Shore Nassau County plants appears to be to divert many North Shore facilities to the South Shore Cedar Creek plant to achieve economies of scale. It appears most cost-effective to divert the Great Neck Sewer District, Village of Great Neck, Port Washington Sewer District, Roslyn and Oyster Bay Treatment Plant flows to the Cedar Creek treatment facility, leaving Belgrave and Glen Cove as the major remaining facilities on the North Shore. Belgrave discharges to Little Neck Bay, and was therefore not studied

in detail. In addition, the New York Institute of Technology (NYIT) and C.W. Post treatment plants may be phased out and their flows diverted to the Cedar Creek Sewage Treatment Plant; if not, nitrogen removal should be provided. These concepts must be studied at the 201 level where greater cost estimating accuracy is possible.

The goals of the FWPCA will not be met in every instance in the Nassau-Suffolk study area. Some of the reasons for not attaining water quality goals, particularly those relating to shellfishing, include overriding surface water boundary conditions in western Long Island Sound caused by both treated and untreated sewage discharges, and combined sewer overflows, emanating from New York City; and the impact of internal sources of stormwater runoff to the bays.

Improved groundwater quality may be unattainable in the near-term due to the costs that would have to be incurred in controlling non-point sources of pollution. The actual cost implications of these actions, as well as the effectiveness of the proposed solutions and the probable benefits from attaining the water quality goals as stated in the Act, will require study and evaluation at a much greater level of detail, such as that which is associated with a 201 type of program.

The lowest cost option would maintain existing service area limits. This would involve utilizing on-lot diposal systems, such as septic tanks and cesspools, and could possibly lead to significant groundwater quality contamination in areas of higher population density. Table 3–6 summarizes the impact on costs of the different sewering criteria for Suffolk County. Costs are presented for the various regional, sub-regional and small-plants approaches by study area. The combination of a particular approach (*e.g.*, regional system) with a specific sewering criterion (*e.g.*, one D.U. per acre everywhere) constitutes an alternative. The variability in costs for different sewering criteria depends upon population density patterns in an area, how much of the area is part of the Magothy recharge system, or how much of the area has high groundwater table elevations.

3.3.1.4 Other Structural Alternatives Studied. In addition to the conventional structural sewering alternatives, a variety of newer technologies were examined in the 208 Program. An attempt was made to determine the large scale applicability of a variety of alternatives to the conventional sewering approach. Much of the new technology developed over the past several years is encouraging. However, when evaluating new technology, other factors, such as aesthetics, legal implications, reliability of operation, and implementation feasibility, must also be considered. Once these factors have been examined, recommendations can then be made as to those technologies most applicable to specific Nassau-Suffolk problems.

The approach taken in the evaluation of new technology in the Nassau-Suffolk 208 Program was to first analyze ground and surface water quality problems and their probable causes in the Region. Utilizing a literature review, a variety of new concepts were then described and discussed for applicability to the Nassau-Suffolk area.

The following technologies and concepts which are described in greater detail in Section N of the Areawide Waste Treatment Management Plan, were initially considered:

- Marsh-Pond System for Treatment of Wastes
- Spray Irrigation with Cropping for Treatment of Wastes
- Black/Grey Water Separation
- Modified On-lot Systems (Aerobic Treatment)
- Septic Tanks with De-nitrification Units
- Waterless Composting Toilets
- Vacuum Collection Systems
- Pressure Collection Systems
- De-nitrification of Water Supply
- Dual Water Systems
- Flow Reduction Measures

New technologies that did not address regional water quality problems were then eliminated from further consideration. For the concepts that did address regional problems, typical capital and operation and maintenance costs were developed. The costs were compared to the costs of the traditional sewering and treatment approach. General conclusions were then reached and recommendations were made on those processes most applicable to Nassau-Suffolk that warrant further evaluation on a 201 level.

After analyzing the above listing of technologies, the following were selected for more detailed cost evaluations: marsh-pond, spray irrigation with cropping, black/grey separation, subsurface denitrification of septic tank effluent, denitrification at a water supply well (ion exchange/reverse osmosis*), dual water systems (with denitrification of potable water supply), and flow reduction measures. These technologies were compared with the traditional sewering and treatment approach on the basis of costs for a representative development in Suffolk County. The traditional approach utilized a gravity collection network with secondary treatment and biological nitrification and denitrification.

A number of conclusions were reached as part of the analysis:

1. Modified on-lot treatment systems do not address the water quality problems of the Nassau-Suffolk area since they do not remove nitrate or ammonia. The waterless composting toilet concept probably cannot be implemented although it does address the nitrate problem, but the toilet has possible safety and health problems, and a sludge disposal problem. Furthermore, it is extremely expensive to install in existing homes, and therefore, its economic advantages are severely limited.
2. Vacuum and pressure collection systems should be evaluated at a 201 level of study. Their main attribute is capital cost savings but energy costs may eliminate their use in the future.

*Biological denitrification is another alternative that was not studied in detail.

Table 3–6

SEWERAGE COST BY STUDY AREA (Disposal District) FOR VARIOUS SEWERING CRITERIA [1] [8]
TOTAL PRESENT WORTH [6] [2] (Millions of Dollars)

Study Area	Approach [3]	Sewering Criteria					
		2 DU/A high GW [4] 5 DU/A Mag. [5] 1995	2 DU/A high GW 5 DU/A everywhere 1995	2 DU/A high GW 2 DU/A Mag. 1975	2 DU/A high GW 2 DU/A Mag. 1995	2 DU/A everywhere 1995	1 DU/A everywhere 1995
SWSD							
	Regional	358	444	329	358	463	463
	Regional	412	515	379	414	524	564
West Central							
	Sub-Regional	68.0	77.7	95.1	109	127	194
	Sub-Regional	10.4	167	150	169	230	235
	Small Plants	169	270	242	274	373	381
Huntington-Northport							
	Regional	638	59.6	18.5	23.6	67.7	87.7
	Regional	577	54.4	16.9	21.6	61.8	80.0
	Sub-Regional	530	49.9	15.5	19.8	56.7	73.4
	Small Plants	530	49.9	15.5	19.8	56.7	73.4
Kings Park							
	Regional	21.0	38.9	27.8	35.3	58.9	63.8
	Sub-Regional	27.2	50.4	36.0	45.8	76.4	82.8
	Small Plants	38.8	71.9	51.4	65.4	10.9	11.8
South Central							
	Regional	110	119	107	132	148	151
	Sub-Regional	122	132	118	146	164	167
	Sub-Regional	151	161	145	178	202	206
	Small Plants	191	204	184	226	256	261
Port Jefferson							
	Regional	33.8	32.8	33.8	46.5	46.5	48.1
	Regional	45.0	43.7	45.6	61.9	61.9	64.1
	Sub-Regional	36.3	35.2	36.3	49.9	49.9	51.6
	Small Plants	46.0	44.6	46.0	63.3	63.3	65.5
Yaphank							
	Sub-Regional	193	207	160	348	278	282
	Sub-Regional	186	199	154	238	267	271
	Small Plants	228	244	189	292	327	332
Disposal District No. 11							
	Regional	21.7	21.4	13.3	25.8	26.8	30.2
	Sub-Regional	25.2	24.8	15.4	29.8	31.0	34.9
	Small Plants	25.5	24.8	15.4	29.8	31.0	34.9
Disposal District Nos. 12, 15, 16							
	Sag Harbor	0.00	0.00	–	17.1	17.1	17.1
	Amagansett	11.3	11.3	–	27.1	27.1	27.1
	Hampton Bays	17.1	17.1	–	19.6	19.6	19.6
	East Quoque	24.2	24.2	–	24.6	24.6	24.6
Disposal District No. 13							
	Greenport	16.0	16.0	–	24.2	24.2	24.2
	Mattituck	7.01	7.01	–	18.4	18.4	18.4

Table 3–6 . . Continued

Study Area	Approach (3)	Sewering Criteria					
		2 DU/A high GW (4) 5 DU/A Mag. (5) 1995	2 DU/A high GW 5 DU/A everywhere 1995	2 DU/A high GW 2 DU/A Mag. 1975	2 DU/A high GW 2 DU/A Mag. 1995	2 DU/A everywhere 1995	1 DU/A everywhere 1995
Disposal District No. 14							
	Shelter Island	7.25	7.25	–	14.1	14.1	14.1
Disposal District No. 17							
	Fishers Island	0.00	0.00	–	6.20	6.20	6.20

(1) *Costs do not include recharge, mid-bay or ocean outfalls, or lateral portions of the collection systems.*
(2) *Present worth at 6 3/8% interest amortized over 20 years, CRF (Capital Recovery Factor) = .08986.*
(3) *Where more than one regional or sub-regional option is listed, different configurations of regional or sub-regional systems were studied; they are discussed in detail in Section H of the Areawide Waste Treatment Management Plan, Appendix F—Cost Memoranda.*
(4) *Two dwelling units per acre in high groundwater table areas.*
(5) *Five dwelling units per acre in the Magothy recharge area.*
(6) *Costs are based on mid-1977 cost data, ENR (Engineering News Record) = 2580; they account for the staging of construction through the 20-year planning period (1975–1995).*
(7) *Cost obtained from Suffolk County Department of Environmental Control.*
(8) *All costs in this table reflect secondary treatment.*

3. The marsh-pond and septic tank denitrification systems should be tested in the field under normal operating conditions and without experimentally controlled operation. Both are promising new technologies. (Refer to Section 1.4.3.2.)
4. Spray irrigation and other forms of land application may be viable, the concept should be evaluated in local studies.
5. Black/grey water separation systems may have limited application and should be evaluated in the field under normal operating conditions.
6. Water conservation and flow reduction measures should be generally recommended for implementation. Although the Nassau-Suffolk Region does not have a potable water shortage, water conservation measures are beneficial because they might slightly reduce flows to treatment plants or to on-lot systems. Furthermore, the potential savings in energy from reduced pumpage may be significant.
7. Intentional degradation, which allows for exceeding groundwater discharge and/or drinking water standards, is unacceptable under current State and Federal statutes. Limited or controlled degradation that does not exceed standards but leads to water quality that is poorer than baseline conditions is unavoidable in much of the planning region. In other areas, groundwater quality in selected aquifer zones has already exceeded drinking water standards. Where such aquifers are necessary to meet water supply requirements, treatment of water at the wellhead should be considered as a viable management procedure.
8. Another management option in areas described under seven above is the tapping of unaffected aquifers for specialized uses. For example, the Lloyd aquifer in Nassau County could be developed to supply drinking water needs to limited coastal areas. Dual piping systems can also be employed to isolate drinking water from water used for other purposes.
9. Blending of good quality groundwater with water that has already been degraded is a viable technique for continuing to meet drinking water standards in problem areas. This may extend the life of an affected aquifer while still maintaining water of acceptable quality for consumption.

3.3.1.5 Animal Feedlot Operations. On Long Island, this category of point sources is represented, for the most part, by duck farms. Commercial duck farm operations are generally located close to marine waters and presently contribute bacterial and chemical pollution to surface waters. Commercial duck farms are required to obtain operating permits, designed to reduce and finally eliminate duck waste pollution. (Refer to Section J.)

Management options available are:

1. Prohibit the location of animal feeding operations where they may pollute surface waters or groundwater.
2. Expand monitoring and surveillance procedures to foster uninterrupted compliance with permit conditions.
3. Provide effective legal remedies for rapid abatement of illegal pollutant discharges.

3.3.2 Residuals Management. In the context of this study, residual wastes are considered to include solid wastes (refuse), hazardous wastes and domestic sludges. Hazardous wastes in the bi-county area generally include concentrated industrial pretreatment or treatment sludges. They may also include other miscellaneous liquid products and small amounts of toxic, solid materials. They do not include radioactive wastes. Disposal of residual wastes represents a potential impact on water quality, primarily as the result of surface and/or groundwater contamination at the disposal site.

General concepts and specific alternatives are discussed for each of the three types of residual wastes. For solid wastes, concepts necessary to formulate a comprehensive management approach are discussed, including considerations for management and control strategies.
gies are also covered.

For hazardous wastes, a model hazardous waste treatment disposal facility is recommended and conceptually designed for each county. A discussion of the various processes in the flow scheme and treatment costs are also covered.

For sludges, specific alternative disposal techniques as well as alternative management approaches such as regional, sub-regional and local systems are described for both counties. Capital and annual operation and maintenance costs are developed from generalized cost functions. The purpose of evaluating these alternatives is to identify those disposal techniques and sludge management approaches that should be investigated further. Solution of the sludge disposal problem has become urgent because of the planned discontinuance of ocean dumping. Sludge management studies have been and are being conducted on regional and local levels, in response to this discontinuance.

3.3.2.1 Solid Waste Management Concepts. A review of the present situation in the Nassau-Suffolk Region indicates that present disposal systems (landfills and incineration) in general, do not provide adequate safeguards to prevent environmental degradation as they attempt to handle the approximately 3,000,000 tons per year of solid wastes generated. Also, existing county solid waste management plans do not address controlled landfills and do not present any alternatives to the processes of conventional incineration and landfilling.

Recently, the trend in the Nassau-Suffolk area has been towards the development of regional resource recovery facilities, but each has been an individual effort for a specific geographic area rather than part of a comprehensive county or Nassau-Suffolk area approach. A desirable solid waste management concept is that of resource recovery (such as pyrolysis or co-incineration) with residuals disposal in small, controlled landfills after 1985. The current system of incineration and landfilling, with the addition of those resource recovery facilities currently proposed or under construction, will be expanded to fill the solid waste management requirements through 1985.

Efficient, economical and environmentally sound solid waste management for the Nassau-Suffolk area is the goal; the following sections present generalized concepts, constraints and considerations recommended to aid in achieving that goal.

a. *Landfilling.* Landfilling is the only final method of disposal available. Any other process (incineration, co-incineration, composting or resource recovery) generates secondary residuals that require disposal in a landfill.

Landfilling of solid wastes (processed or unprocessed), even under the best conditions and most stringent constraints, will result in the production of leachates and gases—by-products which can degrade the environment. Historically, these by-products have not been controlled, and there are many cases on Long Island of pollution caused by uncontrolled landfills. Because of geology (predominantly porous materials) and dependence upon groundwater, the Nassau-Suffolk area is particularly susceptible and sensitive to this type of degradation.

Having established the need for landfills, what remains is the establishment of the recommended operating constraints. The intent is the creation of small, easily controlled landfills. Size is a very important constraint. If landfills are kept small, corrective measures can easily be implemented if problems arise. Recommended constraints, which should be followed to the maximum possible extent, are as follows:

- Locate no landfills in the Magothy recharge area or in other areas that contribute to deep groundwater flow, or in areas of high water table.
- Establish a maximum size of 25 to 30 acres.
- Accept processed (shredded, baled, incinerated, etc.) wastes only. This will extend the useful life of the landfills.
- Provide a double lining with adequate and proper materials to ensure isolation of any leachate from the surrounding ground or surface water environment.
- Accept no hazardous materials (except in chemical landfills).
- Establish complete leachate collection and treatment systems.
- Establish gas collection and treatment or venting systems.
- Employ impermeable covers, drainage channels or topographic drainage controls to minimize the amount of leachate that is generated.
- Consider locating new landfills down-gradient of existing landfills if the existing landfills are improperly designed and operated and are generating a pollutant plume in the groundwater.
- Provide an impermeable cover upon completion (*e.g.*, PVC asphaltic membrane, or other impervious non-reactive material, followed by two to four feet of cover material) to isolate the complete landfill from rainfall percolation and the atmospheric environment.
- Establish extensive and continuous monitoring systems (surface water, groundwater and gas).

The above constraints provide the optimum land disposal method known at this time and offer the maximum protection to the environment.

In order to limit the size and required number of controlled landfills, some types of intermediate processes are required.

b. *Intermediate Processes.* An intermediate process serves two functions: first, it reduces the volume and changes the characteristics of the

materials requiring disposal; and second, it usually produces a usable by-product either in the form of energy (*e.g.*, steam or fuel) or recoverable materials (*e.g.*, ferrous metals, non-ferrous metals, glass and compost). For ease of comparison, a very brief description of each process follows.

- Incineration—controlled combustion of solid waste. Achieves significant volume and weight reductions. By-products are gases, quench waters and generally inert residue. Resource recovery is not practiced in conventional incineration (exception ferrous metals).
- Co-incineration and pyrolysis—controlled combustion of solid waste and usually dewatered wastewater treatment plant sludges. Achieves significant volume and weight reduction. By-products are gases, quench waters and a generally inert residue. Usually resource recovery is achieved by passing the off gases through a waste heat boiler to generate steam.
- Composting—the aerobic, biological decomposition of solid waste. Achieves volume reduction. Resource recovery is also possible if the materials are applied to plants in accordance with normal cultivation practices, thus permitting the utilization of nutrients. The compost can be used as a soil conditioner.
- Resource Recovery—processes are divided into two classifications: materials and energy, but a mixture of both is usually present in any one system. Materials recovered are used to replace a portion of the materials normally required in the production of iron, aluminum, glass, etc. Energy in the form of fuels for later use or steam for immediate use is generated by these processes. In general, all processes achieve some form of volume reduction.

c. *Recommended Concepts.* It is recommended that, for the short term through 1985, the following tasks be completed:

- Perform detailed evaluations of existing resource recovery facilities and update as new facilities are constructed and started up, especially those currently proposed for the Nassau-Suffolk area. It is felt that, for the long term, resource recovery should receive primary emphasis in solid waste planning.
- Through the regulatory controls contained in 6 NYCRR Part 360, supervise, monitor and initiate the corrective measures required to insure the proper disposal of solid wastes.
- Require all new landfills to be designed for operation under the suggested constraints.
- Formulate a comprehensive solid waste management plan for implementation as soon as possible.

At this time, the two processes showing the most promise for implementation in the future are co-incineration and pyrolysis. Both processes, which may include resource and materials recovery, can be used for the simultaneous processing of solid wastes and wastewater treatment plant sludges, and both generate a form of energy: co-incineration by passing the gases through a waste heat boiler to generate steam; and pyrolysis by passing the fuel rich gases through an afterburner and then through a waste heat boiler to generate steam. In pyrolysis, the fuel rich gases can either be condensed to form a fuel oil or cleaned to provide a fuel gas.

Two other processes (waterwall incineration and refuse derived fuel) are technically viable, and by 1985 it would be expected that they would have undergone sufficient refinement/upgrading to warrant further consideration. Composting, although workable, is not a viable alternative for mixed solid wastes; it should only be considered for sludges and leaves or other agricultural wastes.

Taking into consideration the rapidly advancing technology and the scale of facilities either on line or under construction, it is almost certain that a number of proven systems will be available by 1985. The system recommended for the post-1985 comprehensive plan consists of a complete materials and energy recovery system(s), with disposal of remaining materials in a controlled landfill.

3.3.2.2 Hazardous Waste Treatment Systems. Hazardous waste disposal is only one part of hazardous waste management. Management of hazardous wastes means awareness and control over the wastes from the time of their generation through their transportation, temporary storage, treatment and disposal. In the past, comprehensive hazardous waste management has not been practiced in the Nassau-Suffolk area. Therefore, a brief description of components that make up a good hazardous waste management system is presented below (Refer to Section K of the Areawide Waste Treatment Management Plan.):

1. Regulation and Enforcement—at both State and local levels, are necessary if a proper and effective hazardous waste management system is to be formulated and enacted in order to provide adequate protection for the environment.
2. Survey and Inventory—of all firms in the Nassau-Suffolk area (with appropriate Standard Industrial Classification System Codes) is required to identify all generators. In the bi-county area, the existing NYS Department of Environmental Conservation survey and a Nassau County Department of Health survey should establish this data base.
3. Standard and Effective Identification and Labeling System—is essential so that all personnel involved may readily identify the hazardous waste and initiate proper handling and/or treatment procedures.
4. Waste Transportation Control System—is required for continuous monitoring of the waste flow from generator through disposal. This usually consists of some manifest or "trip ticket" system to ensure accountability.

5. Control at the Source
   a. Waste Reduction—through process changes and/or changes in raw materials, is desirable. Restriction of hazardous chemicals utilized in operations, substitution of less hazardous materials, better quality control and material recovery are all alternatives that may reduce the quantity of hazardous wastes generated.
   b. Waste Separation and Concentration—hazardous waste separation early in process stream flows before contamination of other, non-hazardous process stream flow occurs, isolation of similar wastes into separate disposal containers, and concentration by dewatering or some other process will reduce quantities of hazardous wastes that require treatment and disposal.
   c. Waste Exchange—investigate the possibility of reuse by another firm (*e.g.*, one firm's wastes may be another firm's raw materials or process chemical).
   d. Energy or Material Recovery—extraction of materials from hazardous waste streams may be cheaper than to produce them from virgin materials. Combustion to recover energy or heat value for other purposes may result in savings.
6. Treatment and Disposal
   a. Treatment—for those hazardous wastes not suitable to energy/material recovery systems, some form of thermal, biological, physical or chemical treatment should be applied to detoxify and neutralize the wastes to the maximum extent possible.
   b. Encapsulation/Chemical Waste Landfill—for those hazardous wastes not amenable to recovery, treatment or destruction, volume reduction followed by encapsulation or disposal in a chemical waste landfill is recommended.
7. Emergency Hazardous Waste Management Procedures—required in case of spills so that the best means of correcting the situation and protecting the environment will be utilized.
8. Monitoring of Hazardous Waste Treatment Facilities and Chemical Waste Landfills—to insure proper operation.
9. Hazardous Waste Disposal Site Shut-Down Procedures—to insure that disposal sites are properly closed and maintained after closure.
10. Buffer Zones—in addition to sufficient land for all processes to insulate sites from the public.

Description of Recommended Hazardous Waste Treatment System. Public health and environmental considerations suggest that Long Island disposal of hazardous wastes is the least acceptable of several alternatives. The need to protect the deep flow aquifers, in order to maintain a potable water supply, and the shallow flow system, to prevent degradation of productive marine waters, provides a strong argument for out of area disposal.

Export of hazardous wastes to out of area landfills or processing facilities would meet the local objectives of this Waste Treatment Management Plan. The relatively low volume and somewhat diverse nature of the wastes requiring treatment would probably make this option more cost-effective than local treatment. However, should Federal regulations or legal action preclude such export, consideration should be given to the establishment of a single bi-county facility or individual county facilities. The treatment process, described next, would be the same whether for one or two facilities.

A hazardous waste management system for the Nassau-Suffolk area should include a comprehensive regulatory and monitoring program that directs all hazardous wastes generated in the bi-county area to one or two county owned and operated, centrally located treatment facilities, one in Nassau and one in Suffolk. Alternatively, a single facility might be implemented to serve both counties. Disposal of treatment residuals is by transporting and placing them in properly located, constructed, operated, monitored and controlled chemical landfill, one for each treatment facility. This type of comprehensive, controlled system is required to ensure environmentally safe treatment and disposal of hazardous wastes in the area.

Treatment Processes. The treatment system for hazardous wastes should include physical-chemical treatment, sludge dewatering, incineration, effluent polishing and disposal of treatment residues in a chemical landfill. Facilities proposed for each county differ in that batch treatment of cyanide and chromic wastes is provided in Nassau as opposed to the continuous treatment of these wastes in Suffolk. (Batch treatment may also be employed in Suffolk County after a more definitive analysis is made of the types and quantities of wastes to be treated.) Concentrated metal finishing wastes are of a sufficient volume in Suffolk to require equalization for continuous flow-thru processing.

Estimated costs for each county's facilities are presented in Table 3—7. (See Plan Section K.) The treatment plant is designed to accomodate all hazardous wastes generated within the county that were identified during the 208 Study. It is recommended that once the inventories of hazardous wastes are completed, the design flows be adjusted if necessary. A detailed study is required to establish the design basis for the plant.

The ultimate disposal of residues from these plants is to be by chemical landfill. Residue quantities would be small. An estimate of dewatered sludge (30 percent solids), which would be incinerated, would be 1.1 cubic yards per day. The landfill would be protectively lined, with provisions for leachate collection and treatment, and installation of monitoring wells. Special attention is to be given to the location of the landfill because of possible groundwater contamination. The proposed landfill should be located in accordance with the previously discussed criteria.

The effluent from the hazardous waste treatment plants would be discharged through existing or proposed ocean outfalls, as an additional safety measure.

Table 3–7

COSTS FOR HAZARDOUS WASTE DISPOSAL PLANTS (1)

Alternative	Design Flow (2) (GPD)	Capital Cost	Annual O & M Cost	Total Annual Cost (3)
Bi-county Plant	325,000	$ 6,931,000	$ 458,000	$ 1,050,000
County Plants				
Nassau	65,000	$ 4,363,000	$ 247,700	$ 616,000
Suffolk	260,000	4,513,000	357,600	736,000
Total	325,000	$ 8,876,000	$ 605,300	$ 1,352,000

(1) *Order-of-magnitude cost estimate; based on mid-1977 costs (ENR = 2580)*

(2) *Less trucked-in sludge volume*

(3) *Capital cost amortized over 20 year planning period at 6 3/8%*

3.3.2.3 Sludge Management Alternatives. Alternative sludge disposal techniques for the Nassau-Suffolk area were identified, developed and evaluated. Various management systems and approaches were formulated and capital and operation and maintenance costs were generated. (See Plan Section K.) Seven sludge handling and reduction techniques were examined and include composting, landfilling, land application, incineration, co-incineration (with solid waste), pyrolysis and thermal drying. The alternative management approaches compared regional, subregional and small treatment plants.

In Nassau County, the regional approach was defined as a single sludge processing facility to handle the approximately 90 MG per year of sludge generated in the county. In Suffolk County, a regional approach was defined to include a central processing facility for each particular study area. Total sludge generated from treatment systems in Suffolk is about eighteen MG per year. The study areas are the same as those defined for point source alternatives.

A preliminary screening of the disposal techniques and management approaches was conducted for each area. In Nassau, it was not deemed feasible to combine incinerators, pyrolysis, or thermal drying units with all the domestic treatment facilities, and a regional or sub-regional approach was examined for these processes. In Suffolk, it was considered unnecessary to haul all sludge to a single wastewater treatment plant for subsequent landfilling, provided there are suitable landfill sites available closer to the sludge source. Landfilling, as a sludge disposal option, was examined on a plant-by-plant basis.

Sludges generated from the implementation of non-point source structural abatement alternatives are negligible in quantity compared to domestic wastewater treatment plant sludges. The non-point source sludges can be dewatered by vacuum filter and transported to the nearest regional or sub-regional sludge processing facility. Sludges currently generated from the periodic scouring and dredging of recharge basins are landfilled. This sludge could be placed in a sanitary landfill directly, or treated at a sludge processing facility. The disposal of contaminated dredge spoil from bays and estuaries was not studied as part of the 208 Program.

In general, the degree of confidence that can be placed in the sludge processing costs is somewhat low (± 50 percent) when compared with actual detailed cost estimates. Documentation in the literature on sludge processing costs is not nearly as extensive as documentation found in conventional wastewater treatment processing. In particular, newer technologies, such as composting, land application, co-incineration, thermal drying and pyrolysis have little available cost information. Costs for the newer technologies were obtained, wherever possible, from documents describing actual operating installations.

Nassau County. In Nassau County, all seven of the alternative disposal techniques were evaluated, some being applicable on a regional and sub-regional basis, and others on a local basis.

For purposes of economic analysis, locations for regional sludge processing facilities were considered to be Bay Park, Cedar Creek or adjacent to a solid waste processing facility, *e.g.*, the Town of Hempstead plant. Potential sub-regional locations included Port Washington and Glen Cove.

For incineration, thermal drying and pyrolysis, dewatering was assumed to achieve a cake solid content of approximately 35 to 40 percent, which is sufficient for autogenous combustion. For composting, land application, landfilling and co-incineration, liquid sludges were assumed to be dewatered by vacuum filters to approximately twenty percent solids, which is sufficient for handling as a semi-solid material rather than a liquid.

Transportation costs within the county were calculated assuming the trucking of dewatered material. For the two largest treatment facilities in Nassau County that currently do not dewater (Cedar Creek and Bay Park), costs for pipeline transportation were utilized because of potentially significant savings over trucking. In addition, there is an existing pipeline between Cedar Creek and Bay Park. Additionally, for the land application alternative, sludge was assumed to be barged to available farm land in Suffolk County for application. The actual acreage required for applying all the sludge generated in Nassau County would not be sufficient within county boundaries.

Apart from economic considerations, processes such as pyrolysis, thermal drying, co-incineration, land application and composting lack a significant operating record. While these processes seem promising in many instances, they have also been prone to failures in full-scale operation. Furthermore,the economic feasibility of such processes as thermal drying or composting for the purpose of recovering a saleable by-product such as soil conditioner is a function of the market for this material. If both counties were to undertake full-scale composting operations or thermal drying operations for soil conditioning, there might not be a readily available local market for all the material that would be generated. Further, should New York City utilize the recommended ISC plan of composting sludge, a great deal of

difficulty could be experienced in finding a market for all the compost that would be generated.

Other considerations besides economics affect the feasibility of implementing the various technologies. For example, in land application, concerns include the possibility of applying excess nutrients, heavy metals or organic chemicals that may be found in the sludge. The intent of applying the sludge to the land is to stimulate plant growth by adding various nutrients. Additional nutrients however could be leached out of the sludge and into the groundwater. This same concern applies in the case of heavy metals since wastewater sludges could leach toxic metals such as cadmium, lead and mercury to the groundwater. Further, cadmium is readily taken up into plants and subsequently concentrated. If these plants are utilized for human consumption they may be toxic. Potential bacteriological contamination is a further concern since pathogens may be conveyed from the sludge to the land and then onto plants or into the groundwater.

Theoretically, complete enforcement and implementation of county and local pretreatment guidelines would prohibit large concentrations of metals from reaching domestic wastewater treatment facilities and subsequently being concentrated in the sludge. Due to the number of metal finishing industries in the county, however, it is difficult to ensure that metals will not reach these domestic facilities. The extreme care required to protect the environment from these potentially hazardous materials reinforces the case for a regional approach to hazardous wastes handling.

Table 3–8 summarizes the costs for various sludge alternatives. Costs ranged from a low of $6.28 million per year for landfilling to a high of $16.0 million per year for land application (exclusive of land costs). High transportation costs ($12.4 million) are incurred in barging Nassau County's sludges to Suffolk County farmland near Riverhead. Nassau County could have difficulty in finding 17,600 acres of suitable land (agricultural or park land) for spreading sludge. While landfilling is the least expensive process, (at an assumed cost of $15 per ton), it is contingent upon the availibility of suitable landfill capacity.

Ranking very close to landfilling, in terms of costs, were composting and co-incineration at $6.7 million to $7.2 million depending upon management level (regional, sub-regional or small plant). The ten to fifteen percent difference in cost between landfilling and composting (or co-incineration) is well within the accuracy of the cost estimates. Composting appears to be slightly more costly on a regional basis due to higher transportation costs and minimal economies of scale. Co-incineration at about $7.0 million per year appears quite promising economically, even at low refuse to sludge ratios (2.67 1).

Incineration, pyrolysis and heat drying represent a third group of costs ranging from about $9.5 million (incineration) to $12.2 million (heat drying). Incineration appears to slightly less costly on a regional basis, with economies of scale off-setting increased transportation costs. While incineration is the least expensive of the thermal processes (excluding co-incineration previously discussed), it remains about 50 percent higher than landfilling.

Pyrolysis is approximately ten percent more expensive than conventional incineration. No cost savings were realized in a regional approach as opposed to a sub-regional approach (within one percent). While heat drying to produce a salable product was comparable to pyrolysis on a regional basis, sub-regional costs were about twenty percent higher. With a sale value of something greater than twenty percent of the cost of processing, heat drying could become less costly than incineration or pyrolysis. This again is a function of marketability.

Table 3–8
ESTIMATED ANNUAL COSTS FOR DOMESTIC AND NON-POINT SOURCE SLUDGE DISPOSAL ALTERNATIVES FOR NASSAU COUNTY
(Dollars Per Year)

Management Approach	Transportation Cost (1)	Total Annual Cost (2) (7)
Incineration		
Regional	$ 760,000	$ 9,550,000
Sub-Regional	503,000	9,820,000
Composting (3)		
Regional	$ 760,000	$ 7,070,000
Sub-Regional	503,000	6,740,000
Small Plants	—	6,860,000
Landfilling (4)		
Small Plants	$ 867,000	$ 6,280,000
Pyrolysis		
Regional	$ 760,000	$10,500,000
Sub-Regional	503,000	10,400,000
Heat Drying (3)		
Regional	$ 760,000	$10,400,000
Sub-Regional	503,000	12,200,000
Co-Incineration (5)		
Regional	$ 760,000	$ 6,700,000
Sub-Regional	503,000	7,190,000
Land Application (6)		
Sub-Regional	$12,400,000	$16,000,000

(1) Includes both amortized capital and operation and maintenance costs to transport sludge from existing generation point to central processing facility.

(2) Amortized over 20 years at 6 3/8% interest, CRF = .08986. Total annual costs also include ultimate residue disposal (landfill). Does not include cost of land.

(3) No credit taken for sale of final product.

(4) Assumes utilization of Town of North Hempstead L-4 landfill for North Shore sludges and Oceanside landfill for South Shore.

(5) Assume refuse and sludge are co-incinerated at a refuse:sludge ratio of 2.67. Sludge is dewatered to 20% solids. Costs are allocated to sludge on an "as incinerated" wet ton basis. (See Section K of the Areawide Waste Treatment Management Plan.)

(6) Assumes sludge is barged from Glen Cove and Bay Park to farmland in Suffolk County and applied as a liquid at a dosage of 4 tons per acre per year.

(7) Cost of energy generation or sale is not included in the calculations.

Land application is feasible only in Suffolk County, since there is little land available for this purpose in Nassau County. While land application ranked the highest in cost, a large portion of the total cost (about 75 percent) is accounted for by transportation costs.

All of these processes can be utilized without significant negative impact on the environment. Composting, heat drying and land application would require guidelines on allowable application rates to avoid potential groundwater contamination by excess nutrients, metals or organic chemicals. Incineration, co-incineration and pyrolysis require suitable emission control devices to protect ambient air quality. Quench water from these processes must also be properly treated prior to release to surface or groundwater.

It is recommended that the cost-effectiveness of some combination of landfilling, incineration, co-incineration and composting be evaluated in further detail in the Nassau County Sludge Management Study. Potential impacts on the environment must be evaluated in detail.

Suffolk County. Table 3–9 summarizes Suffolk County costs for incineration, composting, landfilling, pyrolysis, heat drying, co-incineration and land application. Each table provides costs by study area (or disposal district) for various regional, sub-regional and/or small plant options. Each table facilitates a comparison of costs for different management approaches (regional *versus* sub-regional) for each Study Area (or Disposal District).

In reviewing the previous table, it can be seen that costs change from area to area for the same sludge treatment process. This is a reflection of the quantities of sludge to be handled and economies of scale. In general, as more sludge is handled, the unit costs per ton for handling and disposal decrease. This is also true within a single geographic area as regional, sub-regional and small-plant systems are analyzed. Again, economies of scale affect the final cost estimates.

In costing the landfilling option in Suffolk County, a disposal cost of $15 per ton was assumed and includes liners as well as environmental monitoring and leachate treatment. Sludges from various sources would be hauled to the nearest landfill. The co-incineration alternative assumes that solid wastes are diverted to a particular co-incineration facility.

A second case is costed for each of the co-incineration facilities representing a minimum recommendable ratio of refuse to sludge of 2.67. For example, for the Huntington-Northport co-incineration facility, all of Huntington's refuse (956 tons per day) would represent a refuse to sludge ratio of approximately sixteen to one, whereas the minimum necessary ratio would be 2.67 to one, or 160 tons per day of refuse to 60 wet tons per day of sludge.

For many of the areas, there is an economical preference for land application, landfilling and composting as opposed to pyrolysis, incineration and heat drying. Co-incineration appears competitive, depending upon the refuse to sludge ratio. (Co-incineration becomes less economically feasible at lower solid waste to sludge ratios). However, cost is not the only consideration. Environmental impacts must also be evaluated.

For the Huntington-Northport Study Area, composting and land application are economically preferable at a predicted annual cost of $250,000 to $300,000 per year. Co-incineration, incineration and heat drying comprise another level of costs at about $600,000 to $700,000 per year. Pyrolysis represents the highest cost at as much as $1,500,000 on a regional basis and would seem economically prohibitive. In the land application options, specific land disposal sites were not identified. For cost estimating purposes, it was assumed that dewatered sludge would be hauled by truck to farmland in the eastern portions of the county for final disposal.

In the Southwest Sewer District, methods of sludge disposal have already been investigated. Because of the lack of sufficient space in the immediate area, and because energy recovery was a major objective, incineration was the method selected. The sludge incinerators have been constructed alongside the other treatment facilities on the sewer district treatment plant site.

For the West Central Study Area (exclusive of SWSD), only land application and composting are economically preferable, with landfilling being significantly higher than both, by a factor of almost two, and incineration, heat drying, pyrolysis being substantially higher yet. If sewage is diverted to the SWSD, it would entail expansion of the incineration facilities.

The Port Jefferson Study Area shows land application, landfilling and composting relatively cost-effective, with incineration and heat drying not far behind, and pyrolysis being significantly more expensive than all others. For the South Central Study Area, composting and land application appear to be the most economically feasible, with landfilling almost twice as much in cost, and heat drying and incineration and pyrolysis most costly. Co-incineration does not appear economically competitive with composting and land application.

In Yaphank, the situation is very similar to South Central, except that landfilling is somewhat more economically competitive. Riverhead shows land application as economically attractive due to the location of Riverhead relative to the farmland where sludge may be applied. Composting also appears economical, especially since there may be more of a market for the compost material in the agricultural areas of eastern Suffolk County.

For the small plants of Southold, Shelter Island, Southampton, East Hampton, and Fishers Island, composting generally appears slightly higher than landfilling, with land application being slightly lower than landfilling. Co-incineration, heat drying, incineration and pyrolysis were not examined for the small plants of eastern Suffolk County.

The cost estimates for land application do not include land costs. Therefore, in order for this approach to be economically viable, land must be available on a low-cost rental or purchase basis. Actual land costs are very site-specific and so could not be analyzed herein. However, in more detailed studies, land costs must be identified and included in the analysis.

In summary, it appears that in Suffolk County, landfilling, land applica-

Table 3–9

ESTIMATED ANNUAL COSTS FOR DOMESTIC & NON-POINT SOURCE SLUDGE DISPOSAL ALTERNATIVES FOR SUFFOLK COUNTY

SUMMARY BY PROCESS
(Thousands of Dollars)

Study Area	Total Annual Cost (1)						
Management Approach	Incineration	Composting	Landfill	Pyrolysis	Heat Drying	Co-incineration (2)	Land Application
Huntington-Northport							
Regional	603	229	394	983	640	619	280
Regional	601	229	388	980	640	619	280
Sub-Regional	758	316	422	1,590	722	–	280
Small Plants	–	316	422	–	–	–	280
SWSD							
Regional (3)	1,320	464	885	1,420	1,370	1,220	521
West Central							
Sub-Regional	2,260	871	1,540	3,610	2,590	–	713
Sub-Regional	1,830	694	1,350	4,040	2,230	–	606
Small Plants	–	3,280	2,540	–	–	–	713
Kings Park							
Regional	650	247	419	1,030	677	743	268
Sub-Regional	868	343	503	1,740	940	–	305
Small Plants	–	1,060	831	–	–	–	325
Port Jefferson							
Regional	520	196	350	935	584	–	207
Regional	466	176	283	830	457	–	173
Sub-Regional	583	258	310	–	518	–	173
Sub-Regional	674	276	356	–	637	–	194
Small Plants	–	584	474	–	–	–	194
South Central							
Regional	1,300	475	942	1,430	1,380	1,210	481
Sub-Regional	1,660	622	1,060	–	1,750	–	521
Sub-Regional	2,050	1,010	1,210	–	2,090	–	574
Small Plants	–	2,580	1,860	–	–	–	632
Yaphank							
Sub-Regional	1,930	824	1,380	3,300	2,220	1,790	615
Sub-Regional	2,330	988	1,380	–	2,320	–	561
Small Plants	–	2,830	2,000	–	–	–	615
Riverhead							
Regional	431	172	256	921	459	–	138
Sub-Regional	566	253	286	–	509	–	138
Small Plants	–	253	286	–	–	–	138

Table 3—9 . . . Continued

Study Area Management Approach	Total Annual Cost (1) Incineration	Composting	Landfill	Pyrolysis	Heat Drying	Co-incineration (2)	Land Application
Southold							
Small Plants	—	217	172	—	—	—	109
Shelter Island							
Small Plants	—	75	53	—	—	—	46
Southampton-East Hampton							
Small Plants	—	402	297	—	—	—	127
Fishers Island							
Small Plants	—	24	24	—	—	—	30

(1) *Amortized over 20 years at 6 3/8% interest, CRF = .08986.*
(2) *Costs represent average of two different refuse to sludge ratios shown in Section K of the Plan.*
(3) *Incineration has already been selected because of limited available space and energy recovery requirements.*

tion and composting are economically preferable to pyrolysis, heat drying and incineration. Co-incineration becomes more economically attractive for the five western towns (due to refuse generation in concentrated areas). In the eastern areas of Suffolk, land application and composting of sludges should be given serious consideration by virtue of proximity to agricultural land, and the probable lack of high concentrations of heavy metals in the domestic treatment plant sludges.

All of these processes can be made environmentally safe with proper precautions, and their impacts are evaluated in Section Four of this Summary Plan. Those most economically attractive should be examined in greater detail at the 201 level for application to specific areas.

3.4 Non-Point Source Controls

The 208 Program has identified a number of non-point source problems that contribute to ground and surface water pollution in the Region. For each class of non-point sources, the program identified a series of implementable, cost-effective responses that can be utilized to reduce the non-point problem. These non-point controls should be implemented on a priority basis and must, wherever possible, supplement and strengthen existing programs, regulations and structural alternatives.

3.4.1 Identification of Applicable Non-Point Controls. (Refer to Section J of the Areawide Waste Treatment Management Plan.)

3.4.1.1 **Stormwater Runoff Control.** Stormwater runoff from impervious surfaces is generally controlled through the use of infiltration basins or allowed to flow through drainage systems or overland to surface waters. Stormwater runoff often contains plant nutrients (*e.g.,* nitrates), heavy metals, organic compounds and bacteria. Pollutants contributed by runoff constitute significant hazards in many parts of the area, and are particularly deleterious to the Great South Bay system. The program has formulated the following control strategies that can aid in minimizing problems attributable to this pollution source:

- Require the immediate recharge or on-site detention of stormwater, where feasible, in order to reduce the volume of runoff.
- Promote the use of storage areas—either specially constructed detention basins, multi-purpose paved areas, natural ponds or other existing or altered landforms—to reduce sediment transport and coliform contamination from runoff.
- Promote or require the imposition of controls to reduce pollution generated by domestic animals.
- Limit, regulate and, where necessary and practicable, prohibit new shoreline development in order to protect the quality of adjacent surface waters.
- Provide adequate buffer zones surrounding tidal and freshwater wetlands.
- Establish and require compliance with Best Management Practices for land clearance and construction in order to minimize erosion and construction related pollutant discharges.
- Promote or require the institution of municipal street cleaning programs to help minimize the pollution effects of stormwater runoff. Require strict control over the disposal of collected materials in sanitary landfills.

3.4.1.2 Domestic On-Site Disposal Systems. Domestic on-site disposal systems are in widespread use throughout portions of the Nassau-Suffolk area and contribute significant amounts of nitrogen to the area's groundwater. In addition to the usual structural responses, that is, municipal collection and treatment. the Program has identified the following control strategies that can aid in minimizing the pollution source.

- Withold permits for individual systems in any area where its has been determined that on-site disposal is causing significant deterioration of groundwater or surface waters.
- Promote further investigation into the feasibility of utilizing innovative on-site treatment—disposal techniques including, but not limited to, pressure/vacuum systems, alternate leaching fields and in-ground denitrification systems.
- Prohibit or restrict the use of various classes of products that may contribute to the chemical pollution of the groundwater. Such products include various detergents, dry cleaners and septic system cleaners or reconditioners.
- Establish minimum lot sizes in specific areas subject to hydrologic constraints or, if such areas are already developed, provide for and require hook-up to a collection and treatment system.
- Promote the establishment of municipal or neighborhood programs for the routine preventive maintenance of on-site systems.
- Provide for a monitoring program in areas where pervasive violations of the nitrogen standard or the presence of heavy metals or organic chemicals is considered likely.
- Plan for conversion to alternative disposal techniques in those areas where monitoring indicates unacceptable pollutant concentrations.

3.4.1.3 Subsurface Leakage from Domestic Collection Systems. Sewer systems develop leaks as a result of improper construction, materials failure or aging. These leaks may permit domestic and industrial-commerical waste to be carried to the groundwater. The program has identified the following strategies that can aid in minimizing the pollution problems associated with infiltration, exfiltration and clogging:

- Continue to apply stringent performance standards for construction materials and practices, accompanied by agency surveillance during construction.
- Require the establishment of regularly scheduled maintenance and cleaning programs.

3.4.1.4 Product Storage Tanks, Pipelines, Accidental Discharges. Leakage of materials from product storage tanks and accidental discharges may introduce hydrocarbons, organic solvents and toxic industrial liquids into surface and groundwaters. The program has identified the following control strategies which can aid in minimizing the pollution source.

- Require construction standards that will minimize the probability of leakage or, in the event of accident, will minimize the entry of pollutants into ground and surface waters.
- Establish siting and location standards that will prohibit the storage of certain materials in areas where leakage and spills will constitute a significant pollution hazard.
- Establish a monitoring program that will enable a management agency to evaluate the performance of storage facilities in relation to baseline ground or surface water quality.
- Require that owners or operators of storage and transmission facilities develop an emergency shut down, containment and clean-up procedure as a permit condition.
- Promote or, where feasible, require changes in clean-up techniques to minimize the flushing or disposition of hazardous spilled materials to groundwater or surface waters.
- Establish and maintain an emergency notification system with a trained emergency response team capable of responding to spill emergencies.
- Provide for criminal and/or civil liability in cases of ground or surface water pollution caused by violation of permit or operating conditions and assume that compliance with these conditions will not affect such liability.
- Require that accurate product records be maintained and made available to regulatory agencies.
- Require that buried tanks be constructed or protected in such a way as to positively prevent the escape of contents due to tank corrosion, both internal and external. Techniques to be considered include, but are not limited to, the use of non-corrosive materials, cathodic protection, coatings and double-walled tanks.
- Prohibit the establishment of waste piles (stock piles) containing potential pollutants within the flood plain of the 100-year flood.
- Prohibit above and below ground storage of potential pollutants in primary recharge or watershed areas except where reasonable safeguards are provided in order to prevent the escape or movement of such pollutant into ground or surface waters.

3.4.1.5 Discharge and Storage of Industrial Wastes. Industrial wastes discharged to municipal treatment facilities and ground/surface waters may contain a variety of toxic organic and inorganic compounds that constitute a public health hazard. The program identified the following control strategies that can aid in minimizing this pollution source:

- Require adequate pretreatment levels as a condition of discharge.
- Prohibit disposal of waste materials on the land surface, or to groundwater, unless permitted or exempted. (Specific classes of materials may be exempted.)
- Prohibit the discharge of specific classes of industrial waste to

groundwater in any prime recharge or watershed area.

- Expand permit conditions relating to an enumeration of chemical constituents and allowable limits to ensure maximum protection of the groundwater resource.
- Promote and, if necessary, require that specified classes of industrial wastes be subject to a materials recovery process prior to discharge.

3.4.1.6 Landfills. The use of the land for the ultimate disposal of solid wastes, sludges and toxic chemicals constitutes a significant threat to groundwater quality and the public health. The program has identified the following control strategies that can aid in minimizing this pollution source:

- Prohibit all landfill operations that rely on natural attenuation as a means of leachate control.
- Prohibit the location of new landfill operations in primary recharge or watershed management areas.
- Require that landfill operators adhere to a cover schedule and maintain a minimal exposed face. Where appropriate, require a cover of relatively impervious material.
- Classify all landfill sites according to the materials that may be placed in them, with toxic wastes assigned to specific disposal sites that are strictly controlled and monitored.
- Promote the use of volume reduction techniques, and resource recovery and reuse, wherever economically feasible.
- Require permits for all landfill operations, regardless of size.
- Require the provision of an underdrain system and an impermeable barrier where the landfill is located in a permeable soil and where it can reasonably be expected that the quantity and quality of the leachate will have a significant adverse effect on ground or surface waters. Provide for treatment and disposal of collected leachate.
- Establish, maintain or supplement groundwater monitoring and surveillance at each landfill site, both open and closed.
- Require surface liners, proper grading and revegetation of completed landfills to minimize infiltration and ensure compatability with the surrounding area.

3.4.1.7 Recharge of Sewage Treatment Effluent. Sewage treatment plant effluent discharged to the ground does not constitute a major threat to the area's groundwater; however, there may be significant local impacts when discharges are concentrated at a few sites. Most of the plants that discharge to the ground are generally treated to the secondary level; some are denitrified. The program has identified the following control strategies that can aid in minimizing this pollution source:

- Establish and/or enforce strict control of treatment plant operating procedures.
- Provide for public take-over in instances where private owners and operators consistently fail to meet permit conditions.
- Require the use of advanced wastewater treatment techniques in primary recharge areas, or prohibit sewage treatment plant discharges to ground in prime recharge or watershed management areas.
- Establish demonstration projects to test alternative treatment and disposal techniques including, but not limited to, the land application of treated effluent, spray irrigation and marsh-pond basins.
- Establish, maintain or supplement monitoring programs to determine baseline water quality and to ensure early detection of any degradation caused by discharges from sewage treatment plants.

3.4.1.8 Construction-Related Erosion. Sediment is the end product of the erosion that occurs when the protective vegetal cover of the land is removed and rain and wind forces can work freely on the exposed soil. Although erosion is not as serious a problem on Long Island as it is elsewhere in New York State, there are areas where the deposition of sediments can severely damage aquatic or wetland ecosystems. In 1974 the Soil Conservation Service reported that erosion from construction sites accounted for approximately half of all erosion losses in Suffolk County. The program has identified the following control strategies that can aid in minimizing pollution from this source:

- Prepare or support the preparation of a handbook for local officials and developers. The handbook would describe Best Management Practices for the control of construction-related erosion.
- Establish or strengthen sub-division ordinance requirements for the reduction of erosion during and after site development.
- Supplement building permit requirements by including provision for submission of a site clearance, interim grading and restoration plan designed to minimize runoff and erosion.

3.4.1.9 Water Well Construction and Abandonment. Improper construction and practices may permit surface pollutants to enter the groundwater aquifer system and may contribute to the movement of contaminated water between groundwater aquifers. Existing controls over this non-point source of groundwater contamination are not particularly stringent. Drillers are licensed and permits are required before wells can be drilled, except for agricultural wells. In addition, Nassau and Suffolk County Health Departments maintain records on public supply wells, but generally do not sample and inspect the numerous agricultural wells. The 208 Program has identified the following contol strategies that can minimize this pollution source:

- Extend the NYSDEC regulations governing well construction and abandonment to cover wells presently not subject to regulation.
- Require the registration of all persons and/or firms engaged in well drilling activities with the appropriate county management

agency. Require all drillers to obtain a license and post surety or cash bonds before engaging in activites related to well drilling. The license should provide for revocation wherever regulations are violated.

- Establish a program of well inspection. Inspection priority should be accorded to the classes of wells considered most likely to contribute to groundwater contamination.
- Require a permit for the abandonment, sealing or demolition of any public or private well having a capacity greater than 45 gpm and of any observation well or other well installed for the purposes of scientific investigation.

3.4.1.10 Highway Deicing Materials. The storage and application of highway deicing materials contribute to chloride and sodium contamination of fresh surface and groundwaters. Leachate from inadequately protected salt piles and salt-laden runoff from impermeable road surfaces seeps directly into the ground or is diverted to a storm recharge basin. In some places along the shores of Long Island, street runoff is diverted to storm drains that empty into surface waters. The Program has identified the following control strategies that can minimize pollution from this source:

- Require that salt piles be stored in permanent buildings.
- Require the substitution of inert abrasives, such as sand or cinders, for chemical salts wherever possible.
- Modify application procedures and equipment to allow preferential spreading on high hazard road segments.

3.4.1.11 Well Disposal of Heated Cooling Water to Groundwater (Diffusion Wells). Diffusion wells may cause contamination of groundwater through the introduction of heated water and of chemical additives used in the cooling process or for the maintenance of cooling equipment. The Program has identified the following control strategies that can aid in minimizing pollution from this source:

- Restrict the use of chemical additives in cooling processes or in the maintenance of cooling equipment.
- Require that no cooling waters discharged to the ground differ significantly from ambient water except in respect to temperature.
- Provide adequate surveillance to ensure compliance with diffusion well permit conditions.

3.4.1.12 Control of Domestic Animal Wastes. Data provided by the Soil Conservation Service indicates that the animal population of the Region is sufficiently diverse and numerous to add to the BOD, COD, bacterial, nitrogen and phosphorus content of ground and surface waters. Regulations controlling the disposal of waste from domestic animals are generally designed to prevent public health nuisances and do not protect ground or surface water quality. The Program has identified the following control strategies that can aid in minimizing pollution from this source:

- Promote dog sterilization programs in order to limit the growth of the canine population.
- Require that pet owners assume responsibility for the clean-up and disposal of animal wastes.
- Provide for the repeal of dog curbing ordinances, and promote the adoption of clean-up ordinances.
- Require that persons having ownership or control of numbers of domestic animals obtain a permit specifying the Best Management Practices to be followed, including an approved plan for the disposal of wastes.
- Prohibit the continued sale and/or distribution of White Pekin ducks for pets.

3.4.1.13 Groundwater Development. Optimization of groundwater withdrawal practices is required to assure the long term quality of Nassau-Suffolk groundwaters. Although salt water intrusion does not appear to be a significant areawide problem, there have been instances of local contamination due to saltwater intrusion or upconing in pumping wells. The Program has identified the following control strategies that can aid in minimizing pollution from this source:

Management Plan):

- Control pumping patterns, especially of high yield wells, to minimize the interaquifer movements of contaminants.
- Control pumping patterns to minimize local saltwater contamination of supply wells.
- Establish pumping patterns that will minimize the migration of existing contaminants within any aquifer and/or abate existing contamination.
- Formalize interdistrict allocation of public water, where required.
- Encourage use of public lands for groundwater development.
- Amend the New York State law to remove the clause exempting agricultural irrigation wells from operating permit requirements.
- Employ land use controls to limit development in those areas where water supply is restricted.
- Require wellhead treatment of public water supplies in areas where water quality contravenes drinking water standards.

3.4.1.14 Agricultural Chemicals. Large quantities of pesticides and fertilizers are used on Long Island, not only in eastern Suffolk agricultural areas, but also in western Suffolk and in Nassau, where they are applied to lawns, golf courses and nursery stock. Contamination hazards from pesticides are generally controlled by natural physical-chemical biological processes in the soil. Recent developments in pesticide chemistry, however, may yield classes of chemicals that are more persistent and/or toxic. The potential hazard from these chemicals, therefore, cannot be overlooked. Intensive application of fertilizer in domestic, recreational, agricultural and commercial use results in the leaching of a large part of the nitrogen content to groundwater. The Program has identified the following control strategies that can aid in mini-

mizing pollution from these sources:

Pesticides

- Limit or prohibit the distribution and/or use of specific chemicals that are suspected carcinogens.
- Promote the substitution of less persistent or less toxic chemicals for those currently in use.
- Institute measures to control the disposal of used pesticide containers.
- Continue and supplement the licensing of commercial operators.

Fertilizers

- Enlist the active participation of the United States Department of Agriculture, local Soil and Water Conservation Districts, and the Cooperative Extension Service, to conduct information and education programs designed to promote the cost-effective use of fertilizers and erosion/runoff control.
- Limit or prohibit the distribution or sale of those chemical fertilizer formulations that have effective organic substitutes.
- Institute fertilizer use controls in areas with significant hydrologic constraints, *e.g.,* the deep flow Zones I and III. Initial emphasis should be on non-food crops, lawns, golf courses, etc.
- Promote the use of low-maintenance lawns and natural plant materials in order to reduce the need for extensive watering and fertilizing.

3.4.2 Application to Stormwater Control

3.4.2.1 Stormwater Runoff to Bays. A number of factors are considered in formulating and applying control methods to non-point sources. Structural methods (*e.g.,* retention/settling basins) can be used where stormwater is conveyed to the receiving water by a stream or large storm sewer. If the greater portion of flow reaches the water at many diffuse locations, Best Management Practices (usually including street cleaning) are appropriate, if cost-effective. (See Section L of the Areawide Waste Treatment Management Plan.)

Non-point source control in the bi-county area was evaluated on the basis of two factors. The first factor was the presence or absence of a long term problem with bacterial contamination in the receiving water. Closed shellfish areas were used as the indicators for this type of pollution. (It should be noted that, in all but one of the bays studied, the contribution of bacteria from non-point sources far exceeded that from point sources.) The second factor was the relative magnitude of non-point pollution contributed by streamflow as compared with that contributed by diffuse flow. In analyzing this factor, the bays and bay complexes were divided into subdrainage areas, which were then evaluated separately. Also considered was the scale at which the evaluation should be conducted. One approach considers only those streams that have drainage areas of 100 acres or more. Another approach considers all streams.

Structural and Best Management Practice techniques for non-point source control were grouped into the following approaches:

Approach I: Bay divided into reaches and controls applied where a problem is indicated (for example, closed shellfish areas). Structural alternatives applied to streams with drainage basins greater than 100 acres where the proportion of stream runoff to areal runoff is relatively high. Best Management Practices applied to suspect overland flow areas and areas downstream of structural facilities.

Approach II: Reliance on Best Management Practices only, throughout the basin.

Approach III: Application of structural alternatives to all streams with drainage basins greater than 100 acres, regardless of the relative proportion of stream and areal flow. In addition, application of Best Management Practice to all other drainage areas.

Approach IV: No action. To be applied to drainage areas contributing to those bay segments where no problem exists or is expected.

The above approaches were applied to the following bays and bay complexes of significance: Great South Bay complex, Manhasset Bay, Hempstead Harbor, Oyster Bay/Cold Spring Harbor complex, Huntington Bay complex, Port Jefferson Harbor and Peconic Estuary.

For each bay, approaches were developed with associated total annual cost, annual pollutant loads and sludge production.

There are a number of natural ponds in the study area that are located on streams near their discharge points. If the settling capability of the ponds is utilized, then only disinfection may be required. This concept should be evaluated in detail when stormwater structural approaches are being considered. The degree of sedimentation taking place in the natural pond should be estimated by comparing influent and effluent water quality. If sedimentation is effective and if effluent water quality is sufficiently good (*i.e.,* low values of suspended solids or turbidity), only disinfection need be applied.

For a comparison of the costs of structural approaches with Best Management Practices, street sweeping was selected as a representative of the latter approach. It is the most commonly applied Best Management Practice, it has been implemented in the past; its costs have been estimated; and it is being studied extensively in other 208 investigations. Other Best Management Practices could also be included but comparable cost-estimating data and operational experience are lacking. In actual applications, a combination of Best Management Practices would probably be applied to an area to achieve maximum effectiveness.

Great South Bay Complex. As illustrated in Figure 2–3, the Great South Bay Complex basin is made up of parts of basins N1, N2, S1, S2 and S3a. The basin is characterized by its extensive tributary system, the discrete location of its streams, a relatively large percentage of impervious surface area (in N1 and N2), and a gradual basin slope with minimum bank runoff.

The percentage of the total drainage area from which runoff reaches

the bays via streams varies for each subdrainage basin.

Sub-Drainage Basin	% Stream Drainage Area
N1	38.9
N2	54.1
S1	60.2
S2	58.5
S3a	53.4

The above drainage area data take on importance when coupled with data indicating areas closed to shellfishing. Figure 2–8 identifies areas of the Great South Bay complex that were closed to shellfishing as of August 1977. Inspection of Figure 2–8 shows that essentially the entire area of the Great South Bay complex below drainage areas N1 and N2 is closed to shellfishing, as are parts of the Bay below S1 and S2, and a small area of the Bay below S3a.

Approach I attempts to identify areas where structural/non-structural methods are more appropriate, based upon the pollution reduction potential of a particular drainage basin and a history of shellfish bed closings. This approach resulted in the following:

1. Best Management Practices were considered for use in N1, because structural methods offer a relatively low pollution reduction potential and because N1 is entirely closed to shellfishing.
2. Since shellfishing closings occur in a large part of the bay below N2, S1 and S2, and since relatively high pollution reduction potential by structural methods exists, structural methods were considered.
3. Although S3a has a high pollution reduction potential, the need for structural abatement facilities is unwarranted because the shellfish closings occur in small isolated areas. For S3a, therefore, Best Management Practices were considered.

In the sub-drainage basins where structural methods were considered (N2, S1 and S2), land availability was checked to determine whether a storage/sedimentation reservoir could fit the available space. If space was not available, then a swirl regulator-concentrator treatment was selected. The total annual cost estimates (amortized capital and operation and maintenance) as well as an estimate of the recent reduction in coliform bacteria (effectiveness) are graphically illustrated in Figure 3–11. The sludge generated from the non-point source structural abatement facilities would be a small quantity in comparison to projected municipal sludges.

Approach II involves the application of Best Management Practices throughout the entire drainage basin of the Great South Bay complex. It represents the minimum treatment level that can be provided from both a cost and treatment efficiency standpoint. The cost for implementing a street sweeping program was estimated at about $97 per curb mile per year. The estimated total annual costs and effectiveness are illustrated in Figure 3–11.

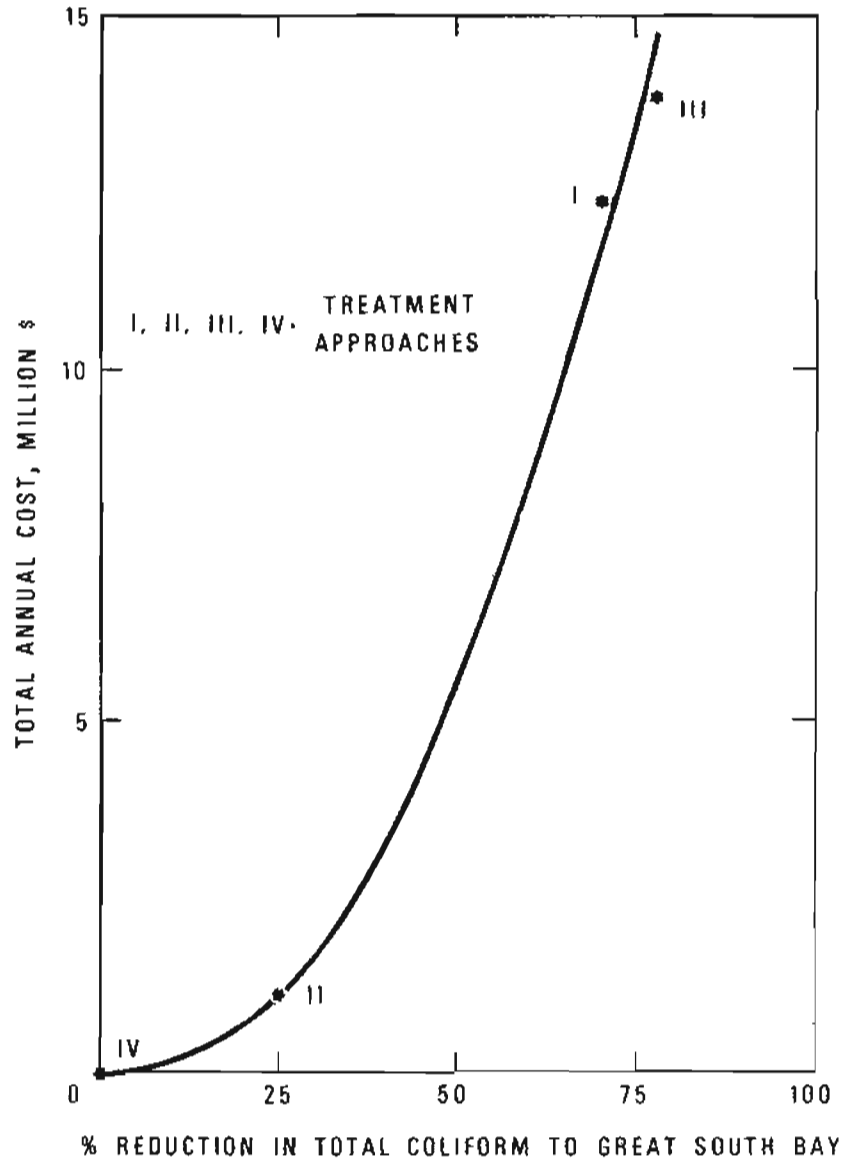


FIGURE 3–11 *Cost-Effectiveness of Various Treatment Approaches for the Great South Bay*

Approach III involves the installation of structural abatement facilities on all streams draining areas greater than 100 acres, and implementing Best Management Practices in those areas of the basin not drained by these streams. The only exception to this is that Best Management Practices were considered for applications to the Mill River, the Connetquot River and the Carmans River, since they are too large to control structurally. Approach III represents the highest degree of treatment that can be provided. The estimated total annual costs and effectiveness are illustrated in Figure 3–11

Approach IV is the no-action alternative. Based on the history of shellfish closings alone, it would appear that some kind of action is warranted and that the no action alternative is not viable.

As illustrated in Figure 3–11, the estimated total annual costs differ significantly between Approaches I and III on the one hand, and Approach II on the other. The cost of implementing a street sweeping program (Approach II) throughout the Great South Bay area is about one to two orders-of-magnitude less than the costs of the other approaches. The estimated treatment efficiency, however, of Approach II is less than it is for Approaches I and III. The total coliform reduction of Approach III is 76 percent, while the reduction by Approach II is 25 percent.*

From Figure 3–11 it would appear that, of the four approaches, the most cost-effective solution is Approach II, which yields the greatest estimated efficiency per unit dollar of cost.

North Shore Bays. In general, the basins contributing flow to the North Shore bays are characterized by a minor tributary system, steep basin slope and significant bank runoff. The exception to this is Oyster Bay/Cold Spring Harbor. The drainage area of the streams in that basin accounts for approximately 44 percent of the total drainage area. It is unlikely, considering the extent of shellfish closing in those areas, that Approach II would be acceptable for any of the bays.

As illustrated in Figure 3–12, total annual costs and treatment efficiencies are the same for Approaches I and II for Manhasset Bay, Hempstead Harbor and Oyster Bay. This is because Best Management Practices were used in Approach I after it was decided that structural methods would not appreciably reduce overall non-point source pollution into the bays because of the small drainage area attributable to streams. In the case of Port Jefferson Harbor, Approaches I, II and III are identical because there are no streams where structural control measures would apply In the case of Huntington Bay, Approaches I and II are identical and III is slightly different. Both of these bays are shown in Table 3–10. Coliform reductions achieved by Approaches I and III differ significantly for the bays illustrated in Figure 3–12. For example, Approach III at Oyster Bay/Cold Spring Harbor results

*Future studies will be required to determine the efficiency of non-structural means of non-point source control. In addition, future modeling studies will be required to correlate the effects of Best Management Practices on receiving water quality.

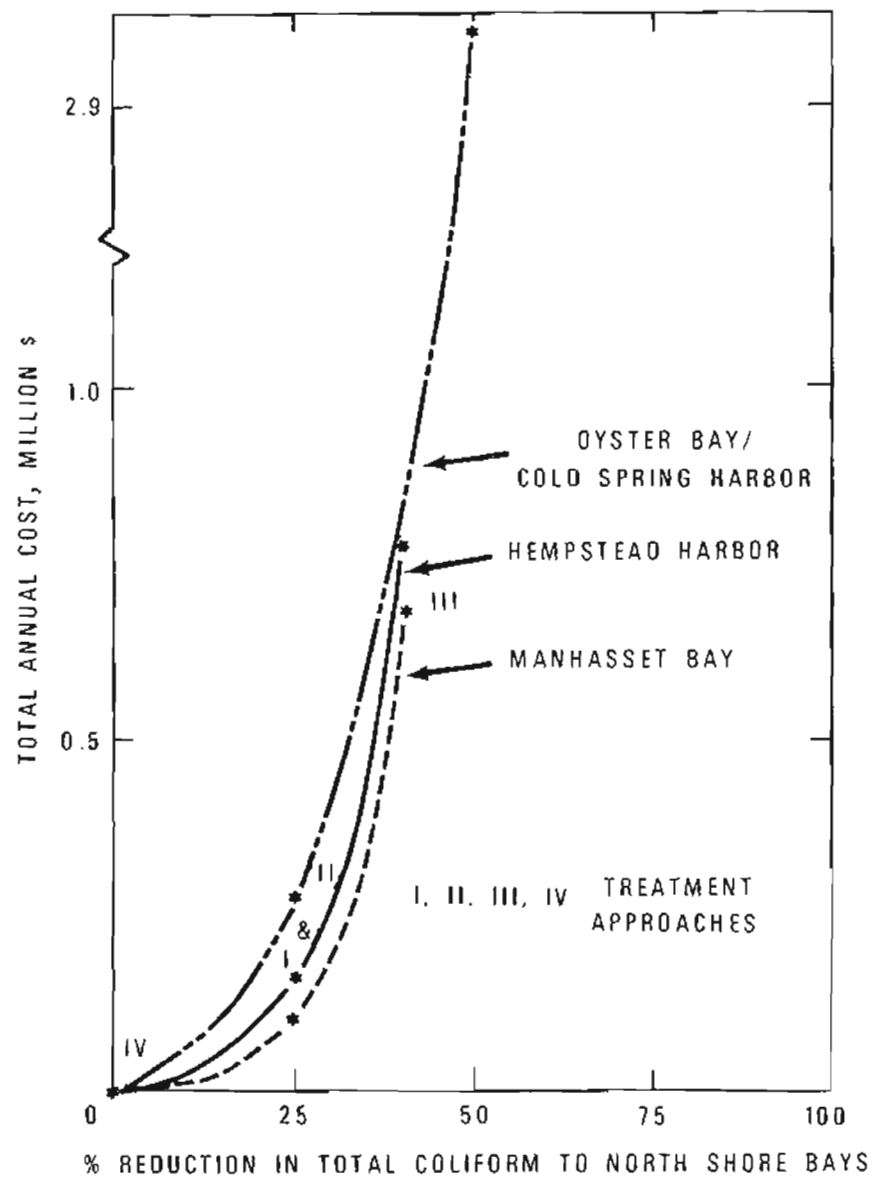


FIGURE 3–12 *Cost-Effectiveness of Various Treatment Approaches for North Shore Bays*

in a coliform reduction of 51 percent (*versus* 25 percent for Approaches I and II). This pattern is generally the same in the other two bays.

Table 3–10 indicates that a structural solution would not achieve much improvement in coliform levels in the Huntington Bay/Northport Bay complex. Port Jefferson Harbor options are limited to Best Management Practices.

Considering Table 3–10 and Figure 3–12, the apparent maximum effectiveness per unit cost of the four approaches for each bay is Approach II Approach II, therefore, appears to be the most cost-effective alternative for all the North Shore bays, assuming that a 25 percent reduction in BOD_5, suspended solids, nutrients and total coliform bacteria can be achieved by Best Management Practices, and that bay water quality standards can be met.

Table 3–10

ESTIMATED TOTAL ANNUAL COST AND EFFECTIVENESS OF APPROACHES TO CONTROL STORMWATER RUNOFF INTO HUNTINGTON/NORTHPORT BAY AND PORT JEFFERSON HARBOR

Bay/Approach	Estimated Total Annual Cost, $	Estimated % Reduction of Total Coliform Load
Huntington/Northport Bay		
I	151,000	25
II	151,000	25
III	213,000	25
IV	– 0 –	0
Port Jefferson Harbor		
I	98,000	25
II	98,000	25
III	98,000	25
IV	– 0 –	0

The dynamic water quality model was used to measure the response to various inputs of stormwater and pollutants to Manhasset Bay and Hempstead Harbor. On the basis of sampling programs and model runs, it is reasonably certain that coliform levels in the outer portions of these bays are dominated by conditions in Long Island Sound, and the inner portions by stormwater runoff from the tributary drainage basin. Coliform levels in these embayments, which are over 70 MPN per 100 milliliters preceding a storm event, can increase to above 2000 MPN per 100 milliliters in response to a "design" storm. The overriding influence of present Long Island Sound water quality will prevent the reduction of coliform levels to below shellfishing standards during storm events, even with a 25 percent reduction of coliform bacteria in runoff. However, Best Management Practices in the control of runoff may insure the suitability of these waters for bathing, following moderate to heavy rainfall.

Peconic Estuary. Flanders Bay-Peconic Estuary is characterized by a major tributary (Peconic River) and a number of much smaller streams. Most of the runoff can be considered bank runoff, with a small portion contributed by the streams. The drainage areas of the streams account for approximately 34.9 percent of the total drainage area of Peconic Estuary. A tabulation of drainage areas of the streams flowing into the Peconic Estuary and the percentage of total drainage area attributable to streams for each subdrainage basin are given as follows:

Sub-Drainage Basin	% Stream Drainage Area
S11b	70
S12a	Negligible
S15a	Negligible
S13b	Negligible

The above drainage area data were compared with the data on areas closed to shellfishing (see Figure 2–8), and the following treatment approaches were developed as part of Approach I:

1. Since Flanders Bay is partially closed to shellfishing, there is a need to reduce the non-point source pollutant loads entering from S11b. It was decided to consider implementation of Best Management Practices in this basin since structural methods are not feasible for large streams such as the Peconic River. Since the southern portion of Flanders Bay has not been closed to shellfishing, the no-action alternative was considered for Mill Creek and Hubbard Creek.
2. For sub-drainage basins S12a, S15a and S13b, no-action was considered acceptable because the bays adjacent to these basins are not closed to shellfishing.

The estimated total annual costs and effectiveness for Approach I are illustrated in Figure 3–13.

Approach II involves the application of Best Management Practices throughout the basin. In the case of Peconic Estuary, this level of treatment seems unnecessary since certain sub-drainage basins (S12a, S15a and S13b) do not appear to contribute to the problem of shellfish closings.

Approach III involves the application of structural abatement facilities on all major streams in S11b and the implementation of Best Management Practices in those areas of the bay not drained by the streams. The exception is that non-point source pollution from the Peconic River is controlled by non-structural measures. Approach III represents the highest degree of treatment that can be provided.

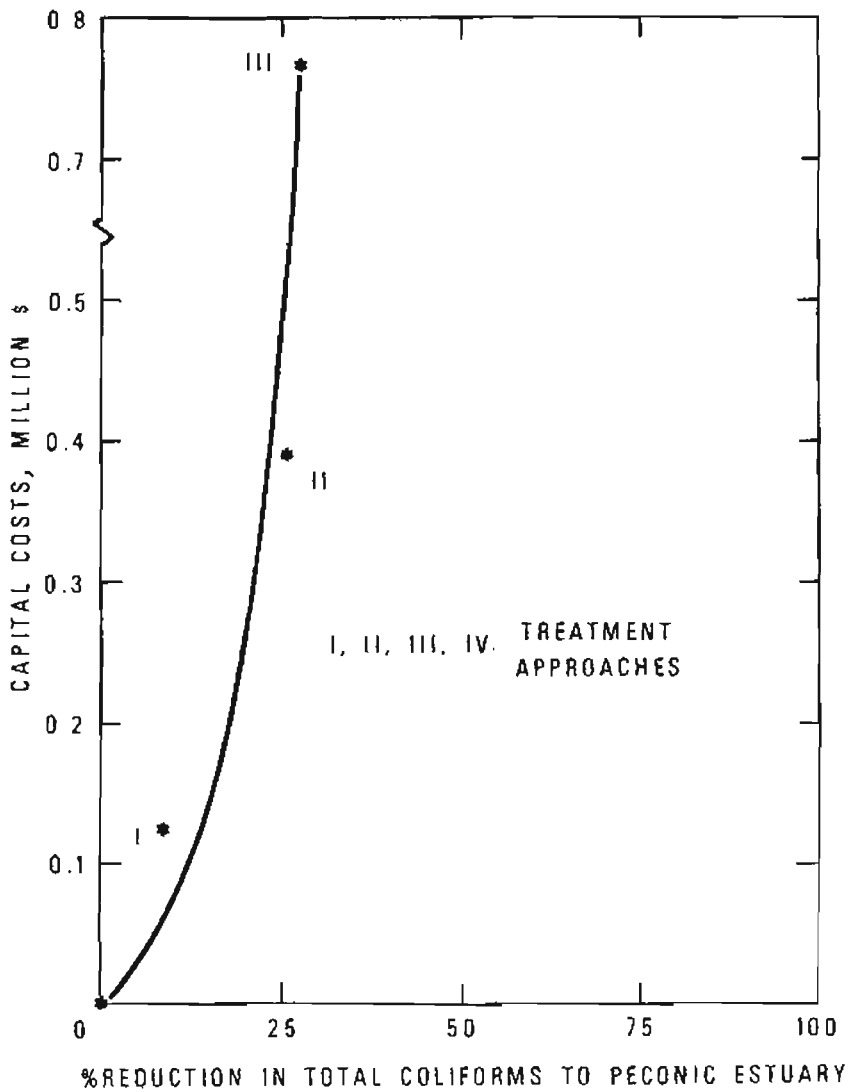


FIGURE 3–13 *Cost-Effectiveness of Various Treatment Approaches for Peconic Estuary*

Approach IV is the no-action alternative. It is reasonable to assume that non-point source pollution from sub-drainage basins S12a, S15a and S13b, need not be reduced since the bay areas adjacent to these basins have not been closed to shellfishing.

Estimated total annual costs and effectiveness are illustrated in Figure 3–13. Figure 3–13 suggests that Approach I or II would provide the most cost-effective solution. However, if water quality is improved and the duck farms that discharge to Meetinghouse Creek attain zero discharge, then Approach IV (no action) may be acceptable for the Peconic Estuary.

One of the major questions concerning stormwater control is the effectiveness of street sweeping/vacuuming as a Best Management Practice. There is no experimental or operational data available to describe its effectiveness in the Nassau-Suffolk area. Therefore, in order to evaluate the efficiency of street sweeping, demonstration programs should be established on the basis of topographic and runoff differences. One should be implemented on the North Shore and one on the South Shore. Sampling of stormwater runoff should be conducted in areas where street sweeping/vacuuming is intensively employed and the results compared with samples from areas where minimal amounts or no street cleaning is provided.

Recharge Basin Analysis. There are between 2000–3000 recharge basins on Long Island, recharging approximately 80 MGD of stormwater runoff to the Long Island aquifers. Street surface contamination consists of hydrocarbons (gasoline, oils, grease), organic chemicals (pesticides), heavy metals (lead, copper, zinc) and fecal matter (bacteria and viruses).

At the present time, there are no systems in use to treat the recharge prior to its entering the ground, although use of a marsh-pond approach as well as mechanical systems appears to be feasible. Therefore, unless the contaminants are removed by the natural vegetation and soils, they may eventually reach the groundwater.

The 208 has determined that surface runoff is a source of pollutants and that some form of treatment may have to be implemented. It is suggested that a concept requiring little maintenance, such as the marsh-pond concept, be investigated on a pilot basis to treat stormwater prior to recharge. The marsh-pond concept was selected for the following reasons:

- Runoff comes in contact with the soil and vegetation roots for a maximum amount of time.
- The vegetation removes heavy metals and organics by bio-assimilation.
- Both of the lined sections of such a system act at settling ponds, effectively removing any silt particles that would otherwise plug up the recharge basin.
- The vegetation will act as a nitrogen sink and if cropped will reduce the nitrates reaching the groundwater aquifers. Cropping would also be necessary to avoid accumulation and recycling.

Some disadvantages of this concept are:

- There will not be enough room for a marsh pond installation in all cases.
- The plants will have to be cropped about once per year and disposed of as potential hazardous wastes.
- Water levels in the marsh may have to be maintained during dry periods to prevent the plants from dying off.
- Variable climatological factors may impair the effectiveness of plant and other biological life in removing pollutants.

The estimated cost of such a system depends heavily on the size of each basin and the acreage requirement of the lined sections. For an average-sized recharge basin of 1.5 acres, the capital cost would be approximately $50,000 to $100,000, with an operation and maintenance cost of about $300 to $500 per year.

Summary. The recharge of untreated urban runoff poses a threat to the groundwater quality on Long Island. Many studies have shown that urban runoff may contain organic chemicals, heavy metals, bacteria and viruses, and may reach the subsurface water through recharge basins. (See Plan Section L.)

A review of possible alternatives leads to the recommendation that a marsh-pond pilot treatment plant be constructed in an existing recharge basin in order to test its ability to remove the pollutants in runoff. After a one year trial period, the operating data should be reviewed and a decision made on whether to implement the concept on a large-scale basis or to abandon it altogether.

If the pilot study proves successful, then a plan of phased construction to fit recharge basins in the Magothy recharge area with marsh-ponds can be prepared.

If it proves to be infeasible to treat at the recharge basins, it may be necessary to begin phasing them out in key groundwater areas. If this policy is implemented, substantial quantities of recharge water will be lost. The impact of this loss on groundwater levels and water supply must be carefully analyzed by existing digital and analog mathematical models before such a policy is adopted.

3.5 Planning Options

3.5.0 Introduction. There are a number of ways of achieving any specific wastewater management objective. Common end objectives can be reached generally through point source controls, non-point controls and/or some mix of the two.

In an attempt to keep the array of alternatives and/or complementary ways of achieving a management objective to a reasonable number, the planning process contained herein was designed to subject all alternatives to continuing evaluation, based on technical and economic feasibility, probable environmental effects and legal-statutory requirements. Where an alternative, or set of alternatives was found to violate any of these requirements, it was either modified or eliminated. It is possible to establish a number of area specific water supply alternatives as tradeoffs or second best solutions to wastewater management problems. However, one of the basic constraints, regarding the selection of the more viable wastewater management alternatives, is maintaining the self-sufficiency of the Region's drinking water supply by maintaining the high quality of the reserves. The nature and role of these trade-offs are discussed in Section Six.

This section describes the most viable alternatives as they relate to specific hydrogeologic zones and adjacent marine surface water elements. These alternatives are broken down into two categories: (1) areawide alternatives, or those alternatives that are generally applicable across all Nassau-Suffolk groundwater zones and surface water elements and, (2) area specific alternatives, or those alternatives that are applicable only to designated Nassau-Suffolk groundwater zones and surface water elements. An example of an areawide alternative is the restriction of the use of fertilizer throughout the bi-county area, whereas an example of an area specific alternative is the prohibition of landfills in selected groundwater zones.

The areawide and area specific alternatives follow. The preferred alternatives, or combinations of alternatives, and the reasons for their selection, are described in Section Six.

3.5.1 Areawide Alternatives

3.5.1.1 Provide for Routine Maintenance of On-Site Septic Tank and Leaching Pool Systems. Provisions should be made for routine pumping and maintenance to extend the service life of the leaching facility and ensure its continued efficacy.

3.5.1.2 Prohibit the Use of Certain Chemical Cleaners in On-Lot Systems. The use of organic solvents and other chemical agents that are used in an attempt to clean or extend the life of an on-lot waste disposal system, but that impair or alter groundwater quality, should be prohibited or controlled.

3.5.1.3 Expand Regulations and Enforcement Regarding the Disposal of Industrial Wastes. Where industrial wastes are discharged to municipal sewer systems, strict enforcement of sewer use ordinances should be insured. Where industrial wastes are discharged to the ground, present regulations should be expanded to include greater coverage of specific contaminants and prescribed allowable discharge levels. This applies primarily to organic chemicals.

3.5.1.4 Regulate the Storage and Transportation of Chemical Products. Permits and other controls should be required for the storage and transportation of chemical products that would pose an environmental threat to either the groundwater or surface water. The regulations should include prescribed practices relating to safeguards, inspection and emergency contingency plans. In addition to industrial chemicals, these products include chemical wastes and sludges, deicing salts and petroleum products.

Particular emphasis should be placed on regulating gasoline storage

facilities at automobile service stations and, to a lesser degree, home heating oil storage tanks. The 208 Study has recognized these two types of facilities as major potential pollutant sources but has not been able to define the precise magnitude of the problem.

3.5.1.5 Restrict the Use of Fertilizers. Since fertilizers constitute one of the largest sources of nitrogen applied to the land surface, they are also a significant potential source of ground and surface water impairment. Pending further necessary study to better define their impact on water quality, public education should, and regulation may, be employed to limit or possibly eliminate the use of all or specific types of fertilizers. Included in the Best Management Practices, some of which may also pertain to agriculture, are modification of application rates, discontinuance of reliance on fast-acting inorganic fertilizers, and promotion of low-maintenance lawns, which would require both less fertilizer and less consumptive use of water.

3.5.1.6 Control Stormwater Runoff. To the extent feasible, surface runoff should be intercepted and disposed of as close as possible to the source. Best Management Practices and/or structural systems should be employed to minimize the volume of runoff and the transport of sediments, nutrients, metals, organic chemicals and microorganisms to surface waters. Recharge basins may need to be modified, where feasible, to improve the removal of nutrients, metals and organic chemicals in stormwater runoff that contribute to groundwater contamination. Inasmuch as most of the techniques for both practical and cost-effective treatment of runoff are still relatively untested, the establishment and operation of several pilot projects is recommended prior to consideration for full scale implementation. Street vacuuming and the use of natural or man-made detention systems with marsh-pond application and/or disinfection are recommended for further investigation and testing.

3.5.1.7 Reduce Animal Wastes. Best Management Practices should be employed to minimize the deposition of animal wastes, primarily from dogs and semi-wild ducks, directly into the surface waters or on impermeable areas draining into surface waters. Among these management practices are the reduction of animal populations, regulation of the acquisition and abandonment of certain domestic animals, and proper animal waste disposal by owners.

3.5.1.8 Minimize Pollution from Site Preparation and Development. Regulations should be established requiring the use of Best Management Practices during site clearance, building construction and site restoration in order to control the erosion from development activities and the subsequent transport of sediment to surface waters.

3.5.1.9 Reduce Reliance on Landfills. Regional and/or subregional resource recovery facilities should be constructed as rapidly as feasible in order to minimize the current reliance on landfills for the disposal of domestic and other non-hazardous wastes. In addition, these resource recovery facilities should also provide for the adequate treatment of wastewaters originating at such facilities. The first resource recovery facility on Long Island is presently being constructed in the Town of Hempstead. Until such facilities become available, all new landfills should be interim in nature and should be provided with dual liner systems to prevent leachate contamination of ground and surface waters. Leachate should be collected and treated. This recommendation is consistent with present New York State Department of Environmental Conservation policy. The location of new landfills should conform to recommendations presented as part of the area-specific alternatives. Abandoned and/or completed landfills should also be upgraded when feasible by providing an impervious cover to prevent water infiltration and the continued production of leachate, especially in deep-flow recharge areas.

3.5.1.10 Provide for the Treatment of Hazardous Wastes. Provisions must be made for the safe disposal of hazardous wastes. Because of the types of industries in the Nassau-Suffolk Region and the wastewater treatment processes they employ, two kinds of hazardous wastes are generated: small volumes of strong, toxic industrial wastes, and industrial waste treatment sludges.

In view of the environmental sensitivity of the study area, continued disposal of these types of hazardous wastes outside of the area should be encouraged. However, if this disposal option is not available in the future, treatment facilities and landfills for hazardous wastes and residuals will have to be provided in the bi-county area.

3.5.1.11 Provide Alternatives to Ocean Disposal of Municipal Treatment Plant Sludge. The major municipal treatment plant sludge processing and disposal approaches that appear viable in the Nassau-Suffolk Region include composting, landfilling, land application, incineration, co-incineration with solid waste, pyrolysis and thermal drying. (These approaches also apply to the sludge from scavenger waste treatment plants.) It has been found that any of the conventional approaches can be implemented in parts of the Nassau-Suffolk area without significant environmental degradation if normal safeguards are taken. Final sludge disposal options should be selected after 201-level detail studies have been conducted, since the final decision should be based upon cost-effectiveness, and the 208 Study has not developed sufficiently detailed cost analyses. The 208 has determined that the conventional approaches are regionally acceptable.

Land-based sludge disposal options (land application, composting) must be accompanied by monitoring or other control programs to insure against contamination from heavy metals, organic chemicals and other pollutants. This is particularly important in hydrogeologic Zones I, II and III. Land-based disposal options will require strict enforcement of industrial pretreatment requirements to minimize the amount of toxic materials in municipal treatment plant sludges.

3.5.1.12 Require Nitrogen Removal for Treatment Plants Recharging Effluent. All waste treatment facilities that discharge to either recharge basins or to streams, should be required to provide nitrogen removal. The level

of nitrogen removal required should be in conformance with all applicable groundwater and surface water standards.

3.5.1.13 Minimize Population Density. Minimize population density by encouraging large lot development (one dwelling unit/one or more acres), where possible, to protect the groundwater from future pollutant loadings.

3.5.1.14 Promote Water Conservation. Water conservation is a matter of particular importance on Long Island, where the sole source of the potable water supply is the groundwater. Conservation of water use will help to preserve this water supply, and to maintain aquifer water levels. An additional benefit will be a reduction in energy consumption, also a matter of general concern. It should be noted, however, that insofar as areawide waste treatment management is concerned, water conservation will have limited benefit.

3.5.2 Area Specific Alternatives. The selection of area specific alternatives, whether structural or non-structural or both will influence the character and extent of future collection and treatment service areas.

In order to facilitate the selection of the most appropriate waste management options and the subsequent determination of the areas that should be served by community collection systems and those that should be served by on-site disposal systems, a series of alternatives is offered for each hydrogeologic zone and surface water element. In the case of the hydrogeologic zones, these range from total reliance on non-structural non-point source controls with no additional sewering to comprehensive sewering at densities of one or more units per acre, in combination with the immediate imposition of selected non-structural controls. In the case of the surface water elements, these range from total reliance on non-structural non-point source controls to the upgrading of treatment plants or the relocation of outfalls done in combination with the imposition of selected non-structural controls. A more complete discussion of these alternatives may be found in 3.3 and 3.4 of this section of the Summary Plan, and in Sections B and H of the Areawide Waste Treatment Management Plan.

An outline of the suggested procedure for relating hydrogeologic zone and surface water element alternatives with 201 study area plans is presented in Section Six.

In most cases several alternatives are listed. The rationale for the consideration of these, rather than some of the alternatives presented in 3.3 and Plan Section H, is discussed below.

Based upon an analysis of population densities and Upper Glacial aquifer nitrate-nitrogen (NO_3-N) concentrations in selected unsewered areas with twenty to 30 year old development and vertical groundwater flows, it was concluded that waste loadings generated by development at densities of ten to eleven persons per acre would result in an average NO_3-N concentration of ten milligrams per liter in the shallow groundwater (An average of ten milligrams per liter implies that approximately 50 percent of the samples will exceed this concentration.) Further statistical analysis of these data indicated that an average level of six milligrams per liter NO_3-N would probably yield concentrations below ten milligrams per liter in 90 percent of the samples. It was calculated that in order to utilize on-site disposal systems, residential density should not exceed five to six persons per acre.

However, since the analyses relating population density to NO_3-N in the groundwater are not conclusive, it was decided that a viable range of alternatives should be offered and that additional study to better define the criteria for delineating service areas be included in a "201" study. In addition to the concern for protecting groundwater quality, consideration was given to factors such as the presence of a high water table or low soil permeability affecting the reliability of individual on-site disposal systems.

The selection of the range of sewering alternatives relating to population density is based upon the analysis of the probabilities of exceeding ten milligrams per liter as indicated from historical data and presented below. (See Section H of the Areawide Waste Treatment Management Plan.)

Table 3–11

POPULATION DENSITY AND OBSERVED NITROGEN CONCENTRATION IN SHALLOW WELLS

Percentage of Individual Well Observations Exceeding 10 mg/l NO_3-N	Predicted Average Concentrations of all Shallow Wells Less Than 100 ft. in a Given Area	Predicted Average Population Density Persons/ Gross Acre
50	10.3	10.9
40	8.7	8.6
30	7.9	7.4
20	7.1	6.3
10	6.0	4.7

Sources: Porter, K.S., et al., 1978, "Nitrogen: Sources and Potential Impact", Cornell University/Cooperative Extension Service.
Appendix B, Section H of the Areawide Wastewater Management Plan.

The initial selection of sewering options of one, two and five dwelling units per acre, as discussed earlier in Section Three, was based upon previously recorded and projected residential densities, on which the cost estimates for sewering and waste treatment alternatives were also based. The initial selection of the one and two dwelling units per acre as maximum and intermediate sewering options is still consistent with the statistical data presented above. However, were one to assume a density of five dwelling units per acre and an average household size of four persons, in the area from which the data was obtained, the resulting population density of twenty persons per acre could be expected to produce an average NO_3-N groundwater concen-

tration of approximately twenty milligrams per liter. This would result in a concentration exceeding ten milligrams per liter NO_3–N in about 90 percent of the observations at shallow wells.

Since the violation probability of 90 percent at five dwelling units per acre is extremely high, the minimum sewering option was modified to reflect a lower and more reasonable density at which sewering would be recommended. The options for plan selection are as follows:

1. Minimum Sewering Option. Sewer at six or more persons per gross acre in areas of high water table and low soil permeability in order to provide the necessary space for adequate on-lot disposal systems. Such systems might require relatively extensive tile fields and would therefore require more than the normal amount of space.

   Sewer at nine or more persons per gross acre everywhere else, since it has been shown that, at these densities, groundwater contamination will probably exceed ten milligrams per liter, if sewering is not initiated.
2. Intermediate Sewering Option. Sewer at six or more persons per gross acre everywhere. Based upon the studies conducted during this program and others, this density appears to be the critical point about which both groundwater quality and cost revolve.
3. Maximum Sewering Option. Sewer at three or more persons per gross acre, since this will probably insure that groundwater NO_3–N levels will not exceed ten milligrams per liter, if non-point controls are also implemented. Unsewered areas will then have more than adequate lot sizes to accommodate any on-site sewage disposal system. However, it should be noted, that this maximum sewering option does not necessarily preclude the sewering of any area, if there is a complete failure of on-site systems or if the groundwater is threatened by contamination from on-site systems.

Regardless of the initial sewering alternative selected, it should be accompanied by a groundwater monitoring program in the less densely populated areas to determine the need, if any, for the creation of a new community sewer system or the expansion of the service area of an existing system.

The intensity and scope of the monitoring effort would depend in part on the sewering alternative selected for any given area. For instance, a comprehensive sewering alternative at four or more persons (one dwelling unit) per acre would probably preclude the necessity for an extensive monitoring system. A system perhaps only slightly broader than the one presently in place might be needed. This would allow for limited monitoring of inorganic chemicals, and in the future, organic chemicals. At the other extreme, total reliance on non-structural controls or even sewering at nine or more persons (three dwelling units) per acre would require an extensive monitoring system of many wells, sampled on a regular basis and with data being continually evaluated. This system is described in more detail in Section Six.

Monitoring of the concentrations of nitrogen, metals and organic chemicals, can be used to identify water quality trends in recently developed areas. The presence of average concentrations of six milligrams per liter NO_3–N in the samples from shallow monitoring wells can be used to signal the presence of existing problems in established areas.

A finding of increasing trends in contaminant concentrations or of a critical level of NO_3–N should initiate the necessary response to protect the public health and the long term quality and usefulness of the groundwater aquifer. In recently developed areas, such a response would comprise the stringent control of relevant non-point sources of contamination, followed by the extension of public water supply in order to minimize dependence on untreated water from private wells where applicable. If there is no indication of improvement in water quality, after continued monitoring, and if the degradation can be reasonably assumed to originate from on-lot sewage disposal systems, controls should be implemented.

In developed areas, especially those undergoing 201 study in the near future, time may not allow for a decision to be based upon trends, nor a determination of the effectiveness of Best Management Practices; therefore, the decision to reduce the nitrogen loading may need to rely primarily on structural controls.

3.5.2.1 Hydrogeologic Zone Alternatives. Wastewater management alternatives consisting of structural, non-structural and non-point source control options are given for each of the hydrogeologic Zones I through VIII. In addition, areawide alternatives having particular importance to a zone have been outlined.

Sewering, in the context used below, is defined as communal collection of wastewater and centralized treatment. Methods of treatment must be evaluated (traditional secondary/tertiary, marsh-pond, spray irrigation, and other innovative methods). This is not indended to preclude the future use of effective on-site treatment systems, as these are approved, in areas indicated for sewering.

Many of the pollutants that impact groundwater and surface waters can be expected to persist regardless of the sewering options that are selected. For this reason, non-point source controls must be regarded as an essential part of a comprehensive wastewater treatment management plan.

Zone I: Deep Flow System (Magothy Recharge Area). This zone is an area of recharge to the deep groundwater reservoirs in Nassau and western Suffolk Counties, and constitutes the major source of public water supply.

a. Wastewater Management Alternatives

   Alternative A—Total Reliance on Non-Structural Controls

   i. Permit no additional sewering.

   ii. Determine the acceptability of a given residential lot size and

of commercial and industrial activities on the basis of its impact on groundwater quality

iii. Strictly control, and possibly upgrade, on-site systems.

iv. Strictly regulate site development and management practices, such as grading and maintenance of vegetation to control runoff.

Alternative B—Minimum Sewering Option

i. Provide sewering for areas with six or more persons (two or more dwelling units) per gross acre in areas of high water table and/or low soil permeability.

ii. Provide sewering for all other areas with nine or more persons (three or more dwelling units) per gross acre.

Alternative C—Intermediate Sewering Option

Provide sewering for all areas with six or more persons (two or more dwelling units) per gross acre.

Alternative D—Maximum Sewering Option

Provide sewering for all areas with three or more persons (one or more dwelling units) per gross acre.

b. Highest Priority Areawide Alternatives

i. Minimize population density by encouraging large lot development (one dwelling unit/one or more acres), where possible, to protect the groundwater from future pollutant loading.

ii. Prohibit the establishment of new landfills, and the expansion of existing ones. Upgrade existing landfills, where possible, to minimize further groundwater contamination.

iii. Restrict the use of inorganic, fast-acting fertilizers. Promote the use of low-maintenance lawns.

iv. Require nitrogen removal for treatment plants recharging effluent.

v. Strengthen and enforce regulations pertaining to industrial waste disposal, product storage and transportation of residuals.

vi. Prohibit the use of certain chemical cleaners in on-lot systems.

Zone II: Impaired Water Quality Area

a. Wastewater Management Alternatives. This zone lies mostly within Nassau County Sewage Disposal District No. 3 (Cedar Creek Facilities Planning Area), and is already scheduled to be sewered. Portions of the water supply have been seriously impaired by organic chemical contamination. For these reasons a single sewering alternative and two water supply alternatives are presented.

i. Convey wastewater to the Cedar Creek Sewage Treatment Plant for subsequent ocean disposal.

ii. Require wellhead treatment (physical/chemical treatment, blending) of public supply water if local water quality does not conform to drinking water standards.

iii. If local water quality does not conform to drinking water standards, or if further pumpage is considered inadvisable, water should be imported.

b. Highest Priority Areawide Alternatives

i. Prohibit the establishment of new landfills, and the expansion of existing ones. Upgrade existing landfills, where possible, to minimize further groundwater contamination.

ii. Restrict the use of inorganic, fast-acting fertilizers. Promote the use of low-maintenance lawns.

iii. Strengthen and enforce regulations pertaining to industrial waste disposal, product storage and transportation of residuals.

Zone III: Highest Grade Reservoir. Groundwater in this zone is generally of excellent quality. The groundwater resource in this zone offers a large potential for further development of public water supplies, provided that measures are taken to ensure the protection of groundwater quality.

a. Wastewater Management Alternatives

Alternative A—Total Reliance on Non-Structural Controls

i. Permit no additional sewering.

ii. Determine the acceptability of a given residential lot size and of commercial and industrial activities on the basis of their impact on groundwater quality.

iii. Strictly control, and possibly upgrade, on-site systems.

iv. Strictly regulate site development and management practices, such as grading and maintenance of vegetation, to control runoff.

Alternative B—Land Use Controls

i. Land use controls should be employed to assure the least intensive use of land wherever possible. Development of this zone for residential, commercial, industrial or agricultural use should be discouraged. However, where residential development cannot be avoided, large lot development should be required. Large land holdings should be maintained and public holdings should be increased to the extent possible.

ii. Institute a water table aquifer monitoring program to provide early warning of incipient degradation of the excellent water quality, and to permit timely action to protect the groundwater.

Alternative C—Maximum Sewering Option

Provide sewering for all areas with three or more persons (one or more dwelling units) per gross acre.

b. Highest Priority Areawide Alternatives

i. Require nitrogen removal for treatment plants recharging effluent.

ii. Provide for the routine maintenance of on-site disposal

systems.

iii. Restrict the use of inorganic, fast-acting fertilizers. Promote the use of low-maintenance lawns.

iv Prohibit the construction of new landfills or the expansion of existing landfills. Presently operating landfills should be upgraded, insofar as possible, in order to minimize groundwater contamination.

v. Control stormwater runoff to minimize transport of nutrients, metals and organic chemicals to groundwaters.

vi. Strengthen and enforce regulations pertaining to industrial waste disposal, product storage and transportation of residuals.

vii. Prohibit the use of certain chemical cleaners in on-lot systems.

Zone IV: North Fork and Eastern South Fork

a. Wastewater Management Alternatives. This zone is characterized by unique groundwater conditions, especially with respect to local quality problems such as high nitrate levels in farm areas and saltwater upconing where pumpage is concentrated. One water supply and four sewering alternatives are presented.

Alternative A—Importation of Future Water Supplies

Agricultural usage would be allowed to continue or expand. Groundwater quality controls should be employed only in areas of present residential use. Public water may be imported from Zone III if groundwater contamination becomes pervasive. Even presently adequate water supplies may be replaced with imported and/or renovated water Wastewater controls will be minimal.

i. Only areas where on-lot disposal systems are subject to failure, or where the surface waters are threatened would be sewered. (This can be equated essentially to the minimum sewering option.)

ii. No new public water supply wells will be installed and existing public water supply wells will be abandoned as concentrations of nitrates or other contaminants exceed drinking water standards.

Alternative B—Total Reliance on Non-Structural Controls

i. Permit no additional sewering.

ii. Determine the acceptability of a given residential lot size and of commercial and industrial activities on the basis of their impact on groundwater quality.

iii. Strictly control, and possibly upgrade, on-site systems.

iv. Strictly regulate site development and management practices, such as grading and maintenance of vegetation to control runoff.

Alternative C—Minimum Sewering Option

i. Provide sewering for areas with six or more persons (two or more dwelling units) per gross acre in areas of high water table and/or soil permeability.

ii. Provide sewering for all other areas with nine or more persons (three or more dwelling units) per gross acre.

Alternative D—Intermediate Sewering Option

Provide sewering for all areas with six or more persons (two or more dwelling units) per gross acre.

Alternative E—Maximum Sewering Option

Provide sewering for all areas with three or more persons (one or more dwelling units) per gross acre.

b. Highest Priority Areawide Alternatives

i. Reduce excessive use of irrigation water and require the permitting, regulation and monitoring of irrigation wells.

ii. Optimize the timing of agricultural fertilizer applications.

iii. Control the establishment of new landfills, and the expansion of existing ones. Upgrade existing landfills, where possible, to minimize further groundwater contamination. In cases of extreme hardship, new landfills may be permitted if extraordinary measures are taken to protect surface and groundwater. However, the relocation of landfills out of the zone should be encouraged.

iv. Optimize pumping patterns to minimize saltwater intrusion in public water supply wells.

v. Minimize population density by encouraging large lot development (one dwelling unit/one or more acres), where possible to protect the groundwater from future pollutant loadings.

vi. Prohibit the use of certain chemical cleaners in on-lot systems.

Zone V—Western South Fork

a. Wastewater Management Alternatives. The groundwater regime and quality problems resemble that of Zone IV, but agriculture is of less importance, therefore the same alternatives as listed in Zone IV apply.

b. Highest Priority Areawide Alternatives

i. Minimize population density by encouraging large lot development (one dwelling unit/one or more acres), where possible, to protect the groundwater from future pollutant loading.

ii. Control the establishment of new landfills, and the expansion of existing ones. Upgrade existing landfills, where possible, to minimize further groundwater contamination. In cases of extreme hardship, new landfills may be permitted if extraordinary measures are taken to protect surface and groundwater However, the relocation of landfills out of the zone should be encouraged.

iii. Reduce excessive use of irrigation water to minimize salt water intrusion.

iv. Optimize pumping patterns to minimize saltwater upconing.
v. Restrict the use of inorganic, fast-acting fertilizers. Promote the use of low-maintenance lawns.

Zone VI—Surface Water Impact Area. This zone is characterized by a shallow flow system, which directly impacts the water quality in eastern Great South Bay and Moriches Bay. In order to protect the important natural resources of the bays, it is necessary to maintain groundwater and stream nitrogen concentrations at, or below, two milligrams per liter. Alternatives developed for this zone stress the protection of the marine surface water quality.

a. Wastewater Management Alternatives

Alternative A—Total Reliance on Non-Structural Controls

i. Permit no additional sewering.
ii. Determine the acceptability of a given residential lot size and of commercial and industrial activities on the basis of their impact on groundwater quality.
iii. Strictly control, and possible upgrade, on-site systems.
iv. Strictly regulate site development and management practices, such as grading and maintenance of vegetation, to control runoff.

Alternative B—Sewering Option

Provide sewering for all areas with three or more persons (one or more dwelling units) per gross acre.

Alternative C—New Ocean Inlet

If this alternative should prove feasible, it will relax the constraints in the above alternatives and provide the selection of additional options as described for Zone VII. Study the feasibility of constructing a new inlet(s) through the barrier island to control and reduce the nitrogen levels in eastern Great South Bay through improved dilution and dispersion.

b. Highest Priority Areawide Alternatives

i. Minimize population density by encouraging large lot development (one dwelling unit/two or more gross acres), where possible, to protect the groundwater from future pollutant loadings.
ii. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to ground or surface waters.
iii. Control animal populations and animal waste disposal.
iv. New landfills should be permitted under current New York State policy, provided the site is landward of the primary coastal zone* and the depth to groundwater is sufficient to ensure an adequate unsaturated zone below the bottom of the landfill.
v. Restrict the use or inorganic, fast-acting fertilizers. Promote the use of low-maintenance lawns.
vi. Require nitrogen removal for treatment plants recharging effluent.
vii. Prohibit any new development along streams and shorelines. Create buffer zones where possible along all water bodies and protect all remaining marine wetlands.
viii. Prohibit the use of certain chemical cleaners in on-lot systems.
ix. Provide for routine maintenance of on-site disposal systems.

Zone VII—South Shore Shallow Flow System. Hydrogeologically, this zone, which contains parts of Nassau and western Suffolk Counties, is similar to Zone VI. Most of the area, however, is currently sewered or is scheduled for sewering within the near future. The alternatives offered for this zone relate primarily to the protection of surface waters. Whereas the adjacent surface waters are not generally as sensitive to nutrient loading as is eastern Great South Bay, the eastern portion of Zone VII does, however, contribute to the nitrogen loading of eastern Great South Bay.

a. Wastewater Management Alternatives

Alternative A—Minimum Sewering Option

i. Provide sewering for areas with six or more persons (two or more dwelling units) per gross acre in areas of high water table and/or low soil permeability.
ii. Provide sewering for all other areas with nine or more persons (three or more dwelling units) per gross acre.

Alternative B—Intermediate Sewering Option

Sewer as in Alternative A and also in areas where potable water is currently obtained from the Glacial aquifer, and densities reach six or more persons (two or more dwelling units) per gross acre.

Alternative C—Maximum Sewering Option

Implement all presently proposed sewer plans, and expand sewering to cover all areas with three or more persons (one or more dwelling units) per gross acre.

b. Highest Priority Areawide Alternatives

i. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to ground or surface waters.
ii. Control animal populations and animal waste disposal.
iii. New landfills should be permitted under current New York State policy, provided the site is landward of the primary coastal zone* and the depth to groundwater is sufficient to ensure an adequate unsaturated zone below the bottom of the landfill.

*The primary coastal zone extends landward for 1000 feet or to the ten foot elevation whichever includes the greater distance from the shoreline or from any stream flowing into marine waters.

Zone VIII—North Shore Shallow Flow System. Although Zones VII and VIII differ hydrogeologically, both are areas that are likely to contribute recharge only to the shallow groundwater system. This flow discharges primarily to streams and marine surface waters, and hence will have a greater effect on these surface systems than on the deep flow drinking water supply. Since Zones VII and VIII are similar with respect to groundwater and surface water constraints, the same alternatives (both areawide and wastewater management) apply to both. The Glen Cove area presents a special problem in that portions of the water supply have been seriously impaired by organic chemical contamination. Water supply options listed for Zone II are applicable to the Glen Cove sector of Zone VIII.

3.5.2.2 Surface Water Alternatives

A. Western Long Island Sound. Western Long Island Sound waters contain high levels of solids, nitrogen and coliform bacteria. Since most of the suspended solids, nitrogen and coliform bacteria levels in western Long Island Sound can be traced to discharges within New York City, Sound conditions are largely beyond the control of the Nassau-Suffolk 208 Program. Long Island Sound conditions are a dominant influence on Manhasset Bay and Hempstead Harbor. Thus, it is the responsibility of the USEPA and the NYSDEC to require the implementation of waste controls necessary to improve water quality to meet the standards specified for this surface water element. These controls may include nitrogen removal for existing sewage treatment plants and the retention and treatment of combined sewer overflows. Pretreatment for metals and/or organic chemicals may be required if it can be shown that toxic contaminants originating in New York City impact Nassau-Suffolk surface waters.

B. Manhasset Bay. Although the contaminant concentrations in western Long Island Sound dominate the water quality within Manhasset Bay, existing point and non-point sources in this embayment currently produce localized high nitrogen and coliform levels. The following options are available for control of these local conditions.

a. Point Source Control Alternatives:

Alternative i — Upgrade the Port Washington, Great Neck Sewer District and the Great Neck Village Sewage Treatment Plants to include nitrogen removal, with outfalls remaining at their present locations.

Alternative ii — Retain secondary treatment and move present sewage treatment plant outfalls to a mid-bay location.

Alternative iii — Divert sewage influent out of the area to the Cedar Creek treatment facility.

Alternative iv — Divert sewage flows from Great Neck Sewer District and the Village of Great Neck to the Port Washington treatment facility.

Alternative v — Delay upgrading, relocations or diversions until western Long Island Sound improvements are committed. Make no local improvements if minimum sewering is selected for the unsewered portions of the surrounding area.

b. Highest Priority Non-point Source Control Measure:

i. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to to surface waters.

ii. Strictly enforce existing ordinances prohibiting the discharge of untreated wastes from boats.

C. Hempstead Harbor. The characteristics of this embayment are similar to those of Manhasset Bay. However, the influence of western Long Island Sound is less dominant. The following control options should be considered for Hempstead Harbor.

a. Point Source Control Alternatives:

Alternative i — Implement nitrogen removal for both the Glen Cove and Roslyn Sewage Treatment Plants.

Alternative ii — Retain secondary treatment and relocate outfalls to mid-harbor sites for both the Glen Cove and Roslyn Sewage Treatment Plants.

Alternative iii — Divert the Roslyn influent to Glen Cove, Port Washington or Cedar Creek.

Alternative iv — Delay upgrading, relocations or diversions until western Long Island Sound improvements are committed. Make no local improvements if minimum sewering is selected for the unsewered portions of the surrounding service area.

b. Industrial Point Source Control Alternatives:

Monitor and abate all industrial discharges to Glen Cove Creek.

c. Highest Priority Non-point Source Control Measures:

i. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters.

ii. Encourage the relocation of solid waste handling operations and landfills, which are now sited within the coastal zone, to sites outside it.

D. Oyster Bay. Oyster Bay has relatively good water quality and is surrounded by a large number of wetland areas. Except for the densely developed, unsewered Bayville area, which is affected by on-site treatment system failures, the choices for this surface water body relate to the level of commitment to the maintenance of a pristine Oyster Bay environment. Non-point source controls are especially important for the protection of the local shellfishing industry.

a. Point Source Control Alternatives:

Alternative i — Retain the present method of treatment and outfall for the Oyster Bay Sewage Treatment Plant. If a plant

is constructed at Bayville, locate the outfall in Long Island Sound.

Alternative ii Divert the Oyster Bay influent (and Bayville, if sewered) out of the area to the Cedar Creek treatment facility in order to retain the relatively pristine quality of the embayment.

Alternative iii Implement nitrogen removal at the Oyster Bay treatment facility.

Alternative iv Divert the Oyster Bay influent (and Bayville, if sewered) to the Glen Cove treatment facility.

b. Highest Priority Non-point Source Control Measures:

i. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters.

ii. Prohibit, or severely restrict, all further development in shoreline areas. Establish adequate buffer zones around wetlands. Assign priority to public acquisitions, based on the protection of groundwater quality and natural resources.

iii. Strictly implement existing ordinances prohibiting the discharge of untreated wastes from boats.

E. Huntington Bay. Water quality data shows that the four harbor areas in Huntington Bay exhibit high nitrogen levels and depressed dissolved oxygen levels. Thus, whether or not minimum sewering options are selected, the discharges into those bays require more extensive treatment.

a. Point Source Control Alternatives:

Alternative i Institute nitrogen removal for both the Huntington and Northport Sewage Treatment Plants.

Alternative ii Relocate Huntington and Northport outfalls to mid-bay and allow secondary treatment to be continued.

Alternative iii Institute tertiary treatment and recharge.

Alternative iv Divert all sewage flows to the Huntington treatment facility, or to an alternative regional site.

Alternative v Serve areas outside existing sewered areas by small treatment plants with effluent recharge.

b. Highest Priority Non-point Source Control Measures:

i. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters.

ii. Strictly implement existing ordinances prohibiting the discharge of untreated wastes from boats.

iii. Control animal populations and animal waste disposal.

F. Port Jefferson Harbor. Modeling studies of Port Jefferson Harbor show that sewage treatment plant loads will affect bay water quality only if flows increase significatnly.

a. Point Source Control Alternatives:

Alternative i Utilize secondary treatment and present discharge location, provided that there is no significant increase in flow.

Alternative ii Institute nitrogen removal for the Port Jefferson sewage treatment plant.

Alternative iii Relocate the outfall to mid-harbor and allow for secondary treatment.

b. Highest Priority Non-point Source Control Measures:

i. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters.

ii Strictly implement existing ordinances prohibiting the discharge of untreated wastes from boats.

G. Flanders Bay—Peconic Estuary. The Peconic Estuary, into which the Riverhead Sewage Treatment Plant now empties, shows high chlorophyll counts and frequently low dissolved oxygen levels. A similar condition exists in the numerous creeks that flow into Flanders and Peconic Bays. Thus, discharges into the Peconic Estuary can only be allowed if nitrogen removal is instituted and if flows do not significantly increase.

a. Point Source Control Alternatives:

Alternative i If minimum sewering options are selected for the Riverhead service area, institute nitrogen removal for the Riverhead Sewage Treatment Plant.

Alternative ii If minimum sewering options are selected for the Riverhead service area, relocate the outfall to an open bay location with secondary treatment.

Alternative iii If one D.U./acre or two D.U./acre sewering options are selected for the Riverhead service area, institute nitrogen removal for the Riverhead Sewage Treatment Plant and relocate the outfall to an open bay location.

Alternative iv If one D.U./acre or two D.U./acre sewering options are selected for the Riverhead service area, divert outfall to Long Island Sound or Flanders Bay.

Alternative v Institute tertiary treatment and recharge.

b. Highest Priority Non-point Source Control Measures:

i. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters.

ii. Prohibit, or severely restrict, all further development in shoreline areas. Establish adequate buffer zones around wetlands. Assign priority to public acquisition, based on the protection of groundwater quality and natural resources.

iii. Initiate a study to determine the impact of duck sludges as a source of nutrients and bacteria, and the feasibility of their removal.

c. Special Monitoring Requirements
Provide for further monitoring, specifically for dissolved oxygen nutrients and chlorophyll a, to better define and select one of the point source control alternatives.

H. Mecox Bay. The only outlet for Mecox Bay is an ephemeral channel connecting to the Atlantic Ocean. This inlet provides limited flushing and drainage of the bay approximately 50 percent of the time. In order to protect the important natural resources of the bay, it is necessary to maintain groundwater and stream nitrogen concentrations at, or below, two milligrams per liter

a. Point Source Control Alternatives:
Alternative i Prohibit new point source discharges to the bay.
Alternative ii Provide nitrogen removal or complete effluent recycling for duck farm discharges located in the drainage area.

b. New Inlet Alternatives:
Study the feasibility of stabilizing the inlet from the Atlantic Ocean to provide adequate flushing and dispersion.

c. Highest Priority Non-point Source Control Measures:
i. Prohibit, or severely restrict, all further development in shoreline areas. Establish adequate buffer zones around wetlands. Assign priority to public acquisition, based on the protection of groundwater quality and natural resources.
ii. Provide for routine maintenance of on-site disposal systems.
iii. Restrict the use of inorganic, fast-acting fertilizers. Promote the use of low-maintenance lawns.
iv. Initiate a study to determine the impact of duck sludges as a source of nutrients and bacteria and the feasibility of their removal.

I. Shinnecock Bay. Shinnecock Bay is a shallow bar-built estuary, whose water quality is regulated by tidal flushing through the ocean inlet. The inlet is in a mode of unstable deposition, and it is imperative to keep it open, in order to maintain the present water quality conditions.

a. Point Source Control Alternatives:
Alternative i Prohibit new point source discharges to the bay.
Alternative ii Maintain the ocean inlet to provide adequate flushing and dispersion.

b. Highest Priority Non-point Source Control Measures:
i. Prohibit, or severely restrict, all further development in shoreline areas. Establish adequate buffer zones around wetlands. Assign priority to public acquisition, based on the protection of groundwater quality and natural resources.
ii. Provide for the routine maintenance of on-site disposal systems.
iii. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters.

J. Moriches Bay Moriches Bay is a shallow bar-built estuary, whose water quality is regulated by tidal flushing through the ocean inlet. The inlet is currently subject to an unstable scouring trend, and flushing is increasing. However, it is still desirable to maintain groundwater and stream nitrogen concentrations at, or below, two milligrams per liter in order to protect the bay's important natural resources.

a. Point Source Control Alternatives:
Alternative i Prohibit new point source discharges to the bay.
Alternative ii Provide nitrogen or complete effluent removal from duck farms located in the drainage area.

b. Highest Priority Non-point Source Control Measures:
i. Control animal populations and animal waste disposal.
ii. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters.
iii. Initiate a study to determine the impact of duck sludges as a source of nutrients and bacteria and the feasibility of their removal.

K. Great South Bay. Great South Bay is a large and complex system. Control strategies for specific pollutant loads need to be formulated on a case by case basis using the available data analyses and modeling tools. In general, western Great South Bay is well flushed and eastern Great South Bay is poorly flushed. Strict controls are required for the eastern portions of the bay. In order to protect the important natural resources of the bay, it is necessary to maintain groundwater and stream nitrogen concentrations at, or below, two milligrams per liter.

a. Point Source Control Alternatives:
Alternative i Prohibit new point source discharges into eastern Great South Bay and divert to an ocean outfall.
Alternative ii Prohibit new point source discharges into eastern Great South Bay and recharge tertiary treated effluent.
Alternative iii Provide nitrogen removal for the Patchogue Sewage Treatment Plant.

b. New Inlet Alternative:
Study the feasilbity of constructing a new inlet through the barrier island to control and reduce the nitrogen levels in eastern Great South Bay.

c. Highest Priority Non-point Source Control Measures:
i. Control stormwater runoff to minimize the transport of sedi-

ments, nutrients, metals, organic chemicals and bacteria to surface waters.

ii. Control animal populations and animal waste disposal.

iii. Restrict the use of inorganic, fast-acting fertilizers. Promote the use of low-maintenance lawns.

iv. Require nitrogen removal for treatment plants recharging effluent.

v. Prohibit any new development along streams and shorelines. Create buffer zones where possible along all water bodies and protect all remaining marine wetlands.

vi. Strictly implement existing ordinances prohibiting the discharge of untreated wastes from boats.

L. Western South Shore Bays. Western South Shore bays are relatively well flushed but are sensitive to high pollutant loads. The dominant nitrogen and coliform loads requiring control are contributed by the Bay Park Treatment Plant discharge.

a. Point Source Control Alternatives:

Alternative i Locate the Bay Park Sewage Treatment Plant outfall offshore.

Alternative ii Divert the Long Beach Sewage Treatment Plant effluent to the proposed Bay Park ocean outfall.

Alternative iii Institute further study to determine which of the following steps should be selected, if water quality standards are violated in Bannister Creek: divert the Lawrence treatment facility effluent to Reynolds Channel, divert the influent to the Bay Park plant; provide nitrogen removal.

b. Highest Priority Non-point Source Control Measures:

i. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters.

ii. Control animal populations and animal waste disposal.

iii. Strictly implement existing ordinances prohibiting the discharge of untreated wastes from boats.

M. Nearshore Atlantic Ocean. It is the responsibility of the USEPA and NYSDEC to implement the necessary wastewater controls to prevent the discharge of contaminants and floatable material into the New York Bight. Such contaminants and floatables have periodically impaired the use of regional ocean bathing beaches. These regulations should apply to the control and treatment of raw or inadequately treated sewage discharges, industrial discharges and combined sewer overflows from sites located in New York City and New Jersey.

N. Fresh Water Bodies. The largest source of loadings to freshwater streams and lakes is non-point inputs. Generally, the major water quality contaminations of those water bodies are nutrients and bacteria. However, the greater problem is not the effects of these contaminants on the streams themselves, but the contribution they make to the pollution loads on some of the bays.

a. Point Source Control Alternatives:
Require nitrogen removal for all treatment plants which discharge to streams.

b. Highest Priority Non-point Source Control Measures:

i. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters.

ii. Control animal populations and animal waste disposal.

iii. Prohibit any new development along streams and shorelines. Create buffer zones where possible along all water bodies, and protect all remaining marine wetlands.

iv. Provide for routine maintenance of on-site disposal systems.

3.5.3 Selection of Alternatives for the Areawide Waste Treatment Management Plan. Section Three has marshalled all the significant options available for the management of point and non-point sources, and has identified those which are most pertinent to the hydrogeologic zones and surface water segments of Nassau and Suffolk Counties. The economics has been discussed, wherever useful information is available.

It has been seen that marine surface water quality is closely associated with the quality of groundwater in adjacent areas. Furthermore, the enhancement of both groundwater and surface water quality demands the employment of many of the same point and non-point source controls, both structural and non-structural.

The environmental impacts of all the pertinent options are examined in the following section, Section Four.

On the basis of the information summarized in Section Three and Four (and available, in full, in the reports generated in the course of the 208 Study Program), the final selection of the elements of the Areawide Waste Treatment Management Plan is made and exhaustively discussed in Section Six.

Section 4 Environmental Assessment

4.0 Introduction

The Water Quality Management Plan (WQMP) will have a wide range of environmental and health impacts. These include surface water, groundwater, solid waste, land use and air impacts. The design of the Nassau-Suffolk 208 Program has allowed a detailed investigation of surface water and groundwater impacts, an overview of solid waste impacts, and a snapshot of land use and air impacts. Thus, surface and groundwater impacts, which are the most significant, have been emphasized in this assessment.

There are four major types of control available for preservation of surface and groundwater quality. There are structural and non-structural point source and non-point controls. There are uncertainties associated with the impacts of each control type. Structural point source controls have uncertainties of cost burden and of engineering feasibility for organics removal. Structural non-point controls have both cost uncertainties and engineering effectiveness uncertainties (new technologies). Non-structural point source controls have legal/institution implementability uncertainties. Non-structural non-point controls have implementability uncertainties and also uncertainties as to abatement effectiveness. Non-structural controls are the environmentally preferred approach since they involve the least extensive secondary environmental impacts and are least irreversible. Structural point source controls constitute the least environmentally sound approach since they involve extensive commitment of resources and major rerouting and alterations of natural biogeochemical cycles.[1] This in turn means that structural point source controls impose extensive secondary impacts and are largely irreversible. Costly untested technologically intensive approaches are then required to mitigate secondary impacts.

There are several key water quality problems that have been addressed in this assessment. These are nutrient levels and ratios in bays, pathogens in bay waters and shellfish, salinity gradients in Great South Bay, water table levels, organic chemicals in groundwater, nitrogen in groundwater, hazardous waste loads and sludge loads. Careful control of some of these problems can only be achieved by sacrificing the level of control of some others. Thus, tradeoffs exist between various categories of environmental risks and controls. The tradeoffs have been presented in this assessment and must ultimately be resolved by government and/or citizen decisions.

The section discusses those environmental impacts which are likely to result from the various planning options as set forth in Section 3.5. The impacts are discussed in terms of several types of health-related and ecological effects. These categories of effects are set forth in Section 4.1. Types of effects which can be discussed on an areawide basis are presented in Section 4.2. This section has been organized to correspond to Section 3.5.1, "Areawide Alternatives" as closely as possible. Type of effects specific to the bays and groundwater zones are presented in Section 4.3, which corresponds to Section 3.5.2 "Area Specific Alternatives." Economic costs are discussed in Section 4.4. These four sections are then drawn together in a final section which presents a summary of the overall tradeoffs, and recommendations (Section 4.5). The tradeoffs are displayed by means of a pollutant residuals allocation model specifically designed for this assessment.

[1] Including H_2O, carbon, nitrogen, phosphorus, potassium and trace nutrient cycles.

4.0.1. Impact Categories. The assessment discusses environmental impacts in the four categories suggested by 40CFR6 (Subpart E):

1. *Short Term Primary Impacts.* These effects, relevant only to structural options, are generally immediate results of construction that will be abated once the actual construction is completed. Such short term impacts include those due to dredging, increased erosion, increased turbidity, altered topography, and leaks and spills from construction sites.

2. *Long Term Primary Impacts.* Such effects are not transitory, but result from the permanent alteration of an environment by an action. Long-term nutrient, bacterial and BOD increases or decreases fall under this category, as does the loss or addition of wetlands and open spaces. Populations of organisms may increase or disappear as a result of such changes. If short-term impacts such as vegetation removal and erosion are not alleviated, they may become long-term impacts.

3. *Secondary Impacts.* Secondary impacts are not a direct result of an activity, but are induced as succeeding links in a chain of effects set off by the initial action. Secondary impacts as a result of water quality management include, for example, induced land use changes and development as a consequence of sewering programs, air quality impacts of sludge generation and disposal, and alterations in salinity gradients in Great South Bay resulting from groundwater table changes; whereas loss of potential public works jobs could be considered a secondary impact of not sewering.

Intermedia tradeoffs and transfers are an important class of secondary impacts that are usually overlooked in resource management and planning because of the technical difficulty in relating cause to effects or to the magnitude of the effects. Intermedia tradeoffs include surface water-groundwater, surface water-air and surface water-solid waste tradeoffs.

4. *Irreversible and Irretrievable Commitment of Resources.* The natural environment is composed of many links and feedbacks, which give the system flexibility to adapt to changes in the physical world. This flexibility is tested whenever natural disasters, such as storms or hurricanes, occur. Changes induced by humans, if done wisely and prudently, may be dealt with in a similar way by an ecosystem. However, as man continues to alter the environment, the ecosystem eventually fails to adapt, and permanent destruction of the previous habitats results. This category includes those actions, such as the extinction of a species or loss of a wetland, that will result in permanent loss of a resource. These actions are beyond the ability of the environment to alleviate, and therefore should be very carefully considered before implementation.

4.0.2 Uncertainties. The evaluation of environmental impacts is complicated by uncertainties as to the effectiveness of control measures. These uncertainties are due to the newness of many of the control technologies. There have been few previous applications for the controls and therefore performance data is largely lacking. Some of the main uncertainties that are encountered are summarized in Table 4—1.

Table 4—1

UNCERTAINTIES IN PROPOSED CONTROL MEASURES

	Type of Uncertainty				
Measure	Engineering (feasibility of the technology)	Performance (effectiveness of the technology)	Legal Institutional (implementability	Public Cost Burden (cost to taxpayer)	Private Cost Burden (cost to industry)
Best Management Practices, runoff controls		X	X		
Legal/institutional non-point controls		X	X		
Structural non-point controls		X		X	
Industrial pre-treatment	X		X		X
Sewering at 1 to 3 D.U./Gross Acre			X	X	
Stream Augmentation	X	X		X	
Recharge	X	X		X	

4.1 Assessment Criteria: Categories of Health and Ecological Effects

The effects of the proposed 208 Plan for Long Island have been evaluated with respect to several types of environmental risk. These include public health problems, natural resource problems, and other environmental problems. These types of problems are set forth below. The evaluations of some of them are straightforward. For example, health risks due to metals are evaluated in terms of drinking water standards. Others are more qualitative. For example, health risks due to viruses have no standards associated with them.

4.1.1 Health Risks. Health risks being considered in this assessment are of three types: first, the effects of toxic chemicals and pathogenic organisms in drinking water; second, the effects of pollutants in fish and shellfish used for human consumption; and third, the carcinogenic effects of organics in drinking water. These various effects have been considered according to pollutant type: metals, organics, nitrates, coliform bacteria and viruses.

4.1.1.1 Metals. Public health standards (NYS Health Standards,) for various metals in drinking water are shown in Table 4—2. Standards for metals take into account an individual's overall intake of the metal. Such standards are also applicable to metals in food such as shellfish and fish. These standards can be used to evaluate the acceptability of plan alternatives with respect to trace metals health risks.

A sampling program has been carried out to measure metal concentrations in various water environments. It was carried out as part of a sampling program to measure levels of organic contaminants in groundwater. Thus,

Table 4–2

MAXIMUM CONTAMINANT LEVELS FOR METALS

	NYS[a] Drinking Water Regulations (mg/l)	NYS[b] Groundwater Regulations (mg/l)	Proposed Groundwater[c] Classifications, Quality Standards and Effluent Standards and or Limitations (mg/l)
Arsenic	0.05	0.2	0.05
Barium	1.0	2.0	1.0
Cadmium	0.01	0.02	0.01
Chromium (hexavalent)	0.05	0.1	0.05
Lead	0.05	0.1	0.05
Mercury	0.002	–	0.002
Selenium	0.01	0.02	0.01
Silver	0.05	0.1	0.05
Iron	–	0.6	0.3
Manganese	–	0.6	0.3
Zinc	–	0.6	5.0
Copper	0.1	0.4	–

[a]*Levels allowable in drinking water under the NYS Department of Health Drinking Water Standards. Source: Sanitary Code, Subpart S–1 Public Water Supply.*

[b]*Levels allowable in groundwater under New York State Regulations, Title Six, Section 703.4. Source: NYS, 1967.*

[c]*Title Six, 703.5 Proposed, NYS, May 1977.*

the sampling plan was designed to test water quality of areas likely to be organically contaminated. The set of samples does not necessarily represent the set that would have been selected if the major purpose was to identify metal contaminant problems. However, there are a variety of samples from areas near landfills, scavenger waste lagoons, and effluent discharges, as well as from typical residential areas. Thus the set of samples is reasonably representative of expected areas of contamination by metals. The metals for which the samples were tested (arsenic, barium, cadmium, chromium, lead, mercury and selenium) are those included in the 1976 EPA Interim Primary Drinking Water Regulations. A total of 124 samples were tested. Barium, selenium and silver were low in all samples. Arsenic, cadmium and chromium were low in most samples; however, they were high in certain types of effluent. Lead occurred at a significant level in various types of samples, and further diagnostic sampling would be prudent. Mercury occurred at concentrations in violation of standards in 38 samples with no apparent patterns of occurrence. A further sampling effort is needed to verify the extent of the problem and to identify possible sources. Table 4–3 summarizes the results.

4.1.1.2 Organics. Health risks from organic chemicals include (1) toxic effects, (2) carcinogenesis risk from low levels of organics in drinking water, (3) bioaccumulation in certain organs of shellfish and fish, and (4) tainting of shellfish and fish by hydrocarbons and other odor and taste-inducing organics. Monitoring results have indicated that the first and second of these four types of problems are of real concern (*e.g.*, ERCO; NCDH, 1977a). The third was of concern in the past when DDT and related pesticides were in common use (Porter *et al.*, 1977) and is now mainly of concern with respect to fish that spawn in such areas as the Hudson River where substances such as PCB's occur (ERCO). The fourth has not been shown to be a problem on Long Island.

Table 4–3

SUMMARY STATISTICS FOR COMPLETE SAMPLING PROGRAM
(mg/l unless otherwise noted)

Metal	EPA 1976 Drinking Water Standard	Observed Range	Observed Mean	Observed Median	Percent Violations of Standard	Percent Higher than 50 Percent of Standard Value
Arsenic	0.05	<0.0025–0.14	0.0004	<0.0025	0.8	0.8
Barium	1.0	<0.03–0.5	<0.03	<0.03	0.0	0.8
Cadmium	0.01	<0.00015–0.039	0.0013	<0.0005	2.4	3.2
Chromium	0.05	<0.0002–0.069	0.0015	<0.0002	0.8	1.6
Lead	0.05	<0.0007–0.24	0.01	0.002	6.4	6.4
Mercury (μg/l)	2	<0.13–5.2	1.8	0.44	18.7	37.0
Selenium	0.01	<0.004–0.011	<0.004	<0.004	0.8	2.4
Silver	0.05	<0.00025–0.14	0.002	<0.00025	1.6	2.4

SAMPLING PROGRAM

Included in the 208 was a sampling program initially designed to determine in a general way whether or not organic chemicals in domestic wastes or runoff would preclude treated sewage recharge. Early in the sampling effort it became clear that several organics were being identified in significant quantities. However, the techniques available for analysis of volatile organic compounds are still in a state of development (ERCO). Thus, it was difficult to quantify levels of volatile contaminants during the first part of the sampling program. Also, available toxicological literature is sketchy so that it is difficult to establish criterion levels. Since every groundwater sample analyzed showed some contamination, a pollutant hazard was indicated. This result, which did not answer the original question concerning recharge, is very significant from a public health standpoint. The last half of the sampling program was revised in order to address existing contamination from various sources rather than potential recharge effects. The final samples included some designed to help identify contaminant sources. The results for the second half of the sampling program were quantitatively accurate. For example, the final 24 samples were accurate to within twenty percent. The analytical results indicate that there is a significant public health risk. Further sampling programs are required to reduce present uncertainties concerning precision of the data, distribution of the contaminants, and identification of the sources. A summary of the ERCO results is given in Tables 4–4, 4–5 and 4–6. A summary of results of other surveys is given in Tables 4–7 through 4–10.

Table 4–4

SUMMARY STATISTICS–VOLATILE ORGANIC COMPOUNDS

Compound	# stations measured	# stations detected*		# stations occurring @ >10 μg/l*		# stations occurring @ >50 μg/l*	
trichloroethylene	116	93	(80%)	35	(30%)	15	(13%)
chloroform	82	68	(77%)	20	(24%)	4	(5%)
1,1,1 trichloroethane	116	57	(49%)	25	(21%)	6	(5%)
carbon tetrachloride	78	28	(36%)	1	(1%)	0	
tetrachloroethylene	116	38	(33%)	10	(8%)	5	(4%)
dibromochloromethane	78	15	(19%)	0		0	
diethyl ether	38	6	(16%)	0		0	
1,1 dichloroethane	44	5	(11%)	3	(7%)	0	
bromodichloromethane	78	8	(10%)	3	(4%)	1	(1%)
freon–11	44	4	(9%)	0		0	
1,1 dichloroethylene	44	4	(9%)	0		0	
1,2 dichloroethane	44	3	(7%)	0		0	
bromoform	78	5	(6%)	1	(1%)	0	
1 chloropropane	44	1	(2%)	1	(2%)	0	

percentages given in parentheses.

Table 4–5

SUMMARY STATISTICS–NONVOLATILE ORGANIC COMPOUNDS

Compounds detected at >10 μg/l for at least one station	Number of Stations >1 μg/l	Number of Stations >10 μg/l	Number of Stations >50 μg/l
methyl naphthalene	45	2	1
dimethyl naphthalene	37	3	0
dibutyl phthalate	34	20	8
octyl phenols	27	4	1
C_4 benzene	20	4	0
di-tert-butyl phthalate	20	6	2
phthalate (composition undetermined)	19	2	1
naphthalene	19	3	0
phthalate derivative (composition undetermined)	14	1	0
dibutoxy-ethoxy-ethyl methane	13	4	1
phthalate compound (composition undetermined	8	1	0
acenaphthene	6	1	0
C_{16} alkane	6	2	0
C_{28} alkane	6	1	1
tri-t-butyl orthoformate	6	1	0
diethyl benzene	5	2	0
2,3 dimethyl naphthalene	4	1	0
thymol	3	1	0
cyclohexane	3	2	1
o,m xylenes	2	1	1
isopropyl benzene	2	1	1
C_{20} alkane	2	1	0
trimethyl hexanoic acid	1	1	0

DISCUSSION OF RESULTS

The sampling results show the following:

a. *Water Media Characteristics*

Glacial Aquifer. Over one third of the sixty wells tested were significantly contaminated by volatiles and over one half by methylene chloride extractables. Of more serious concern, one fifth of the wells contained organic contaminants at the 50 parts per billion level, the level currently in use as the threshold for health risks from potentially carcinogenic organics. The sample size is sufficiently large for there to be little doubt that significant levels of organic contaminants reside in the Glacial aquifer.

Table 4–6

SUMMARY STATISTICS–ORGANIC CONTAMINANTS IN WATER, NASSAU AND SUFFOLK COUNTIES

	Volatiles				Methylene Chloride Extractables			
Medium	# stations	# stations w/at least 1 compound >10 μg/l	# stations w/at least 1 compound >50 μg/l	# stations w/at least 1 compound >100 μg/l	# stations	# stations w/at least 1 compound >10 μg/l	# stations w/at least 1 compound >50 μg/l	# stations w/at least 1 compound >100 μg/l
Effluent	12	6	3	0	12	4	1	1
Magothy	11	4	2	1	12	1	0	0
Glacial	66	31	14	7	69	32	12	3
Water Supply	14	8	3	2	11	4	1	1
Lloyd	1	1	0	0	1	1	0	0
Surface Water	1	1	0	0	1	1	0	0

Table 4–7

PESTICIDES IDENTIFIED IN USGS TEST WELLS LOCATED IN SUFFOLK COUNTY[a]

Well No.	Pesticides and/or Herbicides (μg/l) identified in general screening process	Levels observed in subsequent resampling event (μg/l)
S43808	Dieldrin = .01	less than .01
S43815	PCB = trace	
S43819	Silvex = .01	less than .01
S45208	PCB = trace	
S46912	DDE = .01 DDT = .02 Dieldrin = .09	all less than .01
S46913	DDD = .04 DDE = .02 DDT = .08 Dieldrin = .11	all less than .01
S46914	Dieldrin = .02	less than .01
S46963	2,4–D = trace	less than .01
S47222	Silvex = trace	less than .01
S47230	Silvex = trace	less than .01
S47235	DDD = trace DDE = trace	both less than .01
S47977	2,4–D = .07	less than .01
S48425	2,4–D = trace	less than .01
S48946	PCB = trace	
S51575	DDD = 8.1	DDD = 1.6
S51583	Dieldrin = .01	less than .01

[a] *Source: Baier, J.H., 1976.*

Magothy Aquifer. Volatile organics appear to have penetrated to the Magothy aquifer. Methylene chloride extractables have not been measured at significant (>10 μg/l) levels. However, the sample size of Magothy wells tested is small; therefore, no firm statistical conclusions as to the extent of the contamination can be presented.

Effluent. Volatile and methylene chloride extractable organics are present in the effluents that have been sampled. Most of these are sewage treatment plant effluents, some of which are presently recharged. The halogenated volatile organics may be resulting from chlorination of effluents; however, comparative sampling of chlorinated and unchlorinated effluents is required to verify this.

Lloyd Aquifer, Water Supply, Surface Water. A single sample was taken from this formation. The sample showed no contamination. However, no conclusions are possible from this data.

b. *Chemical Species Characteristics*

Trichloroethylene, Chloroform, 1,1,1 Trichloroethane, Tetrachloroethylene. Three of these substances are occurring in at least fifty percent of the stations tested. Incidence of 50 parts per billion observations is over four percent. Many of the occurrences noted in this study are in glacial aquifer wells. However, sampling of Nassau County Water Wells (NCDH, 1977a) shows a significant level of occurrence of these contaminants in water supply wells, many of which draw from the Magothy. As noted in Section Three, chloroform and trichloroethylene appear on the NAS (1977) list of known animal carcinogens. Thus, the presence of these chemicals in the Magothy aquifer presents a health risk. Identification and control of the sources of these contaminants should be of high priority

Table 4–8

ORGANICS OBSERVED ON LONG ISLAND IN 1976[a]

		Fractions from the Extraction Procedure				
	Volatile Organics	Neutral Fraction	Acidic Fraction	Acid Esterified Fraction	Basic Fraction	Particulate Extract
Untreated storm-water runoff	benzene toluene ethyl benzene p–xylene n–xylene	ethyl phthalate butyl phthalate isobutyl phthalate (T) ethyl hexyl phthalate dioctyl phthalate 2 additional phthalate compounds	methyl–18 methoxy-abiatata 2–isopropy–1,3-dioxolane ethyl benzaldehyde (T) diethyl phthalate methyl palmitate butyl phthalate dioctyl phthalate	methyl nonanoate phthyl eicosane (T) methyl xyristate methyl palmitate methyl stearate squalene (T)	diethyl phthalate dibutyl phthalate diotyl phthalate	ethyl phthalate ethyl hexyl phthalate dioctyl phthalate 2 additional phthalate compounds
Groundwater percolate of untreated storm-water runoff	methylene chloride benzene toluene 3 additional aromatic BC's	ethyl phthalate ethyl hexyl phthalate phthalate compound dioctyl phthalate	diethyl phthalate butyl phthalate Z–isopropyl–1,3–dioxolane dioctyl phthalate 1–decyne (T)	benzyl–Z (benzyl thio) propionate (T) methyl myristata (T) diethyl phthalate methyl palmitate methyl stearate butyl phthalate dioctyl phthalate squalene (T)	dioctyl phthalate	ethyl phthalate butyl phthalate ethyl hexyl phthalate dioctyl phthalate phthalate compound
Blank	methylene chloride (T)	butyl phthalate isobutyl phthalate butyl isobutyl phthalate	ND	ND	butyl phthalate octyl phthalate	ND
Medford effluent, tertiary treatment	ND	isobutyl phthalate butyl phthalate butyl isobutyl phthalate dibutoxyethane (T) iso-octyl phthalate	ND	ND	isobutyl phthalate	isobutyl phthalate butyl phthalate butyl isobutyl phthalate
Groundwater percolate of Medford effluent tertiary treatment	chloroform	isobutyl phthalate butyl phthalate butyl isobutyl phthalate	methyl isoxanoate nor-octyl eicosane nor-decyl docosane b-butyl docosane 11–n decyl docosane n–pentyl beneicosane 10–n–10–n hexyleicosane n–octyl heptadecane methyl tricosane n–nonacosane n–datriaccotane n–octyl tetracosane	ND	ND	ND

Table 4–8 cont'd.

ORGANICS OBSERVED ON LONG ISLAND IN 1976[a]

Woods Hole effluent, secondary treatment	ND	ND	ND	ND	ND	ethyl hexyl phthalate butyl phthalate dibutoxyethane iso–octyl phthalate trimethyl heptane 2–methylnonane 2,2,5,5–tetramethyl-hexan–3,4–dione trimethyl hexane
Groundwater percolate of Woods Hole effluent, tertiary treatment	ND	ethyl phthalate butyl phthalate isobutyl phthalate butyl isobutyl phthalate octyl phthalate	ND	ND	ND	butyl phthalate isobutyl phthalate butyl isobutyl phthalate
Wantagh effluent, secondary treatment	perchloroethylene o–dichlorobenzene	ND	isobutyl phthalate butyl phthalate	butyl phthalate	butyl phthalate methyl undecane methyl decane	butyl phthalate isobutyl phthalate butyl isobutyl phthalate

Key: *(T) = tentative identification.*
ND = no compounds detected in sample
[a]Slimak and Harris, 1976.

Carbon Tetrachloride, Dibromochloromethane. These contaminants have been observed in over 15 percent of the samples. Although they are widely present, they are only found at low levels. Thus, although their wide distribution is of concern, they cannot at present be considered to impose significant health risks.

Other Volatile Organic Contaminants. Eight other volatile compounds have been observed. They occur in only a small number of wells at generally small concentrations. However, in the final set of samples, (QA–1 to QA–24) which were analyzed under the best conditions, both 1,1 dichloroethane and bromodichloromethane occur at significant levels. More samples are needed to say anything about the occurrence of those two compounds. The other volatiles detected are not at present of major concern.

Phthalates. This general class of methylene chloride extractable organics occurs ubiquitously Phthalate compounds were detected at very high levels in about eight percent of the samples. Phthalates occur as plasticizers. Thus, the presence of phthalates may be partially due to use of plastic tubing as part of the sampling devices. Nevertheless, since phthalates occur on the NAS (1977) list of chronic toxins, it is only prudent to consider the observed high phthalate levels as a health risk.

Methylene Chloride Extractable Organic Contaminants. A wide variety of compounds were observed in the samples. Some occurred at levels greater than 50 parts per billion. Eighteen substances occurred at levels greater than ten parts per billion. However, information on health risks imposed by these substances is scanty. Thus, the risk levels cannot presently be assessed.

c. *Patterns of Occurrence*

The 124 samples taken represent 102 different sample stations. In most cases, only one sample was collected at each station. Thus, there is little statistical validity associated with looking at the contaminant levels of individual sites. Tables 4–11 through 4–13 present the data grouped according to suspected source categories. These data suggest a number of interesting patterns, which at present should be viewed as preliminary hypotheses. Further sampling is warranted with respect to all of the suspected source categories.

Table 4–9

SUMMARY OF VOLATILE ORGANIC SAMPLING
OF NASSAU COUNTY MUNICIPAL WATER SUPPLIES[a][b][d]

Organic Compound	Number of Samples Observed at $\geq 10\ \mu g/l$[c]	Number of Samples Observed at $\geq 50\ \mu g/l$[c]	Number of Samples Observed at $\geq 100\ \mu g/l$[c]
1,1,2 trichloroethylene	25	7	2
1,1,1 trichloroethane	16	7	4
chloroform	11	1	0
tetrachloroethylene	7	5	4
1,2 dichloroethylene	6	0	0
benzene	3	1	0
toluene	2	0	0
bromodichloromethane	1	0	0
vinyl chloride	0	0	0
tri-fluorotrichloroethane	0	0	0
carbon tetrachloride	0	0	0
methylene chloride	0	0	0
ethyl ether	0	0	0

[a]Source: NCDH (1977a).
[b]All samples collected between June 1975 and May 1977.
[c]Total number of samples is 303; not all compounds analyzed for in all samples.
[d]Samples analyzed by various labs using various methods.

Table 4–10

SUMMARY OF VOLATILE ORGANIC SAMPLING
OF SUFFOLK COUNTY PUBLIC WATER SUPPLIES[a][b][c]

Organic Compounds	Number of Samples Observed at $\geq 10\ \mu g/l$	Number of Samples Observed at $\geq 50\ \mu g/l$	Number of Samples Observed at $> 100\ \mu g/l$	Total Number of Samples Analyzed
1,1,2 trichloroethylene	46	29	19	125
1,1,1 trichloroethane	41	16	7	121
tetrachloroethylene	18	3	1	122
chloroform	8	2	1	123
carbon tetrachloride	4	0	0	105
1,2 dichloroethylene	2	0	0	30
toluene	1	0	0	48
benzene	1	0	0	49
vinyl chloride	0	0	0	29
trichlorotrifluoroethane	0	0	0	45
bromodichloromethane	0	0	0	62
dichloromethane	0	0	0	7
chlorodibromomethane	0	0	0	1

[a]Source: SCHD, 1978.
[b]Samples collected between February 1976 and January 1978.
[c]Analyses by the following labs: NYSHD, Stony Brook; NYSHD, Albany; EPA, Ada, Oklahoma; New York Industrial Testing Lab; EPA, Edison, N.J.; H2M. Corp., Melville, N.Y.

HEALTH RISK FROM ORGANICS

The National Academy of Sciences (1977) has recently reviewed the existing toxicological literature on environmental pollutants. It divided the organic contaminants of water supplies into four categories: (1) known or suspected carcinogens (Table 4–14), (2) noncarcinogenic toxins, (3) compounds that have been insufficiently studied with respect to chronic toxicity, and (4) compounds that have not been subjected to chronic toxicity tests.

The NAS results are applicable to Long Island. Table 4–14 presents risks in terms of probability of occurrence of cancer. In order to apply a set of standards, these risk numbers must be translated to allowable concentration levels. This requires establishment of an acceptable level of cancer risk. Such a decision ultimately rests with the citizens or policy makers. Chloroform, carbon tetrachloride and trichloroethylene are all found in Long Island waters and impose significant cancer risks according to animal carcinogenicity studies summarized in Table 4–14.

The NAS risk numbers were developed assuming a linearity of dose-response relationships. If one also assumes lack of synergistic effects, a risk level can be estimated for specific water sources. For example: ERCO sample QA2, from a shallow glacial fire well in a residential area in West Babylon, contained ten micrograms per liter chloroform, no carbon tetrachloride, and 275 micrograms per liter trichloroethylene. The inferred risk calculated by adding risks imposed by each hazardous chemical would be 3.9×10^{-5} lifetime cancer risk from continual exposure to that contaminant level. This could be translated as an expected cancer incidence of about one death per 26,000 individuals. Table 4–15 presents results of similar calculations for wells reported on by the Long Island Water Conference (Holzmacher, 1977).

Phthalates were detected in a large number of samples on Long Island and in some cases at high concentrations. These were found by the NAS to constitute a significant toxicity risk but not a cancer risk. The toxicity of several phthalate compounds has been tested. The NAS reports that 38.5 micrograms per liter and 210 micrograms per liter are threshold levels for safe consumption of di–n–butyl phthalate and di (2–ethyl hexyl) phthalate respectively. The levels observed of di–n–butyl phthalate exceed threshold levels on Long Island, primarily with shallow glacial wells.

Many of the contaminants that are of concern as problems in the Long Island aquifers have been insufficiently studied for toxicity or carcinogenicity according to the NAS. Contaminants listed in tables include tetrachloro-

Table 4–11

EFFLUENT AND GLACIAL CONTAMINATION LEVELS RANKED BY FREQUENCY OF OCCURRENCE OF CONTAMINANTS AT $\geq 10\ \mu g/l$. SAMPLE WAS BIASED TOWARD CONTAMINATED AREAS

	No. of Observations at $\geq 10\ \mu g/l$				No. of Observations at $\geq 50\ \mu g/l$				No. of Samples		
	Volatiles	Methylene Chloride Extractions	Volatiles or Methylene Chloride Extractions #	(% of all observ.)	Volatiles	Methylene Chloride Extractions	Volatiles or Methylene Chloride Extractions #	(% of all observ.)	Volatiles	Methylene Chloride Extractions	Volatiles or Methylene Chloride Extractions
Effluent											
Effluent Type:											
Leachate	1	1	2	(100%)	1	1	2	(100%)	2	1	2
Domestic chlorinated STP Effluent	4	2	5	(71%)	3	1	3	(43%)	4	7	7
Runoff Effluent	1	1	1	(50%)	1	0	1	(50%)	2	2	2
Glacial											
Overlying Land Use/ Aquifer Characteristics:											
Leachate Plumes	3	2	4	(100%)	3	0	3	(75%)	3	3	4
Commercial/Industrial Unsewered	2	2	3	(100%)	1	1	1	(33%)	2	3	3
Wooded	3	1	3	(100%)	1	0	1	(33%)	3	3	3
Agricultural	7	3	7	(88%)	3	0	3	(37%)	7	8	8
Runoff Recharge	6	3	6	(75%)	3	1	4	(50%)	8	8	8
Residential Sewered	1	7	8	(73%)	1	3	4	(36%)	1	10	11
Domestic STP Recharge	3	4	5	(63%)	0	0	0		7	8	8
Residential Unsewered	5	6	8	(50%)	4	5	7	(44%)	6	16	16
Mixed Unsewered	3	1	3	(43%)	1	1	2	(29%)	3	7	7

ethylene, 1, 2–dichloroethane, bromoform, bromodichloromethane, propyl benzene. Others such as 1, 1, 1–trichloroethane and dibromochloromethane are not included at all by the NAS. Thus, despite existence of information enabling assessment of risks for four compounds of concern to Long Island, major uncertainties about health risks of many other contaminants occurring on Long Island are not resolved by the NAS 1977 report.

4.1.1.3 Nitrates.[1] Nitrates become toxic to humans and other warm-blooded animals only under conditions in which they may be reduced to nitrite. This reduction takes place in the gastrointestinal tract, after which the nitrite may reach the bloodstream and react directly with the blood pigment, hemoglobin, to form methemoglobin. Once altered, the blood pigment can no longer efficiently transport oxygen from the lungs to the tissues and the physiological result is anoxia (lack of oxygen). The direct ingestion of nitrite nitrogen has a more immediate effect on the individual, but nitrite rarely occurs in Long Island drinking waters in sufficient concentrations to cause concern.

The reaction of nitrite with hemoglobin has been documented in approximately 2,000 cases in infants under three months of age in Europe and North America; seven to eight percent of those infants died as a result of the disease.[2] While many infants have not developed methemoglobinemia when fed with well waters having nitrate concentrations greater than ten milligrams per liter (NO_3–N), surveys have demonstrated that a minimal number of cases of infant poisoning were reported when water contained less than ten milligrams per liter (NO_3–N) (USEPA Drinking Water Regulations, 1976). Infants are apparently more susceptible than adults because their fluid

[1]Much of this section is adapted from Porter *et al.* (1978).
[2]This paragraph abstracted from EPA (1976b).

Table 4—12

NINETIETH PERCENTILE OF OBSERVED CONTAMINANT LEVELS ORDERED BY HIGHEST CONTAMINANT LEVEL PER SAMPLE

Sample Type	Sample #	Highest Contaminant Level
Glacial—residential—unsewered	QA 3	592 μg/l bromodichloromethane
Glacial—mixed—unsewered (WS)	QA 17	400 μg/l phthalate compound "a"
Magothy (WS)	QA 13	400 μg/l trichloroethylene
Glacial—agricultural	QA 21	290 μg/l 1,1,1 trichloroethane
Glacial—residential—unsewered	QA 19	285 μg/l trichloroethylene
Glacial—residential—unsewered	QA 2	275 μg/l 1,1,1 trichloroethane
Magothy (WS)	PWG 30	221 μg/l trichloroethylene
Glacial—residential unsewered	JDW 15	171 μg/l dibutyl phthalate
Glacial—Leachate Plume	QA 9	150 μg/l tetrachloroethylene
Glacial—mixed—unsewered (WS)	QA 12	150 μg/l tetrachloroethylene
Magothy (WS)	QA 6	145 μg/l chloroform
Scavenger Waste Lagoon	PWG 44	112 μg/l 1,1,1 trichloroethane
Glacial—residential—unsewered	JDW 14	109 μg/l octyl phenols
Magothy (WS)	QA 10	109 μg/l trichloroethylene

(WS) = water supply well

Table 4—13

NINETIETH PERCENTILE OF OBSERVED CONTAMINANT LEVELS ORDERED BY NUMBER OF CHEMICALS OBSERVED AT $\geq$10 μg/l PER SAMPLE

Sample Type	Sample #	Number of Organic Chemicals Observed at $\geq$10 μg/l
Glacial—mixed—unsewered (WS)	QA 17	8
Glacial—residential—unsewered	QA 19	5
Glacial—residential—unsewered	QA 2	5
Glacial—runoff recharge	PWG 1	5
Glacial—runoff recharge	PWG 2	5
Glacial—commercial/ industrial—unsewered	JDW 13	5
Glacial—residential—unsewered	QA 3	4
Magothy (WS)	QA 6	4
Glacial—residential—sewered	QA 8	4
Control (Passed through plastic tubing)	PWG 23	4
Runoff	PWG 49	4
Glacial—residential—unsewered	PWG 51	4

(WS) = water supply well

Table 4—14

CATEGORIES OF KNOWN OR SUSPECTED ORGANIC CHEMICAL CARCINOGENS FOUND IN DRINKING WATER[a]

Compound	Highest observed concentrations in finished water in U.S. (μg/l)	Upper 95% Confidence estimate of lifetime cancer risk per μg/liter
Human Carcinogen		
Vinyl Chloride	10	5.1×10^{-7}
Suspected Human Carcinogens		
Benzene	10	ID[b]
Benzo (a) pyrene	D	ID
Animal Carcinogens		
Dieldrin	8	2.6×10^{-4}
Kepone	ND	4.4×10^{-4}
Heptachlor	D	4.2×10^{-5}
Chlordane	0.1	1.8×10^{-5}
DDT	D	1.2×10^{-5}
Lindane (γ—BHC)	0.01	9.3×10^{-6}
α—BHC	D	6.5×10^{-6}
β—BHC	D	4.2×10^{-6}
PCB (Aroclor 1260)	3	3.1×10^{-6}
ETU	ND[3]	2.2×10^{-6}
Chloroform	366	3.7×10^{-7}
Carbon tetrachloride	5	1.5×10^{-7}
PCNB	ND	1.4×10^{-7}
Trichloroethylene	0.5	1.3×10^{-7}
Diphenylhydrazine	1	ID
Aldrin	D	ID
Suspected Animal Carcinogens		
Bis (2—chloroethyl) ether	0.42	1.2×10^{-6}
Endrin	0.08	ID
Heptachlor epoxide	D	ID

[a]Source: NAS, 1977
[b]ID = Insufficient data to permit a statistical extrapolation of risk.
ND = Not detected.
D = Detected but not quantified.

Table 4–15

SAMPLE CALCULATIONS OF CANCER RISKS FOR CONTAMINATED WELLS IN NASSAU COUNTY[a] [b]

Supplier	Well No.	Date	Inferred Lifetime Cancer Risk (See Table 7)
Bethpage State Park	1	3/4/77	5.8×10^{-6}
Bethpage State Park	1	12/8/76, 1/17/77	0
Bethpage Water District	6–1	11/29/76	3.6×10^{-6}
Bethpage Water District	6–1	1/21/77	4.4×10^{-5}
Plainview Water District	1–1	12/21/76	2.5×10^{-5}
Plainview Water District	1–3	3/4/77	0
South Farmingdale Water District	6–1	1/3/77	3.4×10^{-5}
South Farmingdale Water District	6–3	2/22/77	0
South Farmingdale Water District	6–2	1/3/77	6.5×10^{-6}
South Farmingdale Water District	6–2	2/22/77	0

[a] *Source: ERCO*

[b] *At the time these wells were sampled, they were restricted from public use. The wells have been resampled and all, except the Bethpage State Park Well, are no longer restricted.*

intake per unit of body weight is greater, and their gastrointestinal tract pH is often high enough to allow nitrate-reducing bacteria to survive. In addition, the predominant hemoglobin at birth (hemoglobin F) is more susceptible to methemoglobin formation, and there is a decrease in the activity of the methemoglobin reducing enzyme.

Recognition of this hazard led the United States Public Health Service in 1962 to adopt a standard for nitrate (measured as N) of ten milligrams per liter in drinking water.[1] The World Health Organization later followed the Public Health Service lead by recommending a similar standard. A survey undertaken by Walton (1951) provided justification for the standard. Subsequently, the standard has been subject to considerable debate. Some have suggested that the standard be relaxed since acute methemoglobinemia is rare in western societies today. For this rarity, however, general acceptance of the standard must be considered a major causative factor. It should also be noted that a large safety factor was not incorporated into the drinking water standard as is the rule with most other contaminants. For example, clinical cases of methemoglobinemia have been reported in areas where the water had less than ten milligrams per liter of nitrate. In addition, new findings have provoked fears that chronic effects also may justify a more stringent standard (U.S. Environmental Protection Agency, 1977) Furthermore, the ten milligram per liter standard should be interpreted in the context of an individual's overall nitrate consumption. The standard assumes that nitrates are being ingested in other forms. Thus, depending on foods eaten, effects may be noted at less than ten milligram per liter or may not be noted until a higher level is reached.

Compared to the acute effect of nitrate, much less is yet known about chronic effects. As in the case with acute toxicity, the actual cause of most chronic effects is due to nitrite produced by the reduction of nitrate. One of the first reports dealing with chronicity of nitrate attributable to drinking water was that of the Russians Diskalenko (1968) and Petukhov and Ivanov (1970). Russian teenage children who consumed drinking water with a nitrate concentration greater than twenty milligrams per liter were found to have a decreased response to stimuli compared to children whose drinking water met the standard. In a later report (Petukhov *et al.*, 1972) it was claimed that children of various ages whose drinking water contained nitrate concentrations up to 45 milligrams per liter evinced a variety of symptoms including: cyanosis, lowered blood pressure and elevated levels of methemoglobin.

Shuval and Gruener (1975) completed extensive epidemiological studies encompassing nearly 3,000 infants up to two years of age. The study included a survey of babies in the Gaza Strip who consumed water with high levels of nitrate. A particular aim of the research was to determine whether or not cases of subclinical disease could be detected. The results showed that there was a relation between concentrations of nitrate in water, used in a powdered milk formula, and levels of methemoglobin. Even infants who consumed water containing nitrates only slightly above the standard had significant increases in the percentage of methemoglobin in their blood. In the subsequent U.S. EPA report (1977) it was concluded these results "provided direct epidemiological support for the current standard."

Nitrosamines are organic compounds (N-nitroso compounds) which are now known to be carcinogenic. Some of the compounds are also mutagenic or teratogenic.[2]

N-nitroso compounds are formed by the combination of amines with nitrites. This reaction, called nitrosation, may occur in the environment or in the animal stomach. Amines may originate in water from a wide variety of sources including industrial and domestic waste. Since nitrate is a potential precursor to nitrite, there is the possibility that the presence of amines and nitrates may, under some conditions, produce nitrosation. Much of the research on nitrosamines undertaken so far has investigated the development of cancer in laboratory animals given nitrosamines (for reviews see Crosby and Sawyer, 1976; and Shank, 1975).

Unfortunately, the degree to which amines or nitrosamines represent a public health hazard in drinking water is not presently known. The epidemiological studies so far attempted must be considered inconclusive (see, for example, Armijo and Coulson, 1975 Zaldivar and Wetterstand, 1975, and Hill *et al.*, 1972).

[1] For NO_3 measured as NO_3 rather than as N the standard translates to 44 milligrams per liter

[2] See the Lancet, December 1 1973, p. 1,243 for a general review.

4.1.1.4 **Coliform and Other Bacteria.** The presence of coliform bacteria in water has long been used as an indicator of fecal pollution. While coliforms themselves are generally harmless to man, their presence is used as a surrogate to indicate that pathogenic bacteria and viruses may also be present (EPA, 1976a)

In productive bay ecosystems, excessive contamination by pathogens can render clams, mussels and oysters unfit for consumption Shellfish tend to concentrate particulate contaminants and associated coliforms when filter-feeding in polluted waters.

A significant portion of the Long Island bays are closed to shellfishing due to violations of the coliform standards. A list of the closed areas is presented in Table 4–16.

The total coliform standard for shellfish harvesting is a median not to exceed 70 MPN per 100 milliliters.[1] The standard for contact recreation is a logarithmic mean of 2,400 MPN per 100 milliliters.[2]

4.1.1.5 **Viruses.**[3] The major human virus groups known to occur in sewage include (1) Enteroviruses—transient members of the human alimentary tract consisting of over 100 species including Polioviruses, Coxsackieviruses and ECHO viruses; (2) Adenoviruses—upper respiratory viruses, which are able to withstand the acidity of the human gut and may be shed in feces; (3) Hepatitis virus, and (4) Reoviruses. While only Hepatitis virus and Poliovirus infections have been conclusively proven to have been transmitted by the water route (*i.e.*, sewage pollution of drinking water, shellfish beds, recreational waters, etc.), studies have indicated the likelihood of similar transmission of some or all of the species mentioned above. A listing of the viruses that may be waterborne, and diseases associated with them is presented in Table 4–17.

There is no historical information on viral levels in Long Island waters. Reports of human virus isolations from diverse aquatic systems in various

[1] The median MPN value in any series of samples representative of waters in the shellfish growing area shall not be in excess of seventy (70) per one hundred milliliters.

[2] The monthly median coliform value for one hundred milliliters of sample shall not exceed 2,400 from a minimum of five examinations and provided that not more than twenty percent of the samples shall exceed a coliform value of five thousand for one hundred milliliters of sample and the monthly geometric mean fecal coliform value for one hundred milliliters of sample shall not exceed two hundred (200) from a minimum of five examinations. This standard shall be met during all periods when disinfection is practiced.

[3] This section abstracted from Vaughn and Landry (1977)

Table 4–16

AREAS CLOSED TO SHELLFISHING DUE TO VIOLATIONS OF TOTAL COLIFORM STANDARDS[a]

Area	Bay	Total Acreage	Acreage Closed to Shellfishing			
			Jan. 1, 1970	Jan. 1, 1976	Jan. 1, 1977	Dec. 1, 1977
1	Hempstead Bay	11,850	5,650	11,850	11,850	11,850
2	South Oyster Bay	6,190	700	4,020	4,020	4,620
3	Great South Bay	11,450	970	1,685	1,685	3,155
4	Great South Bay	18,980	705	1,010	1,010	1,110
5	Great South Bay	16,325	555	625	625	635
6	Great South Bay	11,525	285	550	550	550
3–6	Great South Bay	58,280	2,515	3,870	3,870	3,870
7	Bellport Bay	5,595	845	1,030	1,030	495
8	Moriches Bay	10,900	2,545	6,420	6,420	5,485
9	Quantuck Bay and Canal	730	165	165	165	165
10	Shinnecock Bay	9,170	220	220	220	220
1–10	South Shore Bays	102,715	12,640	26,675	26,675	26,675
11	Mecox Bay	1,045	435	320	320	320
12	Napeague Bay	9,135	0	0	0	0
13	Montauk Harbor	1,085	150	150	150	150
14	Acabonack	310	0	0	0	0
15	Three Mile Harbor	1,025	0	0	0	0
16	Gardiners Bay	48,950	0	0	0	0
17	Northwest Harbor	1,550	0	0	0	0

Table 4–16 . . . Cont'd.

Area	Bay	Total Acreage	Acreage Closed to Shellfishing			
			Jan. 1, 1970	Jan. 1, 1976	Jan. 1, 1977	Dec. 1, 1977
18	Shelter Island South	9,450	180	180	180	180
19	Sag Harbor and Cove	575	145	350	350	350
20	West Neck Harbor	625	0	0	0	0
21	Noyack Bay	3,540	0	0	0	0
22	Southold Bay	1,340	0	0	0	0
23	Hashamomuck Pond	170	0	5	5	5
24	Orient Harbor	3,560	0	0	0	0
25	Coecles Harbor	1,205	0	0	0	0
26	Little Peconic Bay	13,725	0	0	0	0
27	Cutchogue Harbor	585	2	2	2	2
28	Great Peconic Bay	19,060	0	0	0	0
29	Flanders Bay	3,090	470	780	780	780
30	Mattituck Creek	125	5	30	30	30
31	Wading River	50	0	50	50	50
32	Mt. Sinai Harbor	455	0	0	0	10
33	Port Jefferson Complex	1,550	815	815	815	900
34	Western Long Island Sound	88,300	20,915	37,150	37,150	37,150
35	Central Long Island Sound	188,000	2,500	0	0	0
36	Eastern Long Island Sound	121,000	300	300	300	300
37	Stony Brook Harbor	855	0	0	0	0
38	Nissequogue River	555	555	555	555	555
39	Smithtown Bay	22,300	500	900	900	900
40	Huntington Bay	2,420	0	0	0	0
41	Northport Bay	1,825	0	0	0	0
42	Northport Harbor	410	200	345	345	345
43	Centerport Harbor	490	125	185	185	185
44	Duck Island Harbor	185	0	0	0	0
45	Lloyd Harbor	600	0	0	0	0
46	Huntington Harbor	340	90	165	165	165
47	Oyster Bay Harbor	5,040	175	375	375	605
48	Cold Spring Harbor	1,325	95	215	215	215
49	Dosoris Pond	105	0	105	105	105
50	Hempstead Harbor	3,465	1,385	3,465	3,465	3,465
51	Fishers Island Sound	7,990	910	910	910	910
52	Stirling Basin	135	135	135	135	135
53	Pipes Cove	370	0	0	0	0
54	Napeague Harbor	885	0	0	0	0
56	Manhasset Bay	2,725	2,725	2,725	2,725	2,725
61	Cold Spring Harbor	220	0	0	0	0
62	Sebonac Creeks	430	0	0	0	0
63	North Sea Harbor	225	0	10	10	10
64	Wooley Pond	30	0	0	0	0

[a] *NYSDEC (1977b).*

Table 4–17

HUMAN VIRUSES COMMONLY FOUND IN SEWAGE AND DISEASES ASSOCIATED WITH THESE VIRUSES[a]

Group	Subgroup	Number of Serotypes	Type Nucleic Acid	Diseases
Enterovirus	Poliovirus	3	RNA	Mild–Severe Gastroenteritis
				Abortive Poliomyelitis
				Aseptic Meningitis
				Paralylic Poliomyelitis
	Coxsackie-virus			
	A	24	RNA	Summer Minor Illness
				Herpangina
				Aseptic Meningitis
				Common Cold
				Hand, Foot and Mouth Disease
				Infant Diarrhea
	B	6	RNA	Aseptic Meningitis
				Common Cold
				Pleurodynia
				Neonatal Disease
				Sudden Infant Death Syndrome
				Myocarditis
				Pericarditis
	Echovirus	34	RNA	Aseptic Meningitis
				Mild Paralysis
				Febrile Illness
				Conjunctivitis
				Boston Exanthem Disease
				Infant Diarrhea
				Vaginitis and Cervicitis
				Pericarditis and Myocarditis
Hepatitis	A		RNA?	Infectious (viral) Hepatitis
	B		DNA?	Serum Hepatitis
Adenovirus		31	DNA	Acute Respiratory Disease
				Pharyngoconjunctival Fever
				Primary Atypical Pneumonia
				Epidemic Keratoconjunctivitis (shipyard eye)
				Intussusception
				Febrile catarrh
Reovirus		6	RNA	Unknown

[a]Vaughn and Landry (1977).

geographic regions (*e.g.*, rivers, bays, estuaries, treatment plant effluents) have appeared on occasion in the literature. As part of the 208 Program, a viral sampling program was carried out. Sample identifications were limited to enteroviruses. The results, which are summarized in Table 4–18, show that viral contamination is not of major concern in sampled waters.

Generalizing from the numbers in Table 4–18 was not done because of the small sample size and brief duration of the Program. In addition, no information was gathered on non–Enterovirus species, which may also be found in sewage pollution systems (*e.g.*, Adenovirus, Reovirus, Rotavirus (Reo-like), Norwalk-agents).

Viruses in Recharge. Recharge of sewage treatment plant effluent to the groundwater has been suspected of causing viral contamination. An important facet of the 208 Virus Study was the monitoring of several groundwater recharge sites in order to qualitatively assess quality of the effluent and the soil's ability to remove human viruses.[1] While being unable to define all the necessary conditions, it was hoped that the program of monthly viral analysis would be able to indicate the likelihood of returning virus-free effluent to groundwater aquifers.

Although not usually listed among recharge methods, the use of subsurface leaching fields will eventually result in the return of water to the aquifer It is emphatically recommended that effluents of similarly low quality to those found at the Sunrise Sewage Treatment Plant not be used for such purposes.[2] However, the information gathered at this site may be useful as an index of the efficiency of such recharge systems under "worst possible conditions." Viruses were isolated from 80 percent of the sewage treament plant effluent samples taken, while only a 22.2 percent frequency was noted in the groundwater observation well. The data indicated that this type of disposal of low volume effluents in fairly isolated areas would be practical, providing the effluents were of adequate quality.

Among treatment plants discharging into recharge basins, the best results were obtained from the Stony Brook site where no viruses could be isolated from the eight samples taken and from Meadowbrook, where they showed an isolation frequency of 30.0 percent. Previously cited studies have demonstrated an inability of effluent borne viruses to penetrate appreciable distances through soil columns depending on soil composition and effluent application rates. The apparent inability to recover significant numbers of viruses at the Stony Brook site was likely a result of the 80 foot soil depth from the bottom of the recharge basin to the aquifer.

The 34 foot soil layer from basin to aquifer at the Meadowbrook site seemed to be a less efficient virus remover. This conclusion does not account for differences in effluent qualities and soil characteristics. Studies of the

[1]Quantitative assessment would require more elaborate programs than those conducted for the 208 Program.

[2]The Sunrise Sewage Treatment Plant effluent quality problem is a well-known problem, and upgrading of the quality of the effluent has been ordered.

Table 4–18

RESULTS OF VIRAL STUDY[a]

Sample	Percent of Samples Containing Virus	Number of Samples
Drinking Water	0	24
Lake Ronkonkoma	28	7
Penataquit Creek	18	11
Closed Shellfishing Areas—Islip	37	8
Water Column—Great South Bay		
Open Shellfishing Areas—Islip	37	8
Closed Shellfishing Areas—hard clams	28	7
Tissue—Great South Bay		
Open Shellfishing Areas—hard clams	40	5
Closed Shellfishing Areas	0	8
Water Column—Oyster Bay		
Open Shellfishing Areas	12	8
Closed Shellfishing Areas—oysters	37	8
Tissue—Oyster Bay		
Open Shellfishing Areas—oysters	12	8
Babylon Landfill—observation well	10	10
Storm Water Recharge—Massapequa observation well	8	12
Stony Brook STP—secondary chlorinated effluent	33	12
Stony Brook STP— groundwater observation well in recharge basin	0	9
Oyster Bay STP—secondary chlorinated effluent	36	11
Meadowbrook STP—secondary chlorinated effluent	25	12
Meadowbrook STP— groundwater observation well in recharge basin	30	10
Parkland III STP—tertiary chlorinated effluent	54	11
Parkland III STP— groundwater observation weill in recharge basin	30	10
Sunrise Garden Apartments STP— secondary chlorinated effluent	80	10
Sunrise Garden Apartments STP— groundwater observation well in leaching field	22	9
SCHD Experimental Septic System—influent	73	11
SCHD Experimental Septic System— effluent nonchlorinated	9	11

[a]Summarized from Vaughn and Landry (1977).

latter may have indicated the presence of small fissures which would have allowed rapid virus infiltration by channeling. Had the observation well been located further down-flow, rather than within the dome of recharge water, some estimate of virus removal during horizontal flow would have been possible. In the absence of this information, it has been assumed (Vaughn and Landry, 1977) that removal rates through the aquifer would be similar to those encountered during percolation through the recharge basin. Based upon this, Vaughn estimated that viral penetration in the aquifer would not be significant after the first 100 to 200 feet of travel. Confirmation of this hypothesis would require an additional study of the site, including the installation of an additional observation well, 150 feet down the hydraulic gradient from the discharge basin.

The quality of effluents discharged from the Parkland III plant did not resemble those of a properly operated tertiary treatment system.[1] In spite of this, encouraging removal rates were noted in observation well waters. Based upon these data, it is conceivable that the recharge of properly treated effluents would contribute no significant viral contamination to the aquifer. The premise could be confirmed with a study similar to that just completed.

Viruses in Shellfish. There has been increasing concern over the likelihood of human virus carriage by shellfish. While there is little epidemiological evidence for the transmission of enteric disease from the consumption of sewage contaminated shellfish (with the notable exception of infectious hepatitis), the potential for infection cannot be ignored. Fugate, Cliver and Gatch (1975) outlined a number of reasons why a potential health hazard exists: (1) shellfish raising waters are continually being subjected to high levels of pollution from sewage sources; (2) shellfish, being filter-feeders, are able to efficiently concentrate viruses from the surrounding waters; (3) a majority of viruses are concentrated in the digestive organ of the mollusk, which is consumed along with all the other edible parts of the animal; (4) shellfish are frequently consumed raw or with minimal cooking, which may not be sufficient to inactivate the viruses within them.

Oyster Bay was one case study considered by Vaughn and Landry (1977) for the Long Island 208. The "open" and "closed" areas studied in Oyster Bay were probably influenced by separate sources of pollutants. Results showed that 12.5 percent of all water and shellfish samples taken at the open site contained species of human viruses. Likely sources of viral contamination to this region include overland runoff, septic tank or cesspool leaching, and the nearby (one to two miles) discharge of treated sewage effluent from the Oyster Bay Sewage Treatment Plant. While the major viral source could not be determined within the confines of this study, it should be noted that previous work by one of the authors (Vaughn and Metcalf, 1975; Metcalf,Vaughn and Stiles, 1972), conducted in a similar bay system receiving discharge from secondary treatment plants, indicated the presence of human viruses in shellfish beds that were located seven to eight miles from the nearest outfall.

discussed above. Microbial contamination at this site was probably influenced slightly by the sewage outfall, the more likely sources being from overland runoff and septic tank seepage from the numberous older homes surrounding

[1]This problem has been known by the SCDEC and remedial action has been required.

the area. The results of sampling in this area yielded no virus isolates in the water column,[1] yet 37.5 percent of the shellfish tested did contain viruses.

Standards. There is as yet no established standard for viral pollution levels in aquatic systems. The reasons for this include the difficulty of sampling, the nonexistence of a single standard method for enumeration and identification, and the lack of concise epidemiological information concerning the waterborne transmission potentials of the virus groups involved. Despite uncertainty concerning an appropriate standard or threshold level, it appears prudent to minimize the occurrence of viruses in waters used for drinking, bathing or shellfish harvest.

4.1.2 Environmental Effects Directly Related to Bay and Groundwater Quality and Quantity

4.1.2.1 Quantity Effects

4.1.2.1.1 Aquifer Quantity. The availability of sufficient fresh water has long been of concern on Long Island. Long Island is surrounded by saltwater that has encroached upon the freshwater aquifer in some locales. Current information suggests that such saltwater intrusion is a localized phenomenon mainly related to local pumping practices and that the freshwater aquifer is not shrinking significantly (Miller and Sgambat, 1977a).

4.1.2.1.2 Water Level of Streams and Freshwater Wetlands.[2] Although the deep Magothy aquifer is not expected to change significantly, the shallow Glacial aquifer is expected to respond quickly to changes in freshwater recharge. Thus, sewering without local recharge can be expected to lower the water table. Significant lowering of the water table and of potentiometric surfaces has occurred over the last few decades in western and southwestern Nassau County. This appears to have resulted in decreased stream flow. The close dependence of streamflow on groundwater was underscored during the 1962–66 drought when record low flows were observed in fourteen of nineteen principal streams in Nassau and Suffolk Counties. The historical record of the combined annual average streamflow of the nineteen streams indicates a flow of 155 cubic feet per second (cfs) in 1966 as compared to the long-term average of 291 cfs.

Reductions in streamflow and declines in water table elevations can result in changes in the vegetation of certain freshwater wetlands. A total freshwater wetland area of over 1,500 acres has been inventoried within the nine major stream systems of southwestern Suffolk County and southern Nassau County. Water table ponds and lakes, such as Lake Ronkonkoma, Hempstead Lake and Southard's Pond (Carll's River) might experience some lowering of water levels. Marsh and meadow species of plants and trees dependent on a shallow water table environment may eventually occupy a greatly reduced area, closer to the remaining streams. A recent study on Long Island by Beitel (1976) suggests a possible sequence of vegetative succession similar to one that occurred at Artist Lake, Middle Island, New York during a lowering of the water table. In that case, nearshore lake habitats changed to marsh, and then to Red Maple swamp habitats. All waterbodies occurring in groundwater Zone VI, VII and VIII may be expected to be altered in the event of sewering with transport of effluent out of the zone. Streams in Zone VI are of particular concern with respect to secondary effects on Great South Bay salinity.

The tidal marshes on Long Island are marked by specific zones of vegetation. This zonation is a reflection of two basic parameters, (1) the degree to which the zones are inundated by the tides, and (2) the salinity gradients to which the vegetation is exposed. The lowest marsh zone, which is generally inundated with saline water twice a day, is dominated by cordgrass, *Spartina alterniflora. S. alterniflora* grows in almost mono-specific stands across extensive areas of low marsh in Long Island. At somewhat higher elevations, there is a high marsh or salt meadow zone, in which salt hay, *Spartina patens*, and spike grass, *Distichlis spicata*, predominate. Inundation is less frequent here, usually occurring only when tides exceed mean high level. Adams (1963), in a study of the North Carolina salt marshes, found that salt marsh species distribution was highly dependent upon elevation. In fact, Adams discovered that the vertical distribution of ten species of salt marsh plants spanned only one foot. Although there are individual differences between the species zonation in different geographical areas, species tend to be found within a well-defined elevation from the mean water level. Adams developed a mathematical relationship to determine the height of a species from mean sea level in a marsh as a function of the tidal range. This value was calculated for the three major species found in both Long Island and North Carolina (Table 4–19).

The sensitivity of marsh vegetation to the frequency and height of inundation has clear implications for any sort of development that affects the level of the water table. Although very little research exists on the effects of lowering the water table in marshes, much has been documented about the results of ditching upon tidal marshes (Bourn and Cottam, 1939, 1950; Cockran, 1938; Stearns, MacCreary and Dargh, 1939, 1940; Florschutz, 1959). Ditching, which effectively lowers the water table in a marsh, creates a higher, drier environment that the low and mud marsh species cannot tolerate. The delicate zonation patterns are altered, and the highly productive, low-marsh species give way to terrestrial and transaction zones species such as the salt marsh aster, *Aster subulata*, the high tides bush, *Iva Fructescens*, and the groundsel bush, *Baccharis halimifolia*, (Cottam *et al.*, 1938). These plants are not as productive as low marsh vegetation, nor do they contribute and recycle nutrients in the estuary as effectively as low marsh vegetation, particularly cordgrass, *S. alterniflora*. Since the entire range of tidal marsh vegetation is only approximately one foot, net water level changes greater than an inch or two are expected to have drastic effects upon the species present.

[1] A likely reason for this negative finding was the heavy turbidity of the water.

[2] First two paragraphs abstracted from Miller and Sgambat (1977a).

Table 4–19

ELEVATION LEVELS FOR THREE TIDAL MARSH SPECIES*

	Elevation Above Mean Sea Level (ft)	
	Great South Bay	South Shore Bays
Spartina alterniflora	0.35–1.01	1.01–2.02
Spartina patens	0.51–1.46	1.46–2.92
Distichlis spicata	0.49–1.41	1.41–2.82

**Data is based upon indices calculated by Adams (1963), with tidal range of 1–2 ft for Great South Bay and 2–4 ft for the South Shore Bays*

In addition to impacts on vegetation, changes in the water level will affect the invertebrates that inhabit the marshes. When the water table drops, the soil dries and conditions become more acidic, causing a decline of molluscs and crustaceans, which are dependent upon alkaline conditions for construction and maintenance of their shells and exoskeletons (Nealy, 1962). These invertebrates are the main diet of many birds and animals, particularly waterfowl. As food sources for birds decrease, so eventually will the populations of the fowl. Permanent pools on the surface of the marsh may also diminish and dry up as a result of the lowered water table. These pools often support widgeon grass, *Ruppia maritima*, and excellent food for many ducks. The loss of these pools is yet another loss for the bird populations, removing both food and shelter.

The impacts of lowering the water table upon the wetlands in Great South Bay and the western South Shore bays are expected to be great, due to the sensitivity of marsh vegetation to both the height and frequency of inundation, and the water requirements of invertebrate and vertebrate populations. Any development, including sewering, that is expected to alter either the water table level or the height and frequency of inundation of the marsh must be thoroughly examined.

The minimum environmentally acceptable criterion is the maintenance of South Shore streams and wetlands at current flows and inundation levels.[1] The effectiveness of technological measures such as shallow recharge and stream augmentation in preventing ecological change is open to considerable uncertainty.

4.1.2.2 Quality Effects

4.1.2.2.1 Fish. Fish populations are highly mobile within the bay system. They also exhibit a diversity of survival strategies. Some species use the wetland areas of bays as breeding and nursery grounds. A few breed in the bay itself. Many species use the bays only occasionally or as feeding grounds. The various fish which use different parts of the bay system are then affected by changes in those aspects of the system they use. In particular, some may be affected by reduction in wetland areas and salinity changes (Gosselink and Beck, 1977). Accumulation of metals and organics by fish is toxic to fish in some cases and may also affect the edibility of fish caught (EPA, 1977).

Fish occupy different habitats during various life stages. Larval stages tend to be very sensitive to physical factors such as dissolved oxygen, turbidity, temperature and salinity (Tables 4–20, 4–21). Significant changes in salinity levels are likely to change the community composition of fish larvae that use the bays and their marsh edges as nursery grounds.

4.1.2.2.2 Shellfish. Shellfish populations have a low mobility and are affected by various types of changes in their habitat. Salinity changes can alter shellfish distributions and productivity (Maurer *et al.*, 1974). Table 4–22 summarizes the data used for determining the salinity ranges of major species of interest in Eastern Great South Bay for which data exists. The observations from which the ranges were derived were made in Chesapeake Bay and the nearby estuarine communities that have prevailing conditions similar to those of Great South Bay Where available, data from the larval stage of the molluscs was included as long-term salinity changes more severely impact the shellfish at this stage. The margins of the salinity ranges can be assumed to be sub-optimal, with some population decrease due to salinity-related mortality, and reductions in sizes of adult individuals. At the extremes of the range, the following sorts of effects could be expected: reductions in size of mature adults, decreased survival of juveniles and increased mortality due to predation and disease.

Severe dissolved oxygen deficits in near bottom water can cause shellfish mortality (Table 4–20). The various shellfish are selective with respect to substrate habitats (Kinner *et al.*, 1975). Substitution of muddy and silty sediments for sandy sediments may decrease the suitability of bottom areas for certain desirable benthic species. An important factor contributing to productivity of the benthic zones is the diversity of benthic micro-habitats. One of the most important effects of siltation may be the reduction in the diversity of rocky, sandy and muddy habitats present in bays. This may then reduce benthic productivity.

It is also possible that the runoff-derived solids, which appear to be responsible for much of the pollution by organic matter, can clog feeding mechanisms. This effect, however, is clearly dependent on the character of solids being discharged.

Coliform contamination affects the harvestability of shellfish. State standards[2] require that areas be closed when the median of a "representative" sample series is greater than 70 MPN per 100 milliliters.

[1] "Current" flows are definable by statistical measures such as twenty year means and variances or by steady-state or statistical hydrologic models.

[2] New York State Chapter X, Title 6, Section 701.5, SA waters.

Table 4–20

SENSITIVITY OF SELECTED FISH AND SHELLFISH TO DISSOLVED OXYGEN BY LIFESTAGE[a][b]

Species	Lifestage[c]	Sensitivity to Dissolved Oxygen
Blueback herring *(Alosa aestivalis)*	A	Susceptible to low dissolved oxygen
Alewife *(Alosa pseudoharengus)*	A	Susceptible to low dissolved oxygen
Bay anchovy *(Anchoa mitchilli)*	A	Intolerant of low dissolved oxygen
Bunker menhaden *(Brevoortia tyrannus)*	J & A	Susceptible to low dissolved oxygen
Weakfish *(Cynosion regalis)*	S & E	Requires >5 ml/l
	L, J, E	Moderate tolerance to low dissolved oxygen
Mummichog *(Fundulus heteroclitus)*	J & A	High tolerance to low dissolved oxygen to 1 ml/l
Striped killifish *(Fundulus majalis)*	E	High O_2 consumption rate
	J & A	High tolerance to low dissolved oxygen to 1 ml/l
Brown bullhead *(Ictalurus nebulosus)*	E	Need high concentrations of dissolved oxygen
	A	Extremely tolerant
Atlantic silverside *(Menidia menidia)*	J & A	High susceptibility to low dissolved oxygen
Hard clam *(Mercenaria mercenaria)*	E	Normal development at .5 mg/l; 100% mortality at 0.2 mg/l
	L	Growth stops below 2–4 mg/l
White perch *(Morone americana)*	A	Moderate tolerance to dissolved oxygen
Striped bass *(Morone saxatilis)*	E	4–5 mg/l reduces hatching success
	L	4–5 mg/l and lower adverse larval effects
	A	3 mg/l at 16–19° C is probable minimal permissible level
Striped mullet *(Mugel cephalus)*	E	Below 5 ppm decreases survival
	L	Below 4–5 ppm decreases survival
	J & A	Moderate tolerance to low dissolved oxygen
Summer flounder *(Paralichthys dentatus)*	A	High tolerance to low dissolved oxygen
Bluefish *(Pomatomus saltatrix)*	J & A	Highly susceptible to low dissolved oxygen
Winter flounder *(Pseudopleuronectes americanus)*	A	High tolerance to low dissolved oxygen

[a] *ERCO*
[b] *Summarized from Daiber and Thornton, 1976.*
[c] *A = Adult*
J = Juvenile
L = Larval
E = Eggs
S = Spawning Adult

Table 4–21

SENSITIVITY OF SELECTED FISH AND SHELLFISH TO TURBIDITY BY LIFESTATE[a][b]

Species	Lifestage[c]	Sensitivity to Turbidity
Blueback herring *(Alosa aestivalis)*	E	Can take up to 1000 mg/l without apparent effect on hatching
Alewife *(Alosa pseudoharengus)*	E	500 mg/l affected hatching success ($p < .025$)
Anchovy *(Anchoa mitchilli)*	A	Sensitive to turbidity
Bunker menhaden *(Brevoortia tyrannus)*	J	No effect on survival at 1000 mg/l
American oyster *(Crassostrea virginica)*	E	Significant effect on survival and growth at 125 mg/l
	L	Severe mortality at 100 mg/l
	A	Reduction in pumping rates at 100 mg/l
Weakfish *(Cynosion regalis)*	A	Sensitive
Mummichog (Fundulus heteroclitus)	A	Tolerant to high concentrations C_{10} = 23,000 mg/l
Striped killifish *(Fundulus majalis)*	A	High tolerance C_{10} = 23,000
Atlantic silverside *(Menidia menidia)*	A	Highly sensitive LC_{10} = 580 mg/l
White perch *(Morone americana)*	E	1000 mg/l affects hatching success ($p < .005$)
	J	500 to 1000 mg/l has adverse effect on survival ($p < .05$)
	A	Sensitive
Striped bass *(Morone saxitilis)*	E	1000 mg/l affected hatching success; LD_{50} is 3411 ppm
	L	500 to 1000 mg/l affected survival ($p < .005$)
	A	Sensitive
Yellow perch *(Perca flavescens)*	E	Can take up to 1000 mg/l with no effect
	L	500 to 1000 mg/l affected survival adversely ($p < .005$)
Bluefish *(Pomatomus saltatrix)*	J	Sensitive

[a] *ERCO*
[b] *Summarized from Daiber and Thornton, 1976.*
[c] *A = Adult*
J = Juvenile
L = Larval
E = Eggs
S = Spawning Adult

4.1.2.3 **Contact Recreation.** The suitability of waters for contact recreation is evaluated in this report by using the 30-day median 2,400 MPN/100 milliliters total coliform standard.[1]

[1] New York State Chapter X, Title 6, Section 701.5, SB waters.

Table 4–22

SALINITY RANGES OBSERVED FOR VARIOUS MOLLUSCS

Common Name	Scientific Name	Maurer[1]	Others[2]	Thornton[3]
Soft Clam	Mya arenaria	5–20	5–25	
Hard Clam	Mercenaria mercenaria	15–30	10–35	Juvenile 20–32,5
Surf Clam	Spisula solidissima	27–35	10–35	
Razor Clam	Ensis directus	13–28	7–32	
Blue Mussel	Mytilus edulis	20–35	15–35	
Oyster	Crassostrea virginica	Optimum 14–28[4] 5–38		Adult 7–30 Juvenile 15–30
Scallop	Pectin	20–35	17–35	

[1] *Maurer and Watling, "The Distribution and Ecology of Common Marine and Estuarine Pelecypods in the Delaware Bay Area," The Nautilus, (April 1974), 88 (2): pp. 39–45.*
[2] *Reported by Maurer.*
[3] *Thornton, Delaware Coastal Atlas (1976).*
[4] *Maurer and Watling, Studies on the Oyster Community in Delaware, College of Marine Studies, University of Delaware, Newark, Delware (1973).*

4.1.2.2.4 **Aesthetics.** The effects of the 208 options on aesthetics are evaluated mainly in terms of the aesthetics of three zones: shorelines, marine waters and open space. Of these three, generally the 208 Plan will have little effect on aesthetic quality of shorelines. Rather, shoreline improvements can be expected to result from Coastal Zone Management (CZM) programs. Reductions in pollutant loadings to bays will improve the public perception of the quality of those water bodies. Lowering of the water table as a result of sewering with marine surface discharge will reduce wetland acreage, and the associated aesthetic value that relates to the wetlands' role as a habitat for diverse bird, fish and insect communities, and as nurseries for desirable aquatic species. Reduction of wetland acreage may also degrade existing views and vistas. Table 4–23 summarizes the relationships between recreational uses, aesthetics and water quality. Open-space-related aesthetic benefits can derive from watershed management approaches to Zones III and IV and stream buffer zone measures for Zones VI and VII.

4.1.2.2.5 **Bay Nutrient Cycling.** The quantity and composition of nutrient loads are of primary importance in assessing the environmental effects likely to result from wastewater management alternatives in Long Island bays. Nitrogen and phosphorus concentrations in particular are known to regulate the growth of phytoplankton in coastal waters.

In many waters subjected to waste loadings, oxygen-demanding substances depress dissolved oxygen concentrations below saturation. This is generally not a problem in Long Island bay waters where phytoplankton respiration and photosynthesis regulate dissolved oxygen concentrations.

Table 4–23

OVERVIEW OF RELATIONSHIP OF WATER QUALITY AND AESTHETIC QUALITY

Aesthetic Variables	Constituents Causing Aesthetic Degradation	Activity Affected by Aesthetic Degradation
Color	Metals, organics	Contact, noncontact recreation
Turbidity, nuisance algae	Suspended sediment, nutrients	Contact, noncontact recreation
Community diversity	Nutrients, dissolved oxygen	Noncontact recreation

The bay ecosystems also depend upon phytoplankton as primary producers. Thus, changes in nitrogen and phosphorus concentrations due to waste disposal can have a profound influence on bay ecosystems. This consideration is especially important in the shallow Long Island bays where relatively small quantities of effluent can cause substantial increases in ambient concentrations of nutrients.

There are two major types of effects—increases in gross levels and changes in atomic ratios among nutrients. Increases in nitrogen concentrations induce increases in phytoplankton productivity and algal blooms. This causes an increased oxygen consumption. Changes in the molar ratio of nitrogen to phosphorus are more critical than the absolute concentrations in determining the dominant species in phytoplankton communities.

Based upon an evaluation of available data from Long Island bays, Tetra Tech has indicated that 0.4 milligrams per liter total nitrogen is the level above which dissolved oxygen deficits violating the state standard of five milligrams per liter can be expected to occur. The actual maximum nitrogen level may vary from bay to bay and should be evaluated specifically for each bay

Nitrogen (N), phosphate (P) and organic carbon (C) levels are significant indicators of water quality Their ratio is a reliable indicator of the quality and quantity of flora and fauna supportable by the water. Optimally, the molar P:N:C ratio should be near 1:16:106. Generally C is very much higher than 106; and N is a limiting factor, with steady state N/P ratios in the neighborhood of ten to fifteen for most marine waters. N/P ratios less than ten occur at times in healthy Long Island bays. Persistence of N/P ratios below ten, apt to result from the disposal of some wastes, are generally a sign of an unhealthy ecosystem with a tendency to support phytoplankton populations of a limited number of species. Often the resulting species are not suitable food sources for prey-size selected filter-feeders. These alterations in phytoplankton communities tend to have subsequent effects on the marine food web, such as decreased fish and shellfish production. Interestingly enough, there seems to be no evidence indicating that N/P

ratios higher than sixteen have any adverse effects on an ecosystem (McCarthy, 1977). While N/P steady state ratios control the diversity of species and health of an ecosystem, absolute concentrations of these elements determine the total productivity of that ecosystem. Thus, the N/P ratio should be maintained at a proper level to ensure species diversity, while the absolute concentrations of N and P should also be maintained at some level (possible 0.4 milligrams Nitrogen per liter) such that phytoplankton production does not cause severe algal blooms and D.O. deficits.

4.1.3 Other Environmental Concerns. Management of ground and surface water quality is best done in concert with several environmental concerns relating to the ecosystem's natural processes, which protect water quality. These concerns, relating to the safeguarding of certain naturally significant areas, are an important aspect of meeting water quality objectives.

4.1.3.1 Open-Space Watershed Management. Much of Long Island Island's precipitation is recharged. The original vegetation-based ecosystems, such as pine and scrub oak barrens, acted as recharge agents. That is, they (1) held water and nutrients in the vegetation and detritus for slow release to the aquifer, (2) contributed a chemical and bacterial setting which gave aquifer waters a particular chemistry, and (3) provided pervious zones that minimized runoff. Thus preservation of or establishment of similar areas relate to management of groundwater quality and of runoff. On Long Island, there are specific areas that are important to the groundwater and others that are important to the surface water environment. There are a range of approaches that can work. Three of these are as follows:

1a. *Acquisition of areas and preservation as open spaces.* Areas such as wetlands, safe zones surrounding pumped areas and selected recharge areas are best protected in such a fashion.

1b. *Acquisition of areas and regulation of use.* This differs from (1a) in that acquired lands are maintained in a multiple-use status. Regions such as watersheds, regional recharge zones and highly transmissive aquifer zones can be partially protected by institution of such measures for selected parcels of land.

2. *Protective regulation of land uses and activities.* Many of the recharge areas, watershed areas and intensively pumped areas are currently developed to a medium or high density. Control of further development of such areas can protect water resources.

4.1.3.2 Estuarine and Bay Wetland Ecosystems. Wetlands border Long Island bays and estuaries. They play an important role in nutrient cycles, organic matter cycles and marine population life cycles. In addition, wetlands act as buffers, filtering the runoff and siltation inputs to bays. Thus, maintenance of these areas is an important aspect of marine water quality management.

Vegetated tidal wetlands[1] cover some 23,000 acres of Nassau and Suffolk Counties. The largest area of wetlands is found on the South Shore, with the western South Shore bays containing some 8,800 acres within South Oyster Bay, East Bay, Middle Bay and Hempstead Bay. Most of this wetland acreage is on small marsh-islands that do not afford access from the mainland except by boat. To the east, Great South Bay is the next largest wetland bay, containing more than 5,500 acres along its shores and rivers and on Fire Island. In terms of total acreage, Peconic and Flanders Bays are ranked next, containing some 1,400 acres. Most of these habitats are small tracts along creeks that feed into the bays, but there are several tracts encompassing more than 100 acres. Oyster Bay is the site of a National Wildlife Refuge covering more than 3,000 acres, about one-tenth of which are vegetated tidal wetlands. Other North Shore bays have scattered wetland tracts along creeks but much of the bay shoreline has been filled and bulkheaded. The Huntington-Northport complex contains some 300 acres, much of it in Caumsett State Park and Lloyd Harbor. Around Port Jefferson Harbor there are approximately 150 acres of wetlands remaining, while Manhasset Bay and Hempstead Harbor together contain some 170 acres.[2]

Between 1964 and 1972, seventeen percent of the wetlands on Long Island were lost due to dredging and filling activities (O'Connor and Terry, 1972). During a 1973–1977 moratorium period, considerably less marsh was lost. The Tidal Wetlands Act (Article 25 of the Environmental Conservation Law of New York) calls for the preservation and protection of tidal wetlands, preventing their despoilation and destruction, giving due consideration to the reasonable economic and social development of the state" (NYSDEC Tidal Wetlands Land Use Regulations, 6 NYCRR, Part 661, 1977). Most activities, including all types of construction and dredging, are regulated by the State, requiring a permit. However, for many of the activities associated with residential, commercial and industrial development, as well as sewering, treatment plant expansion, and runoff control, permits continue to be issued, although a significant time delay may be involved. The State of New York (Haje, 1976) calculated that only twenty acres of wetland were legally filled from 1973 to 1976. However, since permits continue to be obtainable, enforcement philosophies may not adequately control all types of construction activities which, as discussed below, impact upon wetlands. Although no ecological methodology presently exists to analyze minimum wetland requirements for a bay, the current acreage appears to be critically low for most bays and is probably well below the minimum for a functioning marsh system in Manhasset Bay and Hempstead Harbor. For that reason, special protection of wetlands in those bays with sufficient wetlands, namely Great South Bay, South Shore bays, Peconic Bay and Oyster Bay, are essential parts of an areawide water quality plan. The level of protection afforded by permit activities should be increased in those areas. Water pollution control facilities should be sited to avoid wetlands, wherever feasible.

[1] Defined as intertidal marsh (IM), high marsh or salt meadow (HM), coastal fresh marsh (FM), and formerly connected tidal (FC) vegetated wetlands.

[2] With the exception of the numbers for Peconic/Flanders Bay, numbers presented in this section were provided as preliminary calculations based on 1976 data by the NYSDEC.

4.2 Impacts of Areawide Alternatives

All control measures proposed for the Water Quality Management Plan that can be discussed on a bi-county basis are included in this section. This includes measures specifically designed to be Island-wide in scope (Section 3.5.1) and aspects on zone-specific measure that are common to all zones (general effects associated with parts of Section 3.5.2).

Table 4—24 is a guide to the organization of this section.

Table 4—24

CORRESPONDENCE OF WQMP OPTIONS WITH IMPACTS DISCUSSIONS

WQMP Option		Impacts Discussion	
Section:	3.5.1	Section:	4.2.1
	3.5.1.1		4.2.2
	3.5.1.2		4.2.3
	3.5.1.3		4.2.4
	3.5.1.4		4.2.5
	3.5.1.5		4.2.6
	3.5.1.6		4.2.14
	3.5.1.7		4.2.7
	3.5.1.8		4.2.15
	3.5.1.9		4.2.8
	3.5.1.10		4.2.9
	3.5.1.11		4.2.10
	3.5.1.12		4.2.15
	3.5.1.13		4.2.11
	3.5.1.14		4.2.12
Sewering Options			4.2.13
Treatment Plants			4.2.15
Outfalls			4.2.16

4.2.1 Effects Associated with Miscellaneous Individual Source Control Measures. The non-point source pollutants that the controls identified in Section 3.5.1 seek to abate, constitute a significant portion of the total load to water bodies. In particular, non-point sources contribute up to 99 percent of the coliform load and about 40 percent of the nitrogen load to the bays that were studied. They contribute to nitrogen, metal and organics groundwater contamination. Despite the significance of these measures with respect to abating health risks, there are major uncertainties associated with a few of them. These uncertainties are of two sorts: questions concerning effectiveness and questions of implementability. If these measures are proven to be effective and if the implementation is commensurate with the need, the net result of various recommended controls will definitely be environmentally beneficial. The measures are discussed individually in Sections 4.2.2 to 4.2.12.

4.2.1.1 Short-Term Primary Impacts. Many of the control options for non-point sources will involve a considerable delay before regulatory programs can be drafted and accepted and before enforcement programs can be organized. Thus, the major short-term impacts will be due to continued pollutant loads until measures are implemented. The short-term impacts can be minimized by giving priority to implementing those measures which control those sources imposing the greatest health and environmental effects.

4.2.1.2 Long-Term Primary Impacts

Metals. None of the proposed controls cause additional metal contamination. Controls of diffusion wells, landfills and discharge and storage of industrial materials and wastes will reduce levels of metals discharged to the environment. Generally, metals in marine, fresh and groundwater are rapidly adsorbed onto sediments. This is suggested by low levels of metals, well below standards, in groundwater sampled in this program. It is also indicated by previous research (*NAS*, 1976). Major metal pollutant problems have tended to arise from accumulation of metals in the food chain where there is a high metal level concentrated in sediment or water column. Such a situation may occur when sediment metal levels are high and members of the food chain are detritus feeders. Sediment metal levels should be monitored since metals data is lacking for the Long Island bays.

Organics. None of the proposed controls causes additional organic chemical contamination. Controls of product storage tanks and pipelines, landfills, groundwater development, discharge and storage of industrial materials and wastes, diffusion wells, fertilizer use and pesticides will all significantly reduce organic chemical discharges. It is difficult to determine which controls would be most effective in reducing organic levels, since all the various sources have not been inventoried or monitored.

However, monitoring of the groundwater has shown organic chemical contamination to be a significant health problem (Section 4.1 1.2). Thus, employment of all available controls would be the most prudent strategy Also, as noted, there is a major data gap that needs to be eliminated, namely the lack of data on all sources of organic chemical pollution.

Nitrates. None of the proposed controls cause additional nitrates contamination. Controls of leakage from sewers, effluent recharge, domestic on-site systems, animal wastes and fertilizer use will all help abate nitrate loads. Modeling work done for this program suggests that animal wastes controls and fertilizer use controls will both help abate nitrate loads. The modeling work also suggests that on-site systems and fertilizers are the major sources. However, the model used did not account for non-conservative transport of nitrates in the groundwater below the root zone. Also, comparison of modeling results showed that some areas display particularly high levels relative to model loading numbers. Variation in monitoring well data may be attributable to local groundwater, hydrology and surficial geology. Thus, although controls of on-site systems performance and of fertilizer use are of most importance, the effectiveness of controls will vary geograph-

ically. In some locales, a wide range of controls need to be implemented to meet the ten milligrams per liter standard (I and II) or to obtain lower levels (III and IV). Geographic zones can only be specified in a general way at this time. They have been set forth in Chapter Three (see Table 3–3).

Coliforms and Viruses. None of the proposed controls cause additional coliform contamination. Since pathogen transport through soil and aquifer usually is very limited, none of the controls is likely to affect groundwater quality. Control of animal waste could possibly reduce coliform levels in bays. Although it is difficult to link coliform levels in bays to sources, evidence put forth during this project suggests that dog and duck wastes are significant animal waste contributors to bay coliform levels. However, the best management control measures put forth in 3.4 are unlikely to reduce dog and semi-wild dog and semi-wild duck waste contributions.

Water Quality, Water Level—Streams and Ponds. Control of groundwater pumping patterns will help maintain the water level of streams and ponds. Work done for this study has shown that, regionally, groundwater supply is not a problem, but that water table levels are a problem where recharge is at reduced levels. Locally, both water table and water supply can be depleted in areas that are overpumped. Thus, such controls are highly beneficial.

Fish, Shellfish. The controls being considered in this section mainly affect fish and shellfish in terms of metals, organic chemicals, oils and coliform bacteria. Metals, organics and coliforms have been considered previously in this section. The major impacts of oils on fish and shellfish are likely to be caused by spills and accidental discharges. Control measures are not likely to be of great value in reducing impacts of spills. However, they may slightly reduce the probability of spill occurrence. As of 1977, no major spills have occurred in Long Island bays. However, study of the recent Huntington spill may prove instructive.

Aesthetics, Wetlands, Unique Habitats, Open Space. Land use controls (3.5.1.13) will have a significant benefit in preserving habitats and open space. All of the areawide measures applied to surface water impact zones (IV, V, VI, VII and VIII) will have a positive aesthetic impact due to water quality improvements (see Section 4.1.2.2.4).

4.2.1.3 Secondary Impacts. Most of the proposed controls involve regulatory control of the use of products, the use of land or disposal. Some proposed regulations will have an impact on consumer practices (for example, pet purchases may be affected). Others will have impacts on industry and agriculture (for example, fertilizer use). All regulations will affect staffing requirements for regulatory agencies. Generally, the trade-offs between positive environmental benefits and negative secondary impacts cannot be analytically resolved. There is no way to optimize between two measures which cannot be expressed in common units. The trade-off must then be resolved politically. Below a list is presented of the key trade-offs related to non-point controls:

1. Control of effectiveness of on-site systems *vs.* cost to homeowners for maintenance.
2. Agricultural fertilizer controls *vs.* requirement for trained personnel to properly carry out scientific application.
3. Residential fertilizer controls *vs.* lawn appearance.
4. Efficient organic controls *vs.* cost to industry and to homeowners.
5. Animal waste controls *vs.* inconvenience to owners.

4.2.1.4 Adverse Environmental Impacts. None.

4.2.1.5 Irreversible and Irretrievable Commitment of Resources. No substantial commitments since most of the measures are legal/institutional in nature.

4.2.2 Provide for Routine Maintenance of On-Site Septic Tank and Leaching Pool Systems. The routine maintenance of septic systems will help them to operate with pollutant removal at or near design efficiency Such a measure will be environmentally beneficial with respect to groundwater and surface water quality and public health. One result of such a control will be the generation of additional loads of scavenger wastes. However, the additional scavenger wastes would have to be handled at existing or future treatment plants. Any increases in treatment plant design sizes due to scavenger waste flows would induce effects such as those discussed in 4.12.15. Since septic tank maintenance procedures may lessen the need for sewering, may somewhat reduce groundwater nitrogen and would reduce surface water hazards resulting from system failures, its net effect would be environmentally beneficial.

4.2.3 Prohibit the Use of Certain Chemical Cleaners in On-Lot Systems. This measure is intended to control one of the sources of organic chemical contaminants. Due to the lack of a study on relationships of organics sources to groundwater levels, it is difficult to evaluate the impact of the proposed control. From a conservative standpoint, the measure is environmentally beneficial since it will have a positive effect on groundwater organic chemical levels.

From an areawide planning standpoint, the benefits of this measure are not clear at the present. A comprehensive plan for organic chemicals control is strongly recommended as an extension of the 208 planning process. This is an interim measure that should be followed by development of an overall organics control plan.

4.2.4 Expand Regulations and Enforcement Regarding the Disposal of Industrial Wastes. The strict enforcement of pretreatment regulations is highly beneficial from the standpoint of operation of waste water treatment plants. Expansion of regulations to cover organic chemicals discharges to the ground will probably result in decreased groundwater organics levels. However, the lack of a study of relationships of organic chemicals sources to groundwater levels leaves considerable uncertainty concerning results of controls of those such discharges. An effect of the proposed controls will be increased quantities of hazardous wastes to be disposed of. On an areawide

basis, the proposed measures would have environmental benefits.

4.2.5 Regulate the Storage and Transportation of Chemical Products. Measures to minimize spills and other accidental mishaps of hazardous materials are clearly environmentally beneficial.

4.2.6 Reduce the Use of Fertilizers. Porter *et al.* (1977) showed that fertilizers constitute a major source of nitrates to groundwater on Long Island. Two major sectors to which restrictions can be applied are agricultural use and residential (lawn) use. Figure 4–1 summarizes a Long Island study which shows that scientific fertilizer application in the agricultural sector results in lowered groundwater nitrates. Similar results may be expected for lawn fertilizers, which are largely applied in excess and leach rapidly below the root zone. Other studies have shown that sewage sludge compost, a slow release nitrogen source, results in low nitrate leaching. It is recommended that use of fertilizer be regulated, that low maintenance lawns be planted, and that education relative to scientific fertilizer application be carefully carried out. Such fertilizer controls are environmentally beneficial.

4.2.7 Reduce Animal Wastes. The characteristics of dog, fowl and human wastes are presented in Tables 4–25 and 4–26. The dog population of Long Island is indicated in Table 4–27. These data demonstrate that animal wastes are a significant contributor of both nitrogen and coliform. These

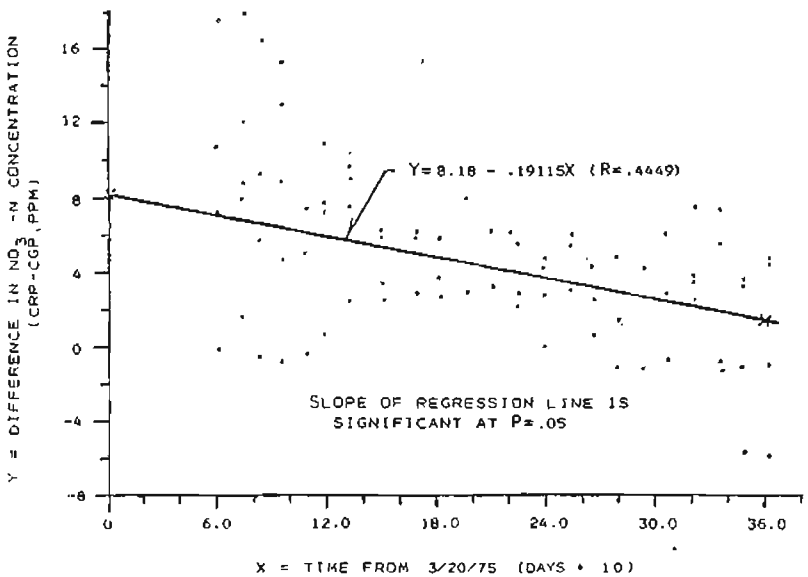


FIGURE 4–1 *Summary of Experimental Data Showing Reductions in Groundwater Nitrates Obtained by Scientific Fertilizer Application*

Source: Baier, J. and K. Rykbost, 1976.

Table 4–25

ANALYSIS OF DOG DROPPINGS: CHICAGO[a]

Constituent	Three Sample Collections		
	1	2	3
Water Soluble, mg/100 ml	16.5	20.2	178.3
Volatile Water Soluble, mg/100 ml	10.3	15.9	145.8
BOD_5, mg/g	78	377.3	300
COD, mg/g	200.7	552	720
Coliform, MPN/g	16,090	16,090	1,400,000

[a]*Source: American Public Works Association (1969).*

contaminants end up in runoff which enters bays and recharge basins. Thus, animal waste controls which reduce these loads would be clearly beneficial. Effective controls may lessen the need for sewering (with respect to groundwater nitrogen) and may reduce coliform levels in bays sufficiently to permit the reopening of shellfish beds.

4.2.8 Reduce Reliance on Landfills. The proposed measures are clearly of environmental benefit. Organic sampling (1978) demonstrated the hazards to groundwater quality associated with landfills.

4.2.9 Provide for the Treatment of Hazardous Wastes. The collection and treatment of hazardous wastes, discussed in 3.5.1.10 and in "K: Residual Waste Control Needs" (NSRPB, 1978) has clear environmental benefits. However, the treatment processes result in hazardous residues and sludges still requiring ultimate disposal. The WQMP recommends (a) removing wastes from the bi-county area or, if that is not feasible, (b) building a bi-county treatment facility, or two county ones. Alternative (a) simply transfers the disposal problem to other areas and does not provide for ultimate disposal of wastes. It is an unacceptable strategy from a regional standpoint, although may appear to be adequate from a bi-county perspective. Alternative (b) is the more acceptable option, it being understood that special precautions must still be taken when landfilling treatment residues and sludges. Chemical landfilling may result in accidental discharges to groundwater, with the resulting contamination of the Magothy aquifer, if the landfill is in the recharge zone, or of the bays.

4.2.10 Provide Alternatives to Ocean Disposal of Municipal Treatment Plant Sludge. The alternatives presented in Section 3.5.1 11 as being equally acceptable are not equal in terms of environmental impact. Incineration is the least desirable because of associated air emissions and high energy expenditures. Co-incineration generates the same emissions but provides some energy savings. Pyrolysis produces significantly less harmful air emissions and provides a high energy return. Landfilling and land application probably are not feasible from land use and pathogen contamination standpoints. Thermal

Table 4—26

BACTERIAL AND NUTRIENT CHARACTERISTICS OF ANIMAL WASTES

Animal	Estimated Per Capita Daily Contribution of Indicator Microorganisms[1]			Average Composition of Daily Waste Lbs per 1000 Lbs Live Weight[2]		
	Fecal Coliform (10^6)	Fecal Strep. (10^6)	Ratio FC/FS	Total Nitrogen as N	Total Phosphorus	Total Potassium
Man	2,000	450	4.4	0.20	0.024	0.064
Ducks	11,000	18,000	0.6	1.42	0.62	0.9
Chickens	240	620	0.4	0.86	0.40	0.35

[1]*Source: Esser, et al., (1977).*

[2]*Source: USDA, et al., (1975).*

drying produces a usable product but requires a significant energy expenditure. Composting provides a stable product with few negative effects. Thus, any or all of three alternatives—pyrolysis, composting and thermal drying—would be environmentally acceptable.

4.2.11 Minimize Population Density. Land use controls would have several important environmental benefits including: (a) avoidance of high density conditions that appear to be associated with significant degradation of groundwater quality, (b) provision for substantial dilution of on- lot residual discharges, (c) preservation of vegetative cover and habitat areas, which provide the setting for natural cycling of micronutrients, (d) minimization of human impacts on the hydrologic cycle.

4.2.12 Promote Water Conservation. Water conservation can decrease sewage flows requiring treatment. Conservation practices could assume particular importance under sewering approaches. Sewering, when coupled with marine surface discharges makes most domestic water uses consumptive. Thus water conservation is environmentally beneficial.

4.2.13 Effects Associated with Sewering Activities. Comprehensive (1 D.U.) and less extensive Island-wide (2 D.U./gross acre and 3 D.U./gross acre) sewering are options for each of the 208 water management zones of Long Island. As a result of these options, substantial construction of both sewer lines and treatment plants will be required. Such activities will tend to (1) safeguard groundwater from nitrate, organic chemicals, and pathogen contamination (with secondary improvements in surface waters); (2) cause a lower water table if there is no recharge (3) increase loads of treated effluent to some combination of bays, ocean, and recharge; and (4) increase the sludge load Effects (2), (3), and (4) are important intermedia impacts that must be considered. Sewering is often judged environmentally beneficial without sufficient consideration of intermedia tradeoffs of groundwater nitrogen and surface water pathogens against surface water quality, air quality, and sludge loads, many of which involve significant health impacts. The major tradeoffs can be summarized as follows:

(a) *Sewering with Surface Outfall.* Limits domestic contributions to groundwater nitrogen, limits public health risks to surface waters resulting from septic tank failures; increases marine/bay nitrogen levels; increases marine/bay coliform levels; decreases streamflows and wetland inundation; involves high costs with high cost uncertainties.

(b) *Sewering with Surface Outfall and Stream Augmentation.* Same as above, although streamflow decreases may (possibly) be mitigated.

(c) *Sewering with Recharge.* Limits domestic contributions to groundwater nitrogen; limits public health risks to surface waters resulting from septic tank failures; may cause groundwater contamination depending on reliability of recharge/treatment technology; may possibly mitigate streamflow and wetland inundation impacts. High cost uncertainties, (engineering uncertainties concerning recharge).

(d) *Sewering only in Selected Areas (high water table, 5 D.U./gross acre densities) with Nonstructural Measures.* limits (with uncertainty) non-point contributions to groundwater nitrogen; limits public health risks to surface waters resulting from septic tank failures; maintains low marine/bay nitrogen levels (with nitrate contributions from groundwater underflow); protects streamflows and wetland inundation levels.

Although, in some areas there may be no presently available alternative for the reduction of groundwater nitrogen, on an areawide basis, sewering should only be used as one of a set of measures to deal with the range of environmental problems.

4.2.13.1 Short-Term Primary Impacts. *Metals, organic chemicals, nitrates, coliforms, virus, water quality, water level, fish, shellfish, contact recreation.* Dewatering activities in sewer excavations may generate a contaminated waste. This pump water must be carefully monitored and disposed of

Aesthetics. Construction of sewer lines, interceptors, and associated

Table 4–27

DOGS ENUMERATED AND LICENSED: NASSAU AND SUFFOLK TOWNS, CITIES AND SELECTED VILLAGES IN 1976[a]

The following municipalities were enumerated and licensed in 1976.

Town	Enumerated	Licensed
Hempstead	69,995	50,682
North Hempstead	21,957	22,573
Oyster Bay	30,525	29,048
Cities		
Glen Cove	2,418	2,064
Long Beach	1,953	1,874
Town		
Babylon	27,515	21,564
Brookhaven	35,324	26,372
East Hampton	1,683	2,302
Huntington	18,175	24,687
Islip	39,811	23,206
Riverhead	2,674	2,824
Shelter Island	378	1,597
Smithtown	12,633	11,894
Southold	2,747	3,066
Southampton	6,500	4,283
Total Enumerations = 287,886		

Village	Enumerated	Licensed
Atlantic Beach	482	222
Bayville	613	613
Bellerose	128	130
Cedarhurst	553	535
Centre Island	113	117
Floral Park	1,629	1,522
Laurel Hollow	320	325
Freeport	3,916	3,336
Garden City	2,002	2,332
Hempstead	3,250	2,593
Hewlett Bay Park	84	79
Hewlett Neck	71	64
Lynbrook	2,258	1,926
Malverne	1,021	1,005
Massapequa Park	3,075	2,727
Mill Neck	291	269
Old Brookville	336	300
Oyster Bay Cove	436	439
Rockville Centre	2,124	2,238
Sea Cliff	896	807
Total Licensed = 249,615		

Village	Enumerated (1974)	Licensed (1975)
East Rockaway	1,535	1,153
Farmingdale	640	621
Hewlett Harbor	208	197
Island Park	526	524
Total Enumerations = 7,973		

Village	Enumerated (1974)	Licensed (1975)
Lawrence	798	693
South Floral Park	131	140
Stewart Manor	267	309
Valley Stream	3,763	3,598
Woodsburgh	105	88
Total Licensed = 7,323		

[a] *Source: Esser et al., (1977).*

structures will cause some aesthetic degradation. Such problems can be minimized, if desired, by planning of construction schedules and of construction practices. Short-term aesthetic problems are probably outweighed by other long-term environmental benefits.

Wetlands. Expansion or upgrading of present treatment plants located around the Long Island bays may result in temporary disruption to the flora and fauna of the surrounding wetlands and to fish and shellfish populations. As a site is developed and prepared, the clearing of vegetation

increases land erosion and alters runoff circulation patterns. The hydrocarbons and other chemicals used in construction tend to spill on the ground and are washed into the soil or into the surrounding bays. Although many of the treatment plants are already located on sites that allow expansion, some will need more land for construction and thus may impinge upon neighboring wetlands.

Comprehensive sewering requires pipeline construction, and in some areas this will involve laying pipes through wetlands. Such an activity involves dredging, which, at least temporarily alters the vegetation and drainage patterns of the area. If dredged material is subsequently replaced and the area is revegetated, these impacts will be minimized.

Although more than 50 percent of Nassau County is presently sewered, including some of the North and much of the South Shore area, less than ten percent of Suffolk County currently contains sewers. Most of the areas surrounding Great South Bay remains unsewered, and if plans for sewering are implemented in this area, great care must be taken to preserve the wetlands and to locate treatment plants away from valuable areas such as the Connetquot River and Bellport Bay. Any construction of pipelines that run through wetlands must be carefully supervised to ensure minimal damage and proper restoration.

Unique habitats. Effects due to sewer and sewage treatment plant construction can be negligible if all structures are built outside habitat areas.

Open spaces. No significant effect.

4.2.13.2 Long-Term Primary Impacts

Metals, organic chemicals. There is a positive effect associated with hookup of industries to sewers, although pretreatment wastes will now have to be disposed of.

Nitrates. In most sewered areas, the level of nitrate in the Magothy aquifer is expected to be significantly less than it would have been had those areas not been sewered. This decrease is most likely to be noted in Zones I, II and III. However, it must be noted that the relationship between sewering, fertilizers, aquifer hydrology and nitrogen has not been firmly established. This decrease in groundwater nitrates is a positive effect, both from a groundwater supply standpoint and with respect to underflow to bays.

Coliform and viruses. Coliform and viruses do not appear to travel long distances in the groundwater (Vaughn and Landry, 1977). Thus, the benefits of sewering in this respect may be limited to (1) reductions of pathogen levels in the vicinity of septic systems and (2) reductions in individual discharges of untreated wastes to bays and streams, including discharges due to system failures.

Water quantity and water table. The comprehensive sewering option tends to reduce the quantity of water being recharged unless sewage treatment plant effluent is recharged. Work done during the 208 Study suggests that the effect on the overall water supply reservoir will be insignificant, but that streams and wetlands will have lowered water levels and the salinity of Great South Bay may be altered. This will be a significant negative environmental impact.

Fish, shellfish, contact recreation, aesthetics. See Table 4–28.

Wetlands. Failure to reclaim areas used in construction of treatment plants and pipelines will result in permanent loss of valuable wetlands. Increased erosion and runoff, and a loss of vegetation and resulting increase in detritus, may upset the ecological balance of the wetlands, reducing their value as nutrient sinks and productive habitats for fish, shellfish and wildlife.

Sewering in areas adjacent to wetlands may prove beneficial in terms

Table 4–28

MATRIX DISPLAY OF LONG TERM PRIMARY EFFECTS OF SEWERING

	Sectors Affected						
Changes Due to Sewering	Freshwater Fish Diversity	Marine Fish Community Diversity	Shellfish Community Diversity	Contact Recreation	Shoreline Aesthetics	Water Quality Aesthetics	Open Space Aesthetics
Water Table	NE	O	O	O	O	NE*	NE*
Stream Flow	NE	O	O	O	O	NE*	O
Great South Bay Salinity	O	NE	NE*	O	O	NE	O
Groundwater Nutrients	PE	PE	PE	O	O	PE*	O

PE = Significant Positive Effect
NE = Significant Negative Effect
O = No Effect
** = Key Effect*

of limiting the sewage that flows into these areas and thence into the bay. The soil in such locations is generally unsuitable for on-site disposal systems because of its vulnerability to high storm tides and its saturation. By installing sewers, one may cause some reduction in the amount of nutrients and bacteria which flow into the wetlands, since on-site systems are reduced in number

Lower water table elevations due to sewering with marine discharge will reduce wetland area extent, especially along the South Shore. This is a significant negative effect.

Unique habitats. No significant effect if structures are properly sited.

Open space. A potential threat is posed to terrestrial habitats. Construction agencies must use available municipal land for the treatment plants, and in many communities on Long Island the most available municipal sites are open spaces, potential park sites and forests. Any strucrural option may represent a tradeoff of water quality against the preservation of terrestrial habitats and the vegetation and wildlife harbored there.

4.2.13.3 Secondary Impact. There are a number of indirect consequences of sewering activities that are too broad in scope to consider in detail in this study. These can be divided into several categories as follows: (1) effects on other environmental media, (2) social and economic effects, (3) public health effects and (4) natural resource effects.

Those aspects of sewering activities likely to induce secondary effects are changes in water levels, interruptions in natural chemical cycles, changes in development patterns and improved surface and groundwater quality.

Effects induced by changes in water level are discussed in this section as part of direct effects and include changes in wetland vegetation and stream ecology Induced water level changes are the subject of an in-depth study to be conducted by USEPA and SCDEC. Impacts on natural chemical cycles cannot be determined in this water quality management program becuase of the lack of data and time-resource constraints. Induced changes in development as a consequence of sewering have been studied at the national level by CEQ (Urban Systems, Inc., 1974). This study concluded that sewering activities will generally induce land development and growth. NSRPB studies indicate that this induced effect has not occurred in the SMSA, and cannot be linked to sewering activities on Long Island The Urban Systems study contends that sewering provides the vehicle for land subdivision and high rise construction in a fashion similar to the well-known strip development of highways. The NSRPB contends that Long Island sewering activities lag rather than lead development. Suffolk County contends that costs to homeowners of sewering discourages growth. No usable analysis of the Long Island situation is available. Thus, the Urban Systems viewpoint cannot be completely discarded.

4.2.13.4 Adverse Environmental Impacts. All those enumerated under Short-Term Primary Impacts and Secondary Impacts, and those adverse under Long-Term Primary Impacts.

4.2.13.5 Minimize Adverse Impacts. In order to mitigate the effects of construction upon wetlands and aesthetics, certain steps can be taken. These include minimizing the construction area, preventing erosion during construction, and restoring the sites following completion of the activity. Particular care should be taken to restore natural drainage patterns and to maintain buffer strips between the construction area and watercourses. Structures should be sited to avoid important wildlife habitats and valuable open space.

4.2.13.6 Irreversible and Irretrievable Commitment of Resoureces. The permanent loss of some wetlands and the degradation of wetland environments by vegetation loss and erosion are two aspects of comprehensive sewering that result in irreversible and irretrievable commitments of resources. If construction activities are handled so as to minimize adverse effects, this permanent loss will be minimal

The decline in streamflow and change in water level of wetlands is a very significant environmental effect. The selection of comprehensive sewering options dictates that one be prepared to trade off improvements in groundwater nitrate level against the loss of freshwater wetlands or be prepared to augment streamflow and freshwater wetland levels. Nassau and Suffolk Counties have recently proposed to the EPA that a comprehensive study of the effects of Sewage Disposal Districts Two and Three (Nassau) and the Southwest Sewer District (Suffolk) on stream flow and Great South Bay salinity be performed. Thus, a better judgment of the impact and extent of stream flow changes can be made when that study is complete.

4.2.14 Effects Associated with Stormwater Runoff Controls. Most of the coliform contamination outside of western Long Island Sound, and much of the nutrients, solids, organics and metals in the surface waters, originate in non-point stormwater runoff. Thus, control of this runoff is a key management alternative for the bays, particularly those where shellfish beds have been closed because of high coliform bacteria levels and those which exhibit elevated nitrogen levels. These include Great South Bay, Moriches Bay, Oyster Bay, Port Jefferson Harbor and Huntington/Northport. The nature of runoff contaminants tends to be different for the different areas (Weston, 1977d). For example, in Oyster Bay, coliform bacteria from semi-wild duck and other animal populations frequenting tributary ponds is a key contaminant. However, not enough is known about the runoff to each bay to be able to demonstrate the major differences. In general, nutrients and total coliform bacteria dominate pollutant loadings in runoff in eastern bays, and metals and organics attain a greater significance in western bays.

The control of storm runoff can be accomplished by employing two types of alternatives for pollution abatement, namely structural and non-structural Best Management Practices. Structural alternatives include the following

1 Sedimentation in storage reservoirs followed by chlorination of the effluent.

2. Sedimentation in storage reservoirs followed by ozonation of the effluent.

3. Primary treatment using swirl regulator/concentrators followed by chlorination of the effluent.

4. Marsh-pond treatment with sedimentation.

5. Natural pond retention and disinfection.

Control by non-structural methodologies involves the following alternatives

1 Employment of Best Management Practices (BMP) to reduce the volume of runoff reaching surface waters by means of on-site recharge, detention (storage in permanent basins or ponds; temporary ponding on dual-purpose paved areas) and retention (use of natural drainage system, creation of broad channels; employment of flow-retarding devices).

2. Use of Best Management Practices designed to limit availability of pollutants in transport by controlling sediments, and by fertilizer and animal waste controls.

3. Interception and disposal of accumulated pollutants before they reach surface waters by street cleaning and catch basin maintenance.

Non-structural controls have been proposed for Long Island bays. The effectiveness of such controls is not known. Thus, a pilot program has been proposed to evaluate the non-structural approach.

If such a pilot program produces poor results, structural measures will be required. On an areawide basis, extensive runoff controls are environmentally beneficial

4.2.14.1 Short-Term Primary Impacts. Short-term primary impacts will result primarily from the construction of detention or retention structures, and specialized treatment plants built specifically to treat stormwater runoff

Metals, organic chemicals. Various contaminants are freed to runoff during construction, including exposed materials (debris, trash), stagnant water, fuel and chemical spillage, vehicle drippings and others. The impacts of runoff and leachate from these materials entering the aquatic ecosystems are varied and relatively unexplored. Synergistic effects of hydrocarbons and heavy metals contamination in shellfish have not been studied, for instance. These effects can be controlled by analysis of soil samples prior to site selection so as to avoid construction in contaminated soils, and by construction of runoff contaminant-control structures.

Nitrates, coliform, virus, water quality, water level. No effect.

Fish, shellfish. The impacts to watercourses and bays associated with construction include the following:

1. Increased volume of water to watercourses from surface runoff
2. Increased turbidity from loss of natural cover and topsoil
3. Increased sedimentation and possible shoaling.
4. Peripherally, loss of wetland habitat.

Fish and shellfish are sensitive to increased turbidity and sedimentation, especially in egg, larval and juvenile stages (see assessment of change in outfall location). Benthic shellfish, once covered, are smothered. It may take up to two years before the area is recolonized. These effects can be minimized by prudent construction practices.

Contact recreation, aesthetics. A significant benefit for contact recreation will be due to reductions in coliform levels. Aesthetic benefits will derive from general water quality improvements. (See Section 4.2.1.6.)

Wetlands. Construction of ponds or basins, as well as the building of facilities to treat the runoff, may result in temporary destruction of wetlands through removal of vegetation and soil erosion. The potential dangers due to site preparation and access, and the storage of machinery and supplies, are similar to those for any other type of construction. In this case, however, large areas of land must be altered in order to meet the size requirements of settling basins (on the order of 400 feet by 200 feet by fifteen feet). Thus, the impact on wetlands is potentially greater, possibly including the destruction of extensive tracts of land that may shelter large populations of wildlife.

Unique habitats, open space. No significant effects when properly sited.

4.2.14.2 Long-Term Primary Impacts

Metals. Structural or non-structural conditions may significantly reduce metal pollution due to runoff. This is due to adsorption of metals onto settleable material

Organics. Some reductions may be noted.

Nitrates, coliforms, viruses. The major purpose of these measures is to provide an environmental/health benefit by reduction of these constituents.

Water quantity, water level. No effect.

Fish, shellfish. Long-term impacts of improving structural and non-structural stormwater runoff controls will result in an improvement in general water quality depending on the control alternatives implemented. Sedimentation in storage reservoirs and/or the use of a swirl/concentrator will remove suspended soilds. At peak design flow, the swirl/concentrator system will remove 60 percent of the suspended solids. Disinfection units can also be linked to these systems to eliminate coliform contamination. However, during a typical five year period, thirteen percent of the storms would result in overflows without treatment.

In the long term, storage with sedimentation followed by disinfection will adequately address the suspended sediments and coliform components of stormwater runoff. Thus, impacts on fish and shellfish associated with turbidity, such as gill clogging and smothering, will be decreased. Additionally, lower coliform levels will render shellfish beds harvestable and may also improve bay quality with respect to bathing.

The non-structural alternatives of detention and retention of more diffuse sources of stormwater runoff will also improve water quality in the long run, by reducing turbidity. Peak flows will be modified, reducing suspended sediment concentrations in watercourses. Retention of water will also enhance the settling of suspended sediments.

Non-structural alternatives may not adequately control such sources of pollution from storm runoff as coliform bacteria, pesticides, metals and hydrocarbons, since they deal only (at least directly) with flows and suspended sediments. It is true, for instance, that some phosphorus and heavy metals adsorb onto soil particles, which settle and are thereby removed. However, nitrates are extremely soluble in water and are not removed by alternatives that merely detain or retard flows. Additions of nitrate as oxidized forms of ammonia and nitrite will fertilize plant communities and lead to overproduction and imbalanced food webs, *i.e.*, ecosystem deterioration. A non-structural alternative that is an exception to this is street cleaning, which has been shown to reduce contaminant concentrations. A pilot study of the impact of street cleaning on runoff quality has been proposed for a South Shore locale. The results of that study will show whether or not structural non-point controls are viable.

Contact recreation. Certain areas of the bays that are valuable for both primary and secondary contact recreation are subject to violations of the coliform standards. The implementation of stormwater runoff control measures should result in significant water quality improvements relative to contact recreation potential, since the major coliform source for most bays is runoff

Aesthetics. Aesthetics can be affected positively if attention is paid to landscaping of runoff detention structures.

Wetlands. The large area requirements of storage ponds will often motivate the developer to use less expensive land, such as wetlands. In addition, the natural drainage patterns may facilitate siting ponds on relatively low land to avoid the need for pumping water Yet the importance of wetlands in the coastal ecosystem is so great that all attempts should be made to avoid permanent loss of these habitats. This is particularly true of storage reservoirs with or without treatment, since they require very large areas. Other control measures, such as the use of already paved areas and recharge areas with vegetation, put much less demand upon the wetlands. Such alternative measures should be utilized wherever possible in the sensitive areas of Oyster Bay and Great South Bay.

Wetland areas themselves can be used as runoff filters and, in some cases, may be constructed specifically for that purpose. Such construction would be a strong positive benefit. It is suggested that a pilot effort be designed to test the practicability of such a runoff-treatment marsh system.

Unique habitats, open space. Care must be taken to avoid the use of environmentally valuable lands for runoff control structures.

4.2.14.3 Secondary Impacts. Management practices that involve street cleaning, or treatment of water, produce addtional residue that must be disposed of in an environmentally acceptable manner.

4.2.14.4 Adverse Environmental Impacts. Control measures involving the construction of ponds or basins exert adverse effects, as discussed above. Pre-emption of open space areas or wetlands introduces tradeoffs between terrestrial, wetland and marine quality.

4.2.14.5 Minimizing Adverse Effects. Site selection on the basis of the environmental value of land and careful supervision of construction practices will help reduce unnecessary impacts. Specific controls for erosion are a necessity. These should include minimal land clearing, covering of stripped areas with mulch, and then replanting when construction is completed.

To avoid encroachment on valuable terrestrial habitat or wetland areas, all efforts should be expended to find alternate sites for retention ponds. Detention ponds may be located within residential or commercial areas and suitably landscaped to serve an aesthetic and recreational purpose in addition to runoff control Avoidance of wetland sites and location of the ponds closer to the sources of urban runoff, will permit removal of the sediments at an early point and will prevent siltation of marshlands.

4.2.14.6 Irreversible and Irretrievable Commitment of Resources. The loss of wetland areas and open space through construction of settling basins and ponds threatens the healthy functioning of the coastal ecosystem. Commitment of such land is usually irreversible, and thus all other control measures and sites should be considered before wetlands or valuable habitats are chosen.

4.2.15 Effects Associated with the Upgrading of Treatment Plants. Upgrading the facilities and capabilities of treatment plants to remove contaminants from wastewater deals directly with the point source aspect of the bay and groundwater quality problems in the bi-county area. With respect to fish and shellfish, preserving the natural conditions of the bay ecosystems is the only way to maintain and enhance the productivity and diversity of the indigenous populations, however, mariculture, a special case, is an exception to that rule. Removing excess nitrogen, a critical limiting nutrient in estuarine ecosystems, and maintaining suitable N/P ratios, will help maintain the natural associations of species and the stability of the trophic structure. It should be noted that nitrogen removal would be unnecessary except for a few bays if the non-sewering options were selected, but would be essential under the one dwelling unit per gross acre and three dwelling units per gross acre sewering options. For many bays, upgrading treatment plants is only effective in concert with non-point controls. Upgrading of plants in Manhasset Bay and Hempstead Harbor will be effective for local harbor improvements if Long Island Sound conditions do not improve.

Upgrading of the existing treatment plant facilities with effluent discharge at the present outfall or construction of a mid-bay outfall have been recommended for Manhasset Bay, Hempstead Harbor, Oyster Bay, Huntington Bay, Port Jefferson Harbor, Peconic/Flanders and Patchogue (in Great South Bay). Specific judgments are made in Section 4.3. Some areawide considerations are discussed here.

4.2.15.1 Short-Term Primary Impacts. Short-term primary impacts on aquatic ecosystems due to construction should be minimal, provided treatment plants are not located in proximity to bay shores or wetlands.

Nor should treatment plants be located on watercourses that feed directly into large streams, rivers or wetlands that either empty into, or fringe, the bay ecosystems. Aquatic ecosystems are impacted by construction in the following ways. (See Figure 4–2.)

1. Increased erosion and loss of topsoil leading to:
   - Increased downstream flooding.
   - Increased bottom sedimentation.
   - Increased turbidity.
   - Increased sediment load
2. Construction-related dissolved or suspended leachate contamination such as:
   - Additions of hydrocarbons.
   - Additions of soil minerals.
   - Additions of heavy metals.
   - Additions of fertilizers or pesticides.
   - Additions of stagnant water.
3. Other changes in aquatic water quality:
   - Changed water temperature.
   - Changed pH (estuarine systems are well buffered)
   - Increased BOD.

Measures to mitigate aquatic impact from upland construction will be site-specific. Thus, specific impacts need to be assessed once structures are sited.

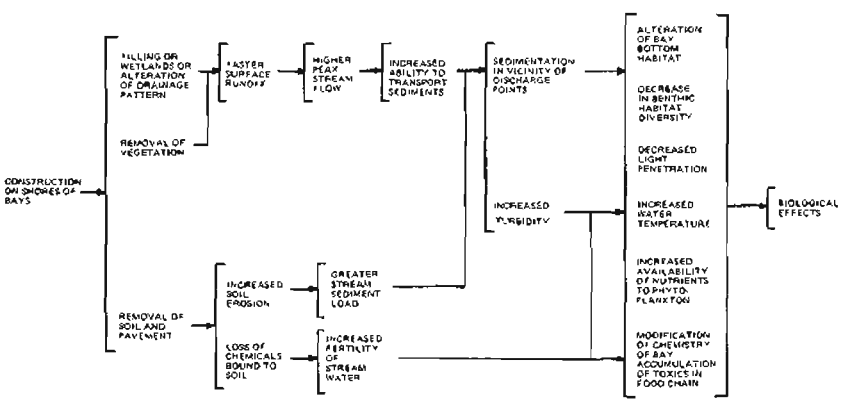


FIGURE 4–2 *Effects of Construction on Bay Conditions*

4.2.15.2 Long-Term Primary Impacts. In general, the long-term effects are beneficial. Improving the quality of effluent discharged in the bay, Sound, and near shore coastal waters can only improve fish and shellfish productivity and diversity, and bathing water quality. In cases where tertiary treated wastes are recharged, effluents to bays are eliminated Noxious species will decline, diversity on all trophic levels will increase, and, as a result, ecosystem stability will be enhanced. Algal blooms associated with nutirent overloading will decrease. Coliform counts will be reduced in some bays, opening shellfish areas to production, and consequently increasing water usage. However, there are some tradeoffs involved. First, augmented treatment generates additional sludge, which requires disposal. Sludge disposal then imposes air pollution loads (in the cases of co-incineration, incineration or pyrolysis) or land requirements (in the cases of composting and land application) Also, advanced nitrogen removal may impose lowered N/P ratios, which may affect the phytoplankton community diversity. Another tradeoff relates to increased residual chlorine caused by increased effluent loads. This chlorine is toxic to marine organisms in some cases and may inhibit growth in the vicinity of outfalls. Table 4–29 illustrates present levels of residual chlorine. Future levels are not expected to be significantly higher At least some dilution will occur in the receiving water Present EPA criteria levels for toxicity are three micrograms per liter of chlorine for salmonid fish and ten micrograms per liter for other freshwater and marine organisms. Thus, chlorine from treatment plants does not appear to pose a significant threat. Similarly, ammonia levels are expected to remain well below the toxicity threshold. When waste effluent is to be recharged, chlorinated effluent will contain unacceptable levels of chlorinated organics and other disinfectant techniques may be required.

Metals and organics. No significant effect.

Nitrates. No health-related effects for surface discharges. Nitrogen concentrations in groundwater will be lowered by sewering and recharge. The net effect of reduction in nitrogen inputs due to sewering with or without recharge is beneficial.

Coliform and viruses. In cases where shoreline areas are sewered and diverted to treatment plants, some of the non-point pathogen loading may be reduced.

Water quality, stream water levels. Beneficial for nitrogen levels.

Fish, shellfish. See Sections 4.3 for a bay-by-bay discussion

Contact recreation. As a public health measure, bathing is generally prohibited in the vicinity of outfalls.

Aesthetics. All effects are highly dependent on treatment plant design and siting. Effects include the following:

- Visual effect of structures.
- Water quality improvements (color turbidity).
- Ecological improvements (increased species diversity).

Table 4–29

1976 STP CHLORINE RESIDUAL AVERAGES
NASSAU COUNTY

Treatment Plant	Average Cl_2 Residual in PPM	Number of Data Points
Cedar Creek STP	3.2	64
Bay Park STP	1.7	60
Lawrence STP	2.1	30
Long Beach STP	2.9	36
West Long Beach STP	1.3	18
Freeport STP	2.7	24
Jones Beach STP	2.3	8
Cedarhurst STP	1.6	13
Inwood STP	1.7	7
Belgrave STP	2.7	8
Great Neck Sewer District STP	2.2	22
Great Neck Village STP	2.3	17
Port Washington STP	2.6	11
Glen Cove STP	2.3	51
Roslyn STP	1.7	20
Oyster Bay STP	1.9	7
Seawanhaka Yacht Club STP	4.0	7
Cold Spring Harbor STP	3.7	11
C.W. Post STP	2.5	6
Farmingdale STP	3.6	5
Meadowbrook STP	1.6	4
Roslyn Duck Pond Chlorinated Discharge	0.5	7

Source: Nassau County Department of Health, 1978.

4.2.15.3 Secondary Effects. A bay discharge is generally less expensive than an ocean outfall which often requires a long conduit (outfall). Recharge which implies the most stringent treatment requirements is generally the most expensive disposal technique. However, the costs of ocean discharge are more favorable when several plants can be routed to one outfall. With respect to sludge generation, treatment plants impose tradeoffs between bay quality and air quality, land use and groundwater quality

4.2.15.4 Short-Term Versus Long-Term Environmental Benefits. The long-term environmental benefits of improved effluent quality are clear. However, in the long term, and as technology advances, alternatives to effluent disposal in the bays should be considered. These include flow reduction and land reclamation. As the demand for fresh water from diminishing conventional sources has increased, the interest in land reclamation of industrial and municipal wastewater effluents has expanded concomitantly. In many areas of the country, wastewater effluents are being utilized to supplement freshwater supplies. Wastewater reclamation technologies employing additions from municipal effluent have been used for irrigation (principally agriculture), groundwater recharge, stream augmentation, overland flows (migration and renovation) and for non-potable domestic use.

4.2.16 Effects Associated with Point Source Outfall Relocations. Relocation of the outfalls to mid-bay sites is advanced as an option for Huntington Bay, Hempstead Harbor, Manhasset Bay, Port Jefferson Harbor and Peconic/Flanders Bay: to an offshore site for Peconic Flanders and South Shore Bays; and/or out of the area for eastern Great South Bay, Manhasset Bay and Oyster Bay. The movement of sewage effluent outfalls does not remove the excess nutrient (N and P) nor the BOD from the ecosystem, but rather ameliorates ecological stress conditions through pollution dilution. In many cases, this is a critical first step towards improving the water quality in the estuarine bays since several of the bays, particularly Great South Bay, have poor flushing rates and consequently tend to accumulate pollutants. When minimum sewering options are selected, such measures are not required. As described in 4.20, non-point controls are required in concert with point source controls to achieve water quality improvement. Specific bay situations are discussed in 4.3.

4.2.16.1 Short-Term Primary Impacts. Relocation of outfalls to mid-bay or offshore locations requires construction activity through the estuarine and marine benthos (Great South Bay) and possibly through barrier islands (Fire Island, Long Beach) and fringing wetlands. In general, line construction across the bay bottoms requires dredging by mechanical or, more likely, hydraulic means. The short-term impacts associated with dredging include the following (Darnell, 1976):

- Modification of bottom topography
  - Trenching and backfilling involve the removal of some benthic deposits and the smothering of others.
- Modification of water circulation patterns
- Increased turbidity of water
  - Increased oxygen demand
  - Reduced light penetration
  - Reduced photosynthetic oxygen production
  - Release of toxic organic compounds
  - Release of pesticides, heavy metals and hydrogen sulfide
  - Increased temperature
- Bottom siltation with very fine sediments
- Destruction of benthic flora and fauna
- Disturbance of nesting areas in wetlands

If construction of effluent outfall pipelines is managed correctly, the modification of bottom topography can be minimized by replacing extracted sediments over the pipeline and by contouring and grading the benthos. Such procedures can also eliminate modification of circulation patterns. Potentially, the most damaging aspect of construction activity in bays involves the

turbidity generated by dredging. Turbidity (or suspended sediments) impacts fish and shellfish in the following ways:

1 Suspended sediments increase the oxygen demand in the water column due to increased microbial action (consequently community respiration) on detrital particles. This causes dissolved oxygen to decrease, imposing potential hazards on organisms highly susceptible to oxygen deprivation, particularly active, migratory fishes, which have high dissolved oxygen requirements and low tolerance to oxygen deprivation (Thornton, 1975).

2. Suspended sediments inhibit transmission of light through the water column, thus decreasing the standing crop of phytoplankton. Phytoplankton helps form the base of the estuarine food web and is the chief component of the diet of most shellfish. This effect has been documented in the South Shore bays (NCHD, 1977b).

3. Suspended sediments can introduce toxic materials, such as pesticides (chlorinated hydrocarbons), heavy metals and radionuclides, to the water column. These materials are selectively incorporated into fish and shellfish by biological magnification, and cause lethal and sub-lethal effects.

4. Suspended sediments clog the gills of fishes, inhibiting carbon dioxide-oxygen exchange and causing asphyxiation.

5. Suspended sediments clog the mucous membranes of many suspension and filter feeder molluscs by mimicking the size of the host organisms' food particles. This causes inefficient feeding, choking, clogging and in many cases, death.

6. The settling of suspended sediments can physically cover and smother whole benthic organisms.

Turbidity affects juvenile forms of many of the ecologically and commercially important fishes, shellfishes and crustaceans in the South Shore, Manhasset Bay, Hempstead Harbor and Port Jefferson Harbor areas. Monitoring of this effect is already required by the EPA. Some of the more important fish species in these locations include the striped bass *(Morone saxatilis)*, the bluefish *(Pomatomas saltatrix)*, the white perch *(Morone americana)*, menhaden *(Brevoortia tyrannus)* and other herrings, and the silverside *(Menidia menidia)*. Important shellfish are the hard clam *(Mercenaria mercenaria)*, the blue mussel *(Mytilus edulis)*, bay scallops *(Aequipecten sp.)*, and softshell clams *(Mya arenaria)*, and in some cases, the American oyster *(Crassostrea virginica)*. Crustacea of interest include the blue crab *(Callinectes sapidus)*. Offshore, the surf clam *(Spisula solidissima)* and the American lobster *(Homarus americanus)* are a commercially important shellfish and crustacean, respectively

The specific effect of suspended sediments on the macroscopic biological community has been well studied. In general, the older the life stage, the more tolerant the species. Adult oysters *(Crassostrea virginica)* are extremely tolerant of high silt loads as are other epi- and infauna of the estuary, which must contend with naturally high silt loads at various times of the year The egg, larval and juvenile stages of estuarine species can be heavily impacted by artificially high concentrations of suspended sediments (Auld and Schubel, 1974; Schubel *et al.*, 1974, Sherk, 1972). The growth and survival of hard clam and oyster eggs and larvae are disrupted at suspended sediment concentrations as low as 125 milligrams per liter (Davis, 1958). Sherk (1972) tested the effects of suspended sediments on various estuarine fishes. Atlantic silversides *(M. menidia)*, juvenile bluefish *(P saltatrix)*, juvenile menhaden *(B. tyrannus)* and young of the year white perch *(M. americana)* are highly sensitive to suspended sediment loads. At the other end of the spectrum, striped killifish *(Fundulus majalis)* and the mummichog *(F heteroclitus)* were most tolerant. Deposition of suspended sediment as a result of water disposal of dredge material covers and smothers clams, oysters, crabs, shrimp and other benthic organisms. Benthic communities, that are completely covered, require two years to re-establish.

Decreases in dissolved oxygen are commonplace with suspended sediments, the oxygen demand in the water column increasing by a factor of as much as eight (Issac, 1965). Decreases in dissolved oxygen impact the more migratory species of fish, such as herrings *(Alosa sp.* and *B. tyrannus)*, silversides *(M. menidia)*, bluefish *(P. saltatrix)*, anchovy *(Anchoa sp.)* and mackerel *(Scomber scombrus)* (Thornton, 1975).

There is evidence to support the claim that suspended dredge material fertilizes the water through nutrient release, although the effect is not an immediate one (Sherk, 1972).

The following is a list of recommendations concerning the deposition of spoil (Clark, 1974; Daiber *et al.*, 1972, 1974, 1976, Marcellus, *et al.*, 1973; Metzgar, 1973, Maurer *et al.*, 1974; Sherk, 1972) as presented in Daiber and Thornton, 1976.

1.Prior to full-scale dredging, there should be a determination of the physical and chemical characteristics of the spoil, in order to decide the most appropriate means of dredge spoil disposal.

2. Spoil should not be placed on high value natural habitats that serve as nursery areas for marine species. These include: marshes, beds of submerged vegetation, protected shallows, oyster reefs, tidal flats.

3. Spoil should not be placed back in the water, if possible, but rather on the uplands. Constraints should be placed on types of materials that can be disposed of in open water. However, effects of upland disposal on groundwater must be monitored.

4 Spoil suitable as "fill" for residential, commercial and industrial development should be used for such purposes. This use is subject to groundwater effects. Constructive alternative uses for spoil should be researched.

5. Abandoned sand and gravel pits in proximity to the water should be used as spoil receptacles provided spoil can be restrained from running off or polluting freshwater supplies.

6. Under certain conditions, spoil can be used to enhance existing marsh or to create new marsh.

7 Spoil deposition sites should be planned to allow future mainten-

ance, as in the creation and development of spoil islands, which have been found to be beneficial for terrestrial habitat and migratory waterfowl.

8. Natural channels should not be blocked with spoil.

9. Beach nourishment and spoil are related problems that should be approached jointly.

10. Temporal aspects of spoil deposition should include consideration of biological factors like spawning seasons and schooling patterns, and factors such as the bathing season.

There is a possible impact on wetlands on the South Shore, where the proposed relocation of the Bay Park outfall to permit ocean discharge may disturb wetlands and bay benthos due to dredging, removal of vegetation, and increased turbidity in the area. Caution must be exercised when planning routes and construction methods and times.

Construction activities for an ocean outrall for Bay Park would probably involve a route passing through Long Beach. This would have various effects on the environs of the City of Long Beach.

4.2.16.2 Long-Term Primary Impacts. The long-term impacts of outfall relocation will greatly improve the water quality in the areas from which the outfalls were moved. The BOD, COD, refractory organics, suspended soilds, total nitrogen, total phosphorus, dissolved minerals, and coliform levels should all decrease.

Moving the outfalls offshore will lower the input of nutrients and BOD to the wetland areas, thus increasing the available oxygen in an oxygen-limited environment. This will be beneficial for many fish and will help reverse the eutrophic tendencies of the wetland areas attributable to pollution.

From a dissolved oxygen standpoint, a reduction in BOD would encourage susceptible species as snapper blues *(P. saltatrix)*, Atlantic silversides *(M. menidia)* and herrings *(Clupeidae)* to use the formerly impacted areas (Thornton, 1975).

Shellfish such as the hard clam *(Mercenaria mercenaria)* and the oyster *(Crassostrea virginica)* are remarkably tolerant to high concentrations of various nutrients, particularly such nitrogenous compounds as ammonia, nitrite ion, nitrate ion and ortho-phosphate (Epifaunio and Srna, 1976) Effluents of secondarily treated domestic sewage rarely contain levels of these chemicals as high as the 96-hour mean lethal tolerance limits reported in that study. However, sub-lethal toxic concentrations of ammonia (7.2 milligrams per liter) will be encountered around sewage outfalls and will restrict the distribution of molluscs. Consequently, the movement of outfalls to areas of increased flushing will induce a corresponding improvement in shellfish density and diversity in present outfall locales.

Although it is true that wetland areas can serve as nutrient sinks for coastal ecosystems, their capacity is not unlimited and should not be overburdened by anthropogenic wastes. Thus, moving sewage outfalls offshore is a positive step in wetland preservation.

4.2.16.3 Secondary Impacts. Negative secondary impacts include problems associated with spoil disposal, costs associated with monitoring outfall construction and operation, and possible saltwater intrusion into wells hydraulically linked with dredge sites.

Ruth Patrick (1949) proposed that moderate pollution would tend to eliminate susceptible species from a community, causing the few that survived to flourish due to reduced competition and greater chance of multiplication. A reduction in pollution should encourage a more healthy, diverse community to evolve.

4.2.16.4 Adverse Environmental Impacts. The risk of leakage from pipelines is always a possibility. If pipes are not properly lined or connected, waste materials may seep into the surrounding soil and alter the vegetation. In the event of violent storms, shifting sands may expose previously buried pipes and perhaps rupture joints. Such an accident would result in great volumes of effluent being discharged directly into the bay and wetland areas, adversely affecting both the vegetation and the wildlife of those areas. Such an event might cause eutrophication and a resulting anoxic area. The leaching of the sewage contaminants to other areas of the bays would then affect water quality and thereby the finfish and shellfish.

4.2.16.5 Minimizing Adverse Impacts. Careful design of pipeline construction is one of the best ways to preclude unnecessary leakage. Siting pipes to avoid wetland areas as well as unstable beaches is vital to safe planning. Geologic conditions should be considered when choosing a route for the line. As mentioned above, proper restoration of the wetland sites affected by pipeline construction is a necessity. Soil must be replaced over the lines, covered with mulch, and planted with marsh vegetation. Precautions must be taken to prevent significant alteration of the drainage patterns due to the soil displacement.

4.2.16.6 Irreversible and Irretrievable Commitment of Resources. None.

4.2.16.7 Relationship Between Short-Term Uses of Environment and Long-Term Environmental Productivity. Moving outfalls to mid-bay or ocean locations, may cause local, temporary perturbations to wetlands and the benthos, but it is beneficial in the long run because of the improvement of water quality and the resulting health of the bay and surrounding wetlands. As long as construction activities are managed in order to minimize habitat destruction, such a project will increase productivity and maintain the healthy ecological functioning of the system.

As was mentioned earlier, relocation of outfalls merely postpones the ultimate resolution of the problem of effluent disposal by physically displacing the outfall to areas of greater water volume and flushing. This is a reasonbale temporary measure to immediately improve the water quality in the bays of Nassau and Suffolk Counties, assuming the short-term impacts are kept at a minimum (*i.e.*, restoration of impacted areas is a must). It appears that properly engineered relocation of the outfalls will cause no irreversible or irretrievable commitment of resources. Planners must realize, however, that

the disposal of the effluent in the nearshore Atlantic Ocean, Long Island Sound, or in the middle of the bays may eventually become unacceptable if effluent quality is not improved. Long Island Sound and the New York Bight, although large expanses of water, are already showing some signs of degradation, and increased loads will only exacerbate the situation.

4.3 Area Specific Impacts

The discussions presented below correspond to the subsections of 3.5.2, "Area Specific Alternatives."

Hydrogeologic Zone Alternatives

(Correspond to Subsections of 3.5.2.1.)

4.3.1 Zone I: Deep Flow System (Magothy Recharge Area). Zone I encompasses much of the residential, transport and commercial and industrial activity areas of Nassau and Suffolk Counties. About ten percent of the area is presently sewered. Other characteristics of Zone I are given in Tables 4–30 to 4–32. The major environmental characteristic of Zone I is that materials released at the surface move downward into the Magothy aquifer. Thus levels of discharge need to be controlled. Zone I is presently well-developed and current land use plans call for continued residential and nonresidential use of the Island's center. Thus, the volume of wastes to be treated and disposed of will grow. Also, pressure to develop existing open spaces will grow. The environmentally favored approach is Alternative IA with possible selective sewering in areas characterized by septic system failures and densities of five or more dwelling units per gross acre, and in other areas indicated by monitoring results. Selection of IA represents a judgement that takes into account the uncertainties concerning implementability and effectiveness of IA and the uncertainties concerning cost-effectiveness and side effects of IB, IC and ID. Both best and worst case situations were considered with respect to the resolution of the various uncertainties.

There are four alternative plans for waste management. These plans represent distinctive approaches; namely, the structural, traditional sewering approach; the non-structural, monitoring, regulatory and non-point source control approach; and intermediate approaches. These approaches have significantly different environmental impacts. One difference relates to the uncertainty of impact. The other relates to secondary problems such as water level and sludge disposal. The sewering approaches (Plans IB, IC and ID) have been in use for years (although the non-point source control aspects of these plans are a new approach). Thus, the impacts are fairly well known. Generally, nitrates, organic chemicals and metals are redistributed from groundwater to waste streams and sludge residues. Water table levels become lower when marine outfalls are employed for ultimate disposal. The effects of Plan ID will be more pronounced than for IB and IC. The non-structural and non-point source control approach (Plan IA) is a fairly untested strategy Thus, there is a high uncertainty associated with the impacts. Sewage nitrogen is altered by on-site systems to ammonia or nitrates and is diluted in leaching fields. Organic chemicals and metals are controlled at the source and collected as concentrated hazardous wastes. Coliform bacteria in runoff are reduced by management practices or treatment.

There are environmental advantages to each approach. Plans ID and IC, and to a lesser extent, IB, have as their main advantage the predictability of impacts. One can be reasonably confident that the plan will significantly reduce nitrate levels in groundwater and that with a combination of industrial

Table 4–30

DOMESTIC TREATMENT SYSTEMS BY ZONE*,**

Zone***	No. of Systems	Avg. Total Flow (MGD)	BOD Effluent lbs/day	SS Effluent lbs/day	F. Coli N/100 ml	TN lb/day	TP lb/day
I	32	15.978	4,087.1	3,596.2	3,712	3,084	498
II	4	.377	247.2	270.3	217	103	–
III	19	2.285	520	344	1,072	302	74
IV	5	0.455	76.7	176	521	182	9
V	1	0.025	1	1	41	2	–
VI	25	2.557	1,277	397	4,190	558	58
VII	24	90.460	15,255	23,189	2,393	22,619	2,671
VIII	12	7.495	3,966	2,031	3,738	2,179	211

Source: Weston, 1976.

***Note: These figures are all based upon the discharge site of the sewer district rather than the areas sewered. For this reason, the coastal zones are particularly high while inland zones may be underestimated. This is especially true of Bay Park STP which has a flow of 63.9 MGD. Although much of the sewer district may be located in Zone I, the outfall flows in Zone VII.*

****See Figure 3–2 for a map of the Zone boundaries.*

Table 4–31

INDUSTRIAL POINT SOURCES BY ZONE*

Zone	Process Flow Rate (gal/day)**
I	675,376,600
II	639,860
III	18,033
IV	87,000
V	35,000
VI	398,600
VII	297,068,000
VIII	396,838,900

Summarized from Weston, (1976).
***Includes thermal discharges.*

Table 4–32

MISCELLANEOUS SOURCES BY AREA*

Zone	Landfills Active & Abandoned	Domestic STP's Discharging to Groundwater	Incinerator Effluent To Ground	Duck Farms	Semi-Wild Duck Concentrations
I	12	34	2	0	0
II	2	3	0	0	0
III	0	17	0	0	0
IV	8	2	0	6	2
V	3	0	0	0	1
VI	5	20	1	17	1
VII	5	5	1	0	3
VIII	4	5	0	0	1

Summarized from Miller and Sgambat, 1977.

hook-ups to sewers, and non-point controls, groundwater metal and organic chemical levels will be reduced. Their major disadvantage is the set of environmental side effects. These include lowered water table elevations, if there are surface discharges of effluent (*i.e.*, lowered surface water body levels and flows), increased sludge loads, and a possible catalyst for further development in some areas. (For a discussion of this effect, see Section 4.2.13.3.) Plan IA has as its major advantage the comprehensive minimizing of waste loads with a minimum of side effects and lower cost. Nitrate, metal, organic chemical, pesticide, salt, oil and coliform bacteria levels might all be significantly reduced if controls were to be properly implemented. Its disadvantage is the presently high uncertainty concerning the impact level that will occur. All four plans, if properly implemented, have environmental benefits. The tradeoffs are (a) between a more costly but more certain approach and a less costly approach with higher environmental benefits but higher uncertainty; (b) greater effort to protect surface water quality, air quality and groundwater quantity, versus greater effort to protect groundwater quality (nitrate levels). With respect to sewage, nitrate levels in the Magothy aquifer underlying parts of Area I are high and variable. This can be seen in Table 4–33. Concerning industrial wastes, organics are a problem in the groundwater as mentioned in Section 4.1.1.2. Table 4–34 summarizes data from Zone I. Studies of recharge basins suggest that runoff contributes both organic chemicals and nitrates.

Table 4–33

SELECTED TEST WELL DATA REPRESENTATIVE OF THE HIGH RANGE OF NITRATE LEVELS IN GROUNDWATER UNDERLYING ZONE I*

Well	Date	NO_3–N(mg/l)	Well Depth (feet)	Aquifer
Jericho Turnpike at LIE, Hicksville	9-7-76	2.5	100	Glacial
Round Swamp Road, Huntington	9-1-76	21	168	Magothy
Miller Place, Syosset	9-7-76	9.3	111	Glacial
Garden City Country Club, Garden City	6-2-76	2.4	63	Glacial
	6-23-76	2.4		
	10-6-76	3.6		
Miller Place, Syosset	9-13-76	14	490	Magothy
	10-23-76	15		
Syosset Circle, Jericho	3-3-76	1.6	400	Magothy
	10-27-76	2.6		

Source: Suffolk County Department of Health, 1977.

Plan IA: No Sewering Emphasis on Individualized Point and Non-point Controls.

Plan IA is considered here in terms of some selective sewering in most areas with population densities of five or more dwelling units per gross acre. Plan IA will reduce nitrate levels somewhat. In general, Zone I is an area of recharge. However, hydrologic characteristics vary locally. Thus there will be locales where higher loads of nitrate will have little effect on ambient levels in the Magothy aquifer. This may be due to direction of aquifer flow, geologic barriers or aquifer chemistry. Proper use of Plan IA should obviate sewering in such areas. Plan IA will maximize the use of the natural nitrogen cycle in the disposal of man-generated nitrates by minimizing structural solutions. Thus, artificial side effects will be minimized.

Land use controls, an important aspect of Plan IA, will be of great benefit in preventing occurence of the conditions of high density residential

Table 4–34

SUMMARY STATISTICS—VOLATILE ORGANIC COMPOUNDS[1]
(Principally Zone 1)

Compound	# stations measured	# stations detected*		# stations occurring @ > 10 μg/l*		# stations occurring @ > 50 μg/l*	
trichloroethylene	116	93	(80%)	35	(30%)	15	(13%)
chloroform	82	68	(77%)	20	(24%)	4	(5%)
1,1,1 trichloroethane	116	57	(49%)	25	(21%)	6	(5%)
carbon tetrachloride	78	28	(36%)	1	(1%)	0	
tetra chloroethlene	116	38	(33%)	10		5	(4%)
dibromochloromethane	78	15	(19%)	0		0	
diethyl ether	38	6	(16%)	0		0	
1,1 dichloroethane	44	5	(11%)	3	(7%)	0	
bromodichloromethane	78	8	(10%)	3	(4%)	1	(1%)
freon–11	44	4	(9%)	0		0	
1,1 dichloroethylene	44	4	(9%)	0		0	
1,2 dichloroethane	44	3	(7%)	0		0	
bromoform	78	5	(6%)	1	(1%)	0	
1 chloropropane	44	1	(2%)	1	(2%)	0	

**percentages given in parenthese.*
[1]Source: Beck, ERCO

and commercial land use that lead to extensive non-point pollution of the Upper Glacial aquifer. In addition, land use controls will act to preserve small undeveloped parcels that constitute the remaining natural habitat. The magnitude of organic chemical loads to be controlled in Plan IA is high, since many industrial wastes will not be diverted to sewers. The loads need to be considerably reduced to keep groundwater organic levels safe from a health standpoint. Each element of the set of non-point and non-structural measures proposed in Plan IA needs to be strictly applied to accomplish that. There is a fairly high uncertainty as to whether the various measures can be applied at a high level of control. Thus, the uncertainty of Plan IA with respect to organic chemicals is high.

Control of metals, nitrogen, organic chemicals and coliform bacteria in runoff is an important aspect of Plan IA. The de-emphasis of sewering must be accompanied by improvement in the quality of runoff to surface waters and to recharge basins. There is a lack of previous experience with implementation of the runoff controls. Thus, there is a high uncertainty as to how effective runoff controls will be in reducing metal, organic chemical, nitrate and coliform bacteria loads. Environmental effects that can be expected from the non-point, non-structural and runoff measures are discussed in Section 4.2.

In summary, Plan IA depends, for a large portion of its effectiveness, on measures such as animal waste control ordinances, fertilizer use ordinances and street cleaning practices, which have a large uncertainty associated with their workability.

Plans IB, IC and ID: Three Dwelling Units Per Gross Acre, with Selective Two Dwelling Units Per Gross Acre and One Dwelling Unit Gross Acre Sewering.

Plan ID, and to a lesser extent, Plans IB and IC, will maintain nitrate levels in groundwater below ten milligrams per liter in locales where nitrates travel downward through the aquifer. However, such locales cannot be mapped in detail. These alternatives may be expected to result in locally high nitrate levels as was suggested by the analysis done for this project, which showed that, in some modeled grid cells, sewering had little correlation with groundwater nitrate (Porter *et al.*, 1978) This approach, however, will result in high nitrogen loading at sewage treatment plants (STPs) Plans IB, IC and ID are designed to avoid violations of groundwater nitrogen standards. They are based on considerable data analysis done during the last two years (Weston, 1977a, 1977b, Porter *et al.*, 1978; Miller and Sgambat, 1977b). Generally, the analyses indicated a large amount of uncertainty as to groundwater nitrogen sources and transport. The data showed that if ten percent violations of standards are an allowable level of nitrate contamination, then sewering at densities of between one dwelling unit per gross acre and three dwelling units per gross acre would result in acceptable nitrate levels with a limited level of enforcement of other controls. Thus, Plan ID is a conservative sewering approach, Plans IC and IB are standard sewering approaches, and Plan IA requires successful implementation and enforcement of other controls for success with respect to nitrogen.

Organic chemicals in industrial effluents will be pretreated and dis-

charged to sewers in Plans IB, IC and ID. Also, the volume of domestically used organics, such as cesspool cleaners, that are introduced to groundwater via on-site systems will be reduced. Thus, a significant fraction of the organics will be controlled by sewering. This leaves a smaller organic load (spills, storage tanks, runoff) subject to the uncertainties associated with non-point measures, which were noted above in the discussion of Plan IA. However, it will be necessary to provide for the disposal of increased quantities of sludges and sewage treatment plant effluents rich in trace organics. Effects of sewering, sewerage treatment plants, and outfalls are covered in Section 4.2.

Runoff controls for Plans IB, IC and ID are the same as those proposed for Plan IA. Thus, the same uncertainties discussed with reference to Plan IA apply. However, with respect to nitrates and organic chemicals, the non-point contribution to the total load is less in Plans IB and IC, and least in Plan ID. Thus, the uncertainties are of less consequence.

4.3.2 Zone II: Impaired Water Quality Area. Zone II encompasses a locality of mixed commercial/industrial and residential land, shown in Figure 2–1. Groundwater quality underlying this area is locally unusable and regionally poor, especially with respect to organic chemicals. This zone has displayed the worst groundwater quality in the region. This can be illustrated by groundwater monitoring data from local wells (Table 4–35) The hydrology of this area is similar to that of Zone I; that is, it is a Magothy recharge area. The plume of already contaminated groundwater can be expected to move down into the deeper portions of the Magothy aquifer then south and up in the South Shore Zones.

Zone II is currently being sewered. Thus, there do not appear to be options available with respect to sewering. For non-point source controls, Plan II calls for strict implementation of the whole range of available controls. In addition, industries would connect to sewers and pretreat their waste streams. Such controls would halt significant degradation of the aquifer Water tables and stream flows will also be reduced as a result of sewering (assuming marine discharge). Implementation of Plan II would generate a sizable quantity of hazardous wastes to be disposed of at the proposed regional facility. Two water supply alternatives, which do not present comparative environmental issues, are also proposed.

In the short term, say a period of up to 50 years, the environmental benefits to be obtained from Plan II would be minimal. No matter how strict the adherence to the plan, the plume of contaminated groundwater would only slowly disperse. Over the long term, environmental benefits could be expected.

4.3.3 Zone III: Highest Grade Reservoir. Zone III encompasses the eastern portion of the Magothy recharge zone, which is generally very high in water quality. The hydrology of this area is similar to that of Zone I, that is, it is a recharge area. It is different from Zone I in that more options for waste management are open. First, less development has occurred. Thus, waste management considerations may have more of a role in determining rational

Table 4–35

RESULTS OF TESTING FOR VOLATILE ORGANICS IN SELECTED WELLS IN ZONE II*

NCDH Well #	Date	Compound	Concentration
8941	07-12-76	Chloroform	7.8 μg/l
3876	11-29-76	Trichloroethylene	2.8 μg/l
		Trichloroethane	1.9 μg/l
		Carbon Tetrachloride	2.3 μg/l
3876	12-06-76	Vinyl Chlorides	< 10 μg/l
		Trichloroethylene	60 μg/l
		Tetrachloroethylene	17 μg/l
		Trichlorethane	15 μg/l
		Chloroform	< 1 μg/l
		Benzene	< 2 μg/l
6078	12-06-76	Vinyl Chlorides	< 10 μg/l
		Trichloroethylene	< 1 μg/l
		Tetrachloroethylene	100 μg/l
		Trichloroethane	< 5 μg/l
		Chloroform	< 1 μg/l
		Benzene	< 2 μg/l

**Source: Nassau County Department of Health (1977a).*

patterns of development. Second, less sewering has occurred. Thus, the option of not sewering is more of a real alternative to be considered.

The plans suggested for protection of the Magothy aquifer in Zone III differ mainly in the extent of the protection that will be provided. Plan IIIB is a "watershed management" plan calling for land acquisition, land use controls and other non-point source controls. Plans IIIA, IIIC, IIID and IIIE are more modest in level of control, calling for a combination of sewering and non-point source controls. Among the environmental advantages of Plan IIIB are (1) control of density of on-site dischargers, thus limiting nitrate loads to groundwater; (2) maintenance of natural recharge sites, thus maintaining water levels and natural treatment of recharge water; and (3) preservation of terrestrial habitats, thus protecting terrestrial populations. However, Plan IIIA with selective sewering is a sound control strategy presenting the same tradeoffs mentioned in Plan IA and is also environmentally acceptable. Plan IIIA has less uncertainty associated with it than IA, since Zone III is further from the New York City industrial center and supports fewer large scale industrial dischargers. Plans IIIC, D and E present many environmental side effects avoided by the other two plans, and previously discussed in connection with Plans IB, C and D However, recharge of effluent is planned for IIIC, D and E, which would minimize water-table effects and introduce a range of possible groundwater contaminants, such as organic chemical contaminants generated by chlorination.

Long Island's groundwater derives from precipitation, which falls on the ground and percolates through the soil to the aquifers. Since the aquifers are used as the only source of drinking water for the area, the quality of the recharge becomes critical. Urban development, through the clearing of land and the paving of many surfaces, has tended to decrease the amount of recharge to groundwater and to increase the amount of runoff to surface waters. The groundwater recharge basin program, begun in Nassau County in 1935, succeeded in partially alleviating the effects of runoff by providing large unlined basins, where water could seep down to the aquifer Yet these basins occasionally fail to provide adequate percolation because of poor design, high water table elevation, or inadequate maintenance. The quality of the recharged water also tends to be poor, contributing to the degradation of water supply. The constituents of this poor quality water are many, deriving mainly from urban and industrial development: metals, fertilizers, de-icing compounds, roadway hydrocarbons, air pollutants, pesticides, animal wastes and concrete leachates. Thus, the maintenance of terrestrial open spaces, free of the influences of development, is of prime concern to Zone III. Furthermore, a good deal of open land exists in this zone at the present time, and it would be of great ecological value to preserve some of that land undisturbed. Thus, the watershed management option for Zone III is beneficial from an ecological point of view.

PLAN IIIA

Plan IIIA is similar to IIIB in its approach; however, it is less comprehensive in its level of control. Thus, Plan IIIA presents most of the benefits enumerated above, but does not allow the full range of benefits obtained by implementation of Plan IIIB.

PLAN IIIC, D, E

Plans IIIC–E call for sewering developed sections of Zone III The environmental implications of sewering are discussed in Section 4.2.13. Sewering can be expected to help preserve the water quality of the aquifer at a high level. However, strict fertilizer and animal waste controls are required if the present excellent water quality is to be maintained. Although present data is not detailed enough for analysis to indicate the relative contributions of different sources of nitrate and organic chemicals in various areas, the data shows clearly that each contaminant is contributed by several categories of sources. Thus, the approach of Plan IIIC, which includes a variety of control measures, is an environmentally prudent one. However, side effects such as changes in the water table (alleviated if wastewater is recharged) and sludge generation are introduced.

4.3.4 Zone IV: North Fork and Eastern South Fork. The aquifer underlying the North Fork is of locally marginal water quality (see Table 4–36). mainly in areas underlying farms. Also, there is the potential for saltwater intrusion if pumping patterns are not carefully managed. This is due to adjacent saltwater bodies in the north and south. Modeling done for the South Fork for this project showed that if pumping patterns were carefully

Table 4–36

EXAMPLES OF HIGH NITRATE-N CONCENTRATIONS IN SELECTED GROUNDWATER TEST WELLS UNDERLYING ZONE IV

Well Location	Date Sampled	NO_3–N (mg/l)
Mattituck	10-22-75	16.3
Greenport	10-19-75	8.2
Southold	11-03-75	12.0
East Mattituck	09-16-75	13.1
Test Plot (North Fork Potato Farm)	03-26-75	23.0
Test Plot	03-26-75	21.0
Test Plot (South Fork Potato Farm)	03-26-75	20.0
Test Plot	03-26-75	17.0

Source: Miller and Sgambat, (1977b).

controlled, water quantity and salinity would not be a problem. However, existing data suggests that water quality will not be a major problem in Zone IV if strict control measures are not implemented.

The alternative plans present several approaches to the problem of water supply on the Forks. Plans IVC to IVE, water quality preservation plans, require sewering in residential areas and/or non-point source controls. Agricultural fertilizers are an important source of nitrates to the groundwater in the North Fork and eastern South Fork. Control of that nitrate source is the central aspect of Plan IVB. Plan IVA, water importation, calls for importation of water for domestic use from areas to the west. Thus, North Fork and eastern South Fork aquifers' water quality would be allowed to degrade despite state and national policies opposing degradation. Sewering would be minimized, allowing water table levels to be maintained. Plans IVC, D and E are sewering approaches which correspond in their impacts to IB, C and D. Plans IVB to E are superior options with respect to public health, since Plan IVA allows irretrievable contamination of the aquifer Plans IVA and IVB are superior with respect to stream flow and wetland preservation since water table levels can be more easily maintained. Plan IVB is the overall environmentally favored approach, involving, again, the same tradeoffs discussed for Zone I.

PLAN IVA

The environmental impact of Plan IVA would involve writing off a segment of the aquifer as a resource. According to today's knowledge of groundwater, this would be a permanent and irretrievable action, at least on a scale of 100 to 200 years. If Plan IVA were implemented, agricultural fertilzation could proceed at any level and landfills serving a large region could be sited in Zone IV. In addition, sewering could be avoided except in localities with septic tank failures.

PLAN IVB

The environmental effects of Plan IVB would resemble those of Plan IA. The success of Plan IVB is to a large measure dependent on non-point and non-structural controls. Due to the importance of farm-related sources, fertilizer controls would constitute a key aspect of the plan. The effectiveness of such measures is subject to uncertainty. Thus, although the level of environmental benefits expected to be obtained from Plan IVB are high, the uncertainty associated with that expectation is also high. Since fertilizer nitrogen is the major contributor of nitrates in Zone IV, Plan IVB with selective sewering is clearly the environmentally dominant option.

PLANS IVC TO IVE

The effects of Plans IVC to IVE would be similar to those of Plans IB to ID. However, since fertilizer nitrogen is the dominant groundwater pollutant in Zone IV, the benefits of sewering are not proportionately as great as for other zones. If Plans IVC, IVD or IVE are implemented, any sewage treatment plant outfalls should be excluded from the creeks of Peconic/Flanders Bays. Rather, they should be located in the open bay or in the ocean. Recharge or stream augmentation with tertiary treatment would be the most environmentally favorable Wastewater Treatment Plan option because of its positive effect on preserving the present water level of streams and wetlands. Currently existing wetlands in Zone IV are critical to the maintenance of acceptable water quality in the Peconic estuary and in the Peconic/Flanders Bay creeks.

4.3.5 Zone V: Western South Fork. The western South Fork area is very similar to Area IV except that agricultural land use is much reduced and is replaced by residential use. Plans VA to VE correspond with Plans IVA to E and the environmental impacts also correspond. The major difference is that the reduced importance of agriculture reduces the difficulties in implementation that were presented when discussing Plan IVB. Zone V also is presently the site of numerous supply wells. Attention to the regulations of pumping patterns is of environmental importance, since modeling of the South Fork showed that poorly managed pumping could result in local saltwater intrusion problems.

4.3.6 Zone VI: Surface Water Impact Area. See 4.3.15.

4.3.7 Zone VII: South Shore Shallow Flow Discharge System. The are underlying Zone VII is a Magothy discharge zone. Thus, contamination from activities in Zone VII will mainly affect the glacial aquifer. Zones VII and VIII are alike in being shallow flow zones. Hence, the discussion of the options for Zone VII is also relevant to the Zone VIII options (Section 4.3.8). The significant difference between Zones VII and VIII is that the former contains a number of streams that feed the South Shore bays. These streams are important recreationally, ecologically, and as a freshwater source to South Shore bays (Section 4.1.2.2). Streamflow will diminish if sewering occurs without recharge or streamflow augmentation. The effectiveness of a shallow recharge program to maintain water table levels is untested and uncertain. Thus, a minimum sewering alternative (sewering only in areas of septic tank failure) is the environmentally preferable option unless VIIA to VIIC are accompanied by effective measures for streamflow protection. Plans VIIA to VIIC are likely to be detrimental to the South Shore bays ecosystem due to alterations of the water budget unless water table preservation measures work. Thus, Plan VIIA to C are environmentally less acceptable without stream augmentation (possibly including shallow recharge). The effectiveness of recharge measures, is still uncertain. All of the proposed non-point controls will have significant environmental benefit.

4.3.8 Zone VIII: North Shore Shallow Flow System. The land constituting Zone VIII occupies a band of varying width along the North Shore of Long Island. Zone VIII has been restricted to those locales for which extant hydrologic data shows a horizontal or upward movement of groundwater. Zone VIII may be expanded to include more of the North Shore when monitoring activities are extended to other locales. A significant proportion of the precipitation in Zone VIII runs off to bays and to bay tributaries. The fraction of precipitation entering groundwater has not been accurately established but appears to vary locally from zero to 50 percent. A significant portion of the shoreline area is also characterized by a high water table. A saturated zone means that septic system failures are likely.

The three plans for Zone VIII are similar to the three for Zone VII. Plans VIIIB and C are sewering options and Plan VIIIA is a minimum sewering option. The environmental tradeoffs are similar to those for Zone I Plan VIIIA, if implemented properly, would be environmentally superior, while Plans VIIIB and C may be environmentally acceptable but involve secondary environmental impacts. For Zone VIII, the uncertainties associated with Plan VIIIA and the secondary impacts of Plans VIIIB and C are less important, since the water is not moving into the Magothy aquifer. All three plans call for sewering of areas of septic tank failure. With present technology, that is the only satisfactory option for the saturated zone. Thus, all plans are acceptable from that standpoint.

All three plans call for siting of landfills within Zone VIII. From a groundwater quality standpoint, this clearly an acceptable strategy. Siting of landfills on sites underlain by horizontally or upward moving groundwater will protect the Magothy aquifer However, care must be taken to protect the natural resources of the bays. Metals and organics may be transported to the bays from landfills via groundwater underflow. Thus, the siting of landfills involves a tradeoff of groundwater quality versus impacts on natural resources. On the other hand, if landfills are not sited, then there remains a significant waste disposal problem with the likelihood that the wastes would be exported from the region. If disposal sites for hazardous wastes are not allowed, ocean dumping is likely From a marine resource standpoint, it appears environmentally sounder to site hazardous waste disposal areas and obtain substantial, if not complete, filtering of leachates before they reach bays rather than to deposit hazardous wastes at ocean dumping sites. With

respect to solid wastes, reuse is the environmentally favorable alternative.

The control of surface runoff is a key requirement in Zone VIII (see Section 4.2.14). Provisions for substantial removal of coliform bacteria and nitrate from surface runoff is a requirement for an acceptable plan for Zone VIII. Surface runoff control has been discussed for each North Shore bay in Sections 4.3.9, 4.3.10, 4.3.11, 4.3.13 and 4.3.14. Surface runoff is a pollutant source that falls somewhere between the alternatives for land area and alternatives for bays. It is important that the topic be clearly integrated into the final plan.

In addition to the points covered above, Sections 4.2.13, 4.2.15 and 4.2.16 discuss some general issues relevant to minimum sewering Plan VIIIA and 4.2.2 discusses some issues relevant to VIIA to C. In summary, the three plans are environmentally acceptable. From an environmental standpoint, VIIIB and C may be unnecessarily cautious, resulting mainly in local surface water improvements. Land use controls under a minimum sewering plan would have significant ecological benefits, as was discussed with respect to Plan IIIB.

Surface Water Alternatives. (Corresponds to Section 3.5.2.2.)

4.3.9 Manhasset Bay. Manhasset Bay is located in northwestern Nassau County, adjacent to Long Island Sound. The shore of the bay is lined with commercial facilities. Most of the shoreline has been filled and bulkheaded, leaving just 87 acres of vegetated wetland remaining (NYSDEC, 1977a). This lack of coastal wetlands by itself represents a significant change in the bay ecosystem. This change has probably caused a significant decrease in vertebrate communities in the bay. The shoreline developments contribute a wide range of pollutants to the bay. The bay is reputed to be one of the best pleasure boat areas on the Sound. There are numerous marinas and yacht clubs. In addition to effects that can be linked to extensive development, the quality of the tidally flushed bay is dominated by conditions in Long Island Sound. These two factors, as well as the treatment plant loadings from three sources, contribute to very high nutrient levels and the contamination of shellfish beds by total coliform bacteria. Although the entire bay is rich in hard clams, it has been closed to shellfishing due to high coliform concentrations. In general, barring improvements in Long Island Sound quality, pollutant abatement measures [(B) (a) (i)], [(B) (a) (iii)], [(B) (a) (iii)] will have only local effect. The flushing of the southern end of the harbor is poor and upgrading of sewage treatment or relocation of the outfalls could achieve locally significant improvements in water quality. However, even if Sound and bay water quality were to be improved, the lack of wetlands would continue to severely constrain the bay's ecological viability.

Modeling has demonstrated that the boundary conditions from the Sound may sometimes overshadow any effects from pollutant sources within the bay (Johanson *et al.*, 1977a). The Management Plan therefore calls for New York City and southwestern Connecticut to institute effective controls on the many sources contributing loads to the Sound. But since such measures are outside the direct scope of the Nassau-Suffolk 208, specific actions have not been detailed in this Plan. Several specific measures are proposed that may have some local beneficial effect on the bay. However, if Sound conditions are not improved, the benefits of extensive local measures such as centralized collection of domestic wastes or treatment plant upgrading will probably not be significant enough to outweigh the costs. Since benefits are not expressible in dollar units, an absolute judgment cannot be made.

Local measures recommended for the bay include upgrading the treatment plants [(B) (a) (i)], moving the outfalls to mid-bay locations [(B) (a) (ii)] diverting flows out of the area [(B) (a) (iii)], and instituting non-point controls. The negative environmental effects from upgrading the Port Washington and Great Neck plants will be minimal in terms of wetland loss, since the surrounding areas are already developed. If steps are taken to control runoff from any needed construction, then the short-term negative impact upon the bay waters will also be minimal. If advanced treatment is implemented without both phosphorous and nitrogen removal, the N/P ratio may be lowered with detrimental effects upon the phytoplankton. However, due to the tidal exchange in the bay and the dominance of the Sound conditions, changes in the N/P ratio will not be great. The beneficial results of this treatment will be local in nature. Some improvements in the nutrient levels and oxygen demand will be noted in the vicinity of the present outfalls. Model predicted buildups in the southern portion of the bay will be mitigated. General nutrient and coliform bacteria levels in the bay will not be much improved due to Sound conditions. No reduction in the closed shellfish zone is anticipated. Benefits from additional treatment measures will be minimal if non-sewering options for surrounding land areas are selected, since the volume of treated flows will remain near present levels.

Moving the outfall to a mid-bay location will probably do more than advanced treatment to relieve high nutrient buildups in the southern and eastern portions of the bay, as shown in the modeled scenarios. However, such an action requires trenching the bottom and backfilling in order to lay a pipeline, and results in short-term adverse effects upon fish and shellfish from the increased turbidity, as noted in Section 4.2.16. There is also the problem of spoil deposition, and in Manhasset Bay, with its developed shoreline, there may be a tendency to use the last remaining wetlands as dump sites. Such wetland use should be avoided. As with the AWT option, benefits of treatment measures will be small if minimum sewering options are selected.

For one dwelling unit per gross acre to three dwelling units per gross acre sewering scenarios, diversion of the effluent out of the area will go further than [(B) (a) (i)] or [(B) (a) (ii)] to improve local water quality and to benefit the organisms of the bay. Planning must be done carefully to assure that the areas to which the flow is diverted can handle the increased flow. In that regard, it should be kept in mind that the ocean and Long Island Sound are not infinite sinks (see Section 4.2.16). The danger of pipeline leakage or deterioration exists, but can be minimized with proper design and

construction. Even complete removal of point sources by diversion of all wastes out of the bay cannot improve either the baywide nutrient balance or the water quality with respect to bacterial levels because of the overriding influence of Long Island Sound.

Non-point and storm runoff loads constitute a significant problem in Manhasset Bay due to extensive shoreline development and lack of wetland to buffer non-point inputs. For example, they account for 30 percent of local nitrogen inputs to the bay. Thus, a control program that does not effectively control non-point inputs will not be an acceptable strategy. The proposed Best Management Practices approach to storm runoff controls [(B) (b) (i)] has some likelihood of reducing the coliform bacteria, nutrient, metal and organic chemical loads to Manhasset Bay. However, it is not known how effective such an approach will be. Hence, it is strongly recommended that a pilot study be implemented to test the effectiveness of Best Managment Practices in reducing non-point runoff.

In summary, a combination of structural measures to control point sources, alternatives [(B) (a) (i)], [(B) (a) (iii)], [(B) (a) (iv)], non-structural measures to control non-point sources, and minimization of sewage flows in surrounding land areas could produce local water quality improvements. The dominating influence of Long Island Sound water on bay water quality makes it impossible for Nassau and Suffolk Counties alone to control the quality of the bay water. However, AWT or mid-bay discharge could have significant local benefits. No action, option [(B) (a) (v)], is another alternative that could be followed at present. If [(B) (a) (v)] were to be selected it would represent a judgment that the local water quality benefits obtainable for other options could not be justified on a cost/benefit basis when compared on an areawide basis with investments in other water quality controls. The onus is clearly on the City of New York to control the large pollutant flows which degrade western Long Island Sound water quality.

4.3.10 Hempstead Harbor. Hempstead Harbor has been highly developed for both industrial and residential use. It has many similarities to Manhasset Bay in terms of loss of wetlands, significance of non-point inputs, and importance of the Sound influence. This harbor handles the largest amount of water-borne commerce on Long Island (Gross *et al.*, 1972) and also shelters many pleasure boats. In general, it is well flushed and subject to substantial influences from Long Island Sound. Although the bay has high potential for production of hard clams, the entire bay has been closed to shellfishing due to coliform contamination. There are also some areas of shoreline and natural woodland, which support beach and upland species, but the wetlands, so vital to nutrient cycling, have all but disappeared. The most recent survey estimates that a total of only about 83 acres of vegetated wetland remains in Hempstead Harbor (NYSDEC, 1977a). Landfill from shoreline development has also changed the character of the bottom sediments and has reduced the harbor area by a small amount. As in the case for Manhasset Bay, local control measures [(C) (a) (i)], [(C) (a) (ii)], [(C) (a) (iii)] or [(C) (b)] will result in only limited, locally observable improvements in water quality. For example, controls on Glen Cove Creek discharges will mainly improve conditions only within that creek, because of the dominance of Sound influence in the open bay. For that reason, the structural measures discussed below are only marginally justifiable from a cost/benefit standpoint, and [(C) (a) (iv)] is an attractive alternative.

Structural controls have been proposed to mitigate pollutants in Glen Cove Creek and the inner harbor. Glen Cove Creek is subject to both municipal and industrial loads. These loads probably contribute significant quantities of nutrients, metals and organic chemicals; however, detailed source inventories are not available. The loads combine to severely degrade local water quality; the industrial loads of metals and organic chemicals constitute the bulk of the problem. Industrial discharges to Hempstead Harbor are specifically considered in alternative [(C) (b)] and it appears that it would be beneficial if such discharges in Glen Cove Creek, which are meeting present standards, were to be pretreated beyond presently required pretreatment or that outfalls be routed out of the area (possibly to the centralized hazardous waste facility). Until treatment measures for the full suite of contaminants are instituted and toxic conditions in the creek abate, implementation of nitrogen controls will have little or no effect on the ecology of Glen Cove Creek.

Currently, the Glen Cove Sewage Treatment Plant is upgrading to include nitrification of wastes and the Powers Chemco plant is ugrading to remove ammonia. However, according to the Tetra Tech model (Johanson *et al.*, 1977b), nitrogen removal is required to alleviate water quality stress. In order to mitigate the localized nutrient concentration in Glen Cove Creek, the Management Plan calls for either nitrogen removal at both the Glen Cove Sewage Treatment Plant and Powers Chemco ammonia removal plant, [(C) (a) (i)], or relocation of both outfalls to mid-bay, [(C) (a) (ii)]. The impacts of these actions are discussed in 4.2.15 and 4.2.16. Either of these actions would substantially improve the nitrogen water quality in Glen Cove Creek, although the harbor as a whole would be only slightly improved because of the overriding influence of Long Island Sound. Upgrading the plants would pose very little threat environmentally, since there are no endangered wetlands or habitats in the vicinity of the plants. Since much of the bottom sediments in the creek have been altered already, and none of the bay is open to shellfishing, the impact of dredging and laying an outfall pipeline is not expected to be adverse if timed to avoid peak periods for spawning and for recreational use.

Similar impacts in Hempstead Harbor can be expected from the various courses of action. The same set of choices as outlined for Glen Cove (upgrade treatment or locate outfall in mid-bay) are applicable to the Roslyn Treatment Plant flows, if one dwelling unit per gross acre or two dwelling units per gross acre sewering is implemented. In particular, the flushing of the southern end of the harbor is poor and upgrading treatment or relocating the

outfall would improve the water quality greatly. Instituting nitrogen removal without phosphorus removal, however, could result in changes in dominant phytoplankton and a consequent perturbation of the marine food web within the southern portion of the harbor. Thus, phosphorus removal with accompanying nitrogen removal should be considered. An estimated nineteen percent of nitrogen loads to the bay are contributed by non-point sources. Metals, organics, coliform bacteria and sediment are also components of the non-point sources. As with Manhasset Bay, wetland edges have largely been filled and runoff directly impacts the bay without the benefit of a buffer. The implementation of non-point controls should accompany point source measures. Non-point controls, for example, could result in lowered coliform levels in water adjoining beaches. However, for this bay, non-point controls alone are clearly not adequate.

In summary, industrial effluent controls [(C) (b)], non-point controls [(C) (c)], and point source controls [(C) (a)] can all produce local improvements in water quality. As with Manhasset Bay, improvement of Long Island Sound conditions is a necessary precursor to the restoration of a healthy nutrient balance and reduction of coliform bacteria in the harbor. Until this can be done, no great improvements in the nutrients, BOD, and finfish and shellfish populations can be expected for Hempstead Harbor, as a whole, and local measures will be only marginally cost-effective. As with Manhasset, the onus is on New York City and southwestern Connecticut to implement the measures that will contribute to improvement in western Long Island Sound and Hempstead Harbor However, AWT or mid-bay discharge could have significant local benefits. No action, option [(C) (a)(iv)], is another alternative that could be followed at present. *If* [(C)(a) (iv)] were to be selected, it would represent a judgement that the local water quality benefits obtainable for other options could not be justified on a cost/benefit basis when compared on an areawide basis with investments in other water quality controls. Best Management Practices [(C)(b)] should be implemented no matter which of the point source control alternatives is selected

4.3.11 Oyster Bay. Oyster Bay supports distinctive commercial and recreational resources. These include a major National Wildlife Refuge Area and a significant mariculture industry. The presence of the refuge area dictates that particular caution be exhibited in order to safeguard the protected wildlife habitats. With respect to 208 alternatives, this mainly suggests that (1) trace contaminants (organic chemicals and metals) that may enter the food web be controlled and (2) overall pollutant loads be controlled to maintain the diversity of planktonic and benthic food organisms near the bottom of the food chain pyramid. The presence of the mariculture industry suggests that the bay system should be protected from pollutants that impose shellfish health risks, such as coliform bacteria and trace contaminants (organic chemicals and metals). In addition to their role as an economic resource, these oyster populations may play a significant role in maintaining nutrient and phytoplankton equilibria. It is likely that these populations, in addition to the extensive wetlands, are partly responsible for keeping the nutrient levels low by acting as sinks.

To safeguard the commercial and recreational resources of the bay and its embayments, several potential pollutants need to be controlled. These include metals, organic chemicals, coliform bacteria and suspended solids. There is a paucity of monitoring data for trace contaminant levels in the water columns, sediments or organisms of the bay system. At present, however, point source inputs of trace pollutants to the bay system are limited. The only industrial sources of significance are oil transport facilities, which are the sites of occasional small spills. Suspended solids are also contributed mainly by non-point sources. Thus, the major concern regards future industrial sources and non-point sources, and, therefore, alternative [(D) (a) (i)] is acceptable.

The plan for waste management in Oyster Bay calls for the application of stormwater runoff controls to reduce coliform levels, [(D) (b)]. Non-point sources are estimated to contribute 77 percent of the bay's nitrogen loads. The use of non-structural measures alone may well be insufficient in reducing contamination due to total coliforms and trace contaminants (*i.e.*, metals, organic chemicals) in a situation where pollutants from non-point sources constitute the bulk of the load. The reductions that will be achieved are not predictable prior to a pilot effort. Both total coliform and metal levels directly affect the harvestability of the shellfish in the bay. Thus, structural runoff controls are desirable for maximum protection of bay resources.

A substantial portion of the existing wetlands in and around Oyster Bay are under the purview of the Oyster Bay National Wildlife Refuge. The existence of the refuge protects the wetlands of Oyster Bay, which are an important stopover on the Atlantic Flyway. Thus, the recommended long-term policy position *vis-a-vis* Oyster Bay is to keep the bay system in a relatively pristine state. Several measures are needed: (1) structural non-point control options are important since the effectiveness of non-structural approaches is uncertain, (2) nitrogen and phosphorus removal for any discharges, [(D) (a) (iii)], should be considered even though modeling runs found that secondary treatment would result in "acceptable" ambient levels; removal of discharges from the bay in favor of recharge or Sound discharge could also be considered, [(D) (a) (ii)] or [(D) (a) (iv)], (3) strict preservation of all wetlands and terrestrial buffer zones is required.

4.3.12 Huntington Bay. Although the waters of this bay complex are relatively well mixed, two of the four harbors, Northport and Huntington, show low dissolved oxygen and high nutrient levels. These two harbors are also the locations of two treatment plant outfalls, and have relatively few wetland areas on their perimeters. Many of the shellfish beds in these harbors, while showing potential for production, have been closed due to coliform contamination.

One of the recommendations for Huntington Bay is nitrogen removal at both sewage treatment plants alternative [(E) (a) (i)]. This would control

the nutrient level and thus avoid algal blooms; however, the phosphorus would remain high and the steady state N/P ratio in these harbors could decrease. Such an effect can alter the dominant phytoplankton species in the water and thus perturb the feeding shellfish, which depend upon phytoplankton for most of their food If phosphorus is also removed, the alternative becomes environmentally superior.

A second option for controlling nutrients in these harbors is moving the outfalls to mid-bay locations [(E) (a) (ii)]. This would reduce the nutrient levels within the bay without significantly altering the N/P ratio, and thus would be beneficial to the phytoplankton and shellfish in the waters. The three other options involve routing sewage out of the area, [(E) (a) (iii), (iv) and (v)]. From the standpoint of Huntington Bay quality, these last three options are the best, although no option adding to effluent loads to Oyster Bay should be considered.

In evaluating these structural options, additional environmental impacts must be addressed. First, it must be noted that, if minimum sewering options for surrounding land areas are selected, flows will remain near present levels. Upgrading of treatment is essential even if non-structural non-point measures are implemented. In order to upgrade the treatment plants under option [(E) (a) (i)], construction of new facilities will be required (see Section 4.2.15). Caution must be exercised to avoid erosion and degradation of surrounding areas. Because there is very little wetland in the area surrounding these plants, wetland loss is unlikely in this case. Of more concern is the second option, which requires trenching the bottom and back-filling to lay a pipeline out to the middle of the bay (see Section 4.2.16). This action may impact upon the benthic organisms, particularly the valuable shellfish. Such effects tend to be transitory in nature. Time of year of construction activities becomes critical. Very high rates of sedimentation may result in habitat loss, clogged shellfish feeding mechanisms, and smothering. Other problems include altered bottom topography and circulation patterns. These effects can be minimized by replacing extracted sediments over the pipeline, grading, contouring the substrate and relocating shellfish following construction. The increase in turbidity can be minimized by careful deposition of spoil, but some effects will inevitably remain. The recharge alternatives [(E) (a) (iii) and (v)] have possible health and feasibility drawbacks associated with them and, in Zones I and VIII, present no particular benefits (Miller and Sgambat, 1977a).

Non-point inputs constitute an estimated 80 percent of nitrogen loading and 99 percent of total coliform bacteria loading to Huntington Bay. Thus, control of non-point inputs [(E) (b)] is in some respects more important than point source controls. The non-structural controls that have been proposed are untested. Thus, the results of a pilot effort such as that suggested in 4.2.14, above, are needed to determine whether structural non-point controls will be required

Wetland acreage has been greatly reduced in the Huntington Bay area over the past fifteen years. There are two interpretations of the effect of this reduction One is that the fewer the remaining wetlands, the more essential is their preservation to the ecology of the area. The other is that once wetlands have been reduced below a critical size, they no longer represent a viable functioning habitat unit in a given system. The authors adhere to the second viewpoint and suggest that strict preservation of wetlands in other bays (Oyster Bay, Peconic Bay) is likely to be much more worthwhile than institution of such measures in Huntington. However, the remaining wetlands in Huntington Bay are clearly a valuable aesthetic resource.

In summary, structural point source controls [(E) (a)] appear to be dominant under maximum sewering (one dwelling unit per acre) schemes for reduction of locally high nitrogen and low dissolved oxygen (D.O.) in Huntington and Northport Harbors. Non-point controls [(E) (b)] are dominant under minimum sewering for nitrogen and D.O. and under all sewering schemes for total coliform bacteria.

4.3.13 Port Jefferson. Port Jefferson Harbor contains valuable shellfish resources, but only some 150 acres of wetland remain. The central harbor, which is a port for commercial shipping, is also the site of the Port Jefferson primary sewage plant treatment outfall. It is this central harbor that is subject to high nutrient levels and contains closed shellfish beds. The embayments, Conscience Bay and Setauket Harbor, are rich in marine and bird resources. Those areas are relatively unaffected by STP outfalls but would benefit from non-point controls. In fact, existing non-point inputs to the embayments contribute to conditions in the open bay.

The structural control plan [(F) (a)] for Port Jefferson does not call for nutrient removal at the treatment plant unless the flow increases dramatically. Since the the sewage treatment plant presently provides only primary treatment, upgrading to secondary treatment alternative [(F) (a) (i)] is expected to mitigate the impacts of increased flow. The Tetra Tech model predicts that a fifteen million gallon per day (the actual flow increase under one dwelling unit per acre sewering is expected to be only some eight million gallons per day) secondary effluent will only slightly degrade nitrate levels and is actually a positive step for phytoplankton growth with respect to nutrient ratios. The anticipated N/P ratios would be higher than those observed at present and thus there is no cause for concern over dominant phytoplankton species. However, if the plant should be upgraded to advanced treatment alternative [(F) (a) (ii)] then a problem may arise unless phosphorus is removed with the nitrogen. Under minimum sewering, no AWT would be required.

Another proposed structural measure is a mid-bay outfall alternative [(F) (a) (iii)]. This alternative is environmentally acceptable in that steady state nutrient ratios will not be affected and nitrate levels will change minimally The dredging that will be necessary to lay the pipe will occur in sediments that are silty and may be somewhat polluted. If care is exercised in recontouring the benthos and in disposing of the spoil, the short-term effects

associated with increased turbidity will be minimal. The most productive shellfish areas are located in Conscience Bay and Little Bay-Setauket Harbor, which are removed from the proposed construction area in the main harbor Thus, effects upon the shellfish may be minimized as well Again, under minimum sewering options, this measure would not be required.

Another structural solution calls for the recharge of any effluent flows in excess of present levels alternative [(F) (a) (iv)]. This would require advanced treatment of effluent to minimize nitrogen discharges to groundwater. A health risk of contributing chlorinated organic chemicals to groundwater would exist if the effluent were to be chlorinated, however, further study of this problem is needed and other disinfection procedures may be required. If health risks associated with disinfection procedures can be eliminated, recharge would be acceptable. Organic chemicals contributed to groundwater by recharge would be much less than non-point and industrial inputs. Metal contributions would probably be negligible due to pretreatment of industrial effluent.

The second portion of the Management Plan calls for stormwater runoff controls to reduce coliform and nutrient levels [(F) (b)] As discussed above, this is a positive measure for the shellfish populations within the embayments, although the nature of Port Jefferson Harbor's sediments suggest that the main harbor may remain an unproductive habitat despite water quality improvements, because of prior pollution and/or the natural state of the sediment.

In summary, the requirements for structural point source measures are moderate under maximum sewering and minimal under minimum sewering strategies. Non-point source controls are needed to maintain and improve the quality of the western embayments. There are no clearly dominant alternatives, although recharge seems to be an attractive choice. In contrast to the western North Shore bays, for which flow diversion to South Shore facilities is feasible, for Port Jefferson recharge is the only presently available option for routing sewage flows away from the North Shore.

4.3.14 Peconic Estuary, Flanders Bay. The Peconic-Flanders system is a particularly sensitive system, since the site is a shallow estuary, with low tidal flushing in the western portion. There are more than 1,400 acres of wetlands, although many areas have been dredged or filled, and wetland destruction continues at a slow rate. Unless such infringement is completely halted and some wetlands reconstructed, the nutrient levels in the estuary will continue to rise, possibly leading to disruption of the ecosystem at some future time. The creeks and Peconic estuary are particularly sensitive, exhibiting high nitrate and low dissolved oxygen.

The wastewater management for Peconic-Flanders requires treatment of the duck farm effluents to remove nitrogen. Some of the farms have already stopped discharging into the river or tributaries; when the three remaining significant dischargers also cease discharging, the nutrient levels will fall to an acceptable level This will have a beneficial effect upon finfish and shellfish, avoiding algal blooms and maintaining a higher dissolved oxygen concentration. Such an action may, however, have a negative effect on the duck farm industry. Although some local farms have recently closed, a connection between regulatory enforcement and the facility demise has not been established. Such losses may be unavoidable if a healthy bay ecosystem with a balanced nutrient cycle is to be maintained.

The upgrading of the Riverhead Treatment Plant will be necessary even if the effluent load does not increase, under the sewering strategies selected. Moving the outfall out of the Peconic estuary to a bay or Sound location, [(G) (a) (ii)], [(G) (a) (iii)], [(G) (a) (iv)], would prove far superior environmentally than maintaining the present outfall [(G) (a) (i)], because of high nitrate and low dissolved oxygen (D.O.) in the estuary. In fact, maintaining the outfall at its present site, [(G) (a) (i)] is environmentally unacceptable. There is more flushing in the bay than in the estuary, so that nutrient buildups are mitigated. As long as the precautions for dredging and construction discussed in Section 4.2.16 are followed, moving the outfall to a Sound location will tend to improve the environmental quality of the estuary and bay. Immediate establishment of a monitoring program [(G) (c)] to measure effects of the present outfall in the Peconic estuary is required under any option, in order to provide information on the nature of D.O. patterns in the estuary.

It is strongly recommended that the D.O. standard for Peconic-Flanders be modified. Historical data show that: (1) the Peconic-Flanders system presently supports productive marine populations, and (2) 23 percent of historical samples are below the present NYSDEC standard. Thus, no matter which options or measures for the Peconic-Flanders system are selected, violations of the present New York State D.O. standard are likely to continue.

It is clear that, due to problems involved in discharging to the Peconic-Flanders system, minimum sewering in Zone IV is a desirable strategy and option [(G) (a) (i)] is unacceptable. Non-point measures [(G) (b)] are needed as well to minimize D.O. and nutrient degradation. Non-point sources contribute 24 percent of nitrogen loadings to Flanders Bay but will contribute a higher percentage when duck farm discharges cease.

4.3.15 South Shore Bays. The South Shore bays, especially Mecox, Moriches and eastern Great South Bay, tend to be sensitive to pollutant inputs. Large portions are shallow, tend to be poorly flushed, and concentrations of nutrients and coliforms readily build up. Such areas support large populations of phytoplankton, which can easily induce dissolved oxygen deficits when nutrient levels rise. They support significant fish and shellfish populations, which are sensitive to salinity changes and which easily accumulate trace levels of metals and organics.

The measures proposed for the South Shore bays are designed to minimize nutrient inputs into the bay. According to Tetra Tech's model, inputs into eastern Great South Bay and the most western of the South Shore bays are already too high and need to be reduced. A similar situation probably

exists for Moriches and Mecox Bays; however, modeling studies and extensive sampling of these bays was not included in the 208 Program. The proposed measures present the most stringent set of controls on nitrogen that could be implemented and are environmentally optimal from nitrogen, phytoplankton and dissolved oxygen standpoints. However, full implementation of the Plan element calling for the reduction of groundwater underflow nitrate-nitrogen concentration to two milligrams per liter will be difficult to achieve.

The strategy of sewering (one, two or three dwelling units per gross acre) gives treatment plant effluent a significant role in the South Shore bays' freshwater budget. The Tetra Tech model suggests that the combination of stream flow reduction and discharge of effluent to the ocean would change the salinity gradients in the bays, especially in eastern Great South Bay. Also, groundwater investigations (Miller and Sgambat, 1977c) show that water table levels and stream flows are reduced along the South Shore in sewered areas. Any change in average bay salinities is likely to impact the distribution of fish and shellfish in the bay This impact would not necessarily be negative, but in the absence of a good predictive tool with which to assess the probable change, the prudent environmental approach is to assume a negative impact. Reduction in stream flows and wetland levels will adversely impact the area of wetland habitat available to birds and fish populations. Thus, from an environmental standpoint, minimizing sewering is desirable, depending upon the level of nitrogen loadings that must also be controlled. For the Zone VII—western South Shore bays system, minimum sewering (only in areas of septic system failures) is judged preferable, based on measures required for water table maintenance and the ability of the bays to flush nutrients entering in the groundwater flow. There is an appreciable decrease in the effectiveness of tidal flushing, as a means of nitrate dispersal, at the eastern end of Zone VII For the Zone VI—eastern South Shore bays system, a judgment is based on a tradeoff of wetland levels and bay salinities versus bay nutrient levels. It is a difficult choice, and strict land use controls together with a variety of nutrient contols would be the best option, with sewering avoided when possible. Stream augmentation (with shallow recharge, if feasible) of all effluents in Zones VI and VII is the only acceptable option if sewering occurs. Any effluents recharged or discharged to streams require extensive tertiary treatment beyond nitrogen removal.

Non-point runoff contributes significant amounts of nitrates and coliform bacteria to South Shore bays. It is strongly recommended that a pilot effort at implementation of both the non-structural and structural approaches be instituted for the South Shore. Only after analysis of data from such pilot efforts can it be determined whether non-structural non-point source controls are effective. From an environmental standpoint, structural controls are the currently prudent strategy, due to the uncertainties associated with the Best Management Practices approach.

Specific considerations for each South Shore bay are as follows:

Mecox Bay. Mecox Bay is characterized by violations of dissolved oxygen and coliform bacteria standards (Bigham and Lorenzen, 1977). The bay exhibits poor flushing through an inlet that requires frequent dredging if it is to be kept open. The naturally poor exchange characteristics of the bay suggest that the bay's poor water quality may be at least partially a natural condition. Nevertheless, the surrounding land areas are somewhat developed and the associated human activities have contributed to the violation of standards. Most notably, residuals from duck farming have been historically discharged to the bay. This practice has left a sizeable deposit of organically rich sludge in Hayground Cove. This deposit contributes to nutrient loading and to oxygen consumption.

Mecox Bay exhibits "threshold" levels of various water quality variables; that is, violations of standards occur, but the biological community that can be observed is not one of chronically low diversity. Augmented loadings can be expected to push the bay ecosystem into a polluted state, whereas decreased loadings can be expected to reduce violations of criteria. Thus, the stringent controls recommended as alternatives [(H) (a)] and [(H) (c)] are environmentally prudent and likely to result in easily measurable ecological benefits. From an ecological standpoint, construction of a new inlet [(H) (b)] is likely to significantly alter the bay's ecology. It is as likely to be detrimental as beneficial.

Sewering in the vicinity of Mecox Bay (parts of Zone V) will affect water levels of wetlands and streams connected to Mecox Bay. Such changes are likely to be detrimental to bay ecology. Thus, sewering alternatives imposed without recharge or flow augmentation are not ecologically prudent.

Shinnecock Bay. Shinnecock Bay is connected to Peconic Bay, Moriches Bay and the Atlantic Ocean. All of these connections are by way of narrow inlets and canals. The exchange of bay water with Atlantic Ocean water is via the Shinnecock Inlet and is considerable, as indicated by Shinnecock Bay salinity (Pagenkopf and Bigham, 1976). Shinnecock Bay tends to display lower nitrogen, coliform bacteria and solids levels than Mecox or Moriches Bays. Thus, the need for a full array of strict controls for Shinnecock Bay is less pronounced than for adjoining bay waters. The measures suggested for Shinnecock Bay [(I) (a)], [(I) (b)] will all be ecologically beneficial. However, the present good condition of the bay and the extensive tidal exchange suggest that strict application of the measures, especially of [(I) (b)] are of lower priority than are similar efforts affecting other sections of the South Shore.

In particular, sewering in the vicinity of Shinnecock Bay is not justifiable on surface water nitrogen grounds and is likely to be detrimental to local wetlands and streams.

Moriches Bay. Moriches Bay is similar to Shinnecock Bay in geologic origin and tidal exchange (Pagenkopf and Bigham, 1976). The bay is large in area and contains valuable wildlife, fish and shellfish habitats. High nutrient and coliform bacteria levels have been noted in Moriches Bay Further additions of nitrogen would pose the threat of serious environmental degradation.

Changes in ambient nutrient levels and in hydrodynamics have historically caused problems in Moriches Bay. In the late 1950's, closing of the Moriches Inlet resulted in significant algal blooms and loss of shellfish productivity. These historical events have demonstrated the ecological necessity of all of the measures [(J) (a)] and [(J) (b)]. Two further considerations, not specifically noted in Section Three, are worth mentioning here. First, an historical study of Moriches Bay nutrient relationships has emphasized the importance of the N/P ratio as an indicator and as a possible controlling factor. Thus, careful monitoring of the ratio is required, if this plan is to be environmentally acceptable. Specific control actions will have to be formulated from time to time, as the ratio shifts. Second, sewering in the area surrounding Moriches Bay (parts of Zones V and VI) will probably be detrimental to the bay ecosystem and will, at a minimum, impose a difficult set of environmental tradeoffs. A benefit of sewering would be decreased nitrogen input to the bay from groundwater underflow; a serious detriment would be lowered wetland water levels and stream flows, unless stream augmentation (with shallow recharge, if feasible) could successfully maintain the water table. Lowered water levels and stream flow would be likely to change the character of the bay's contiguous wetlands and might alter the bay's salinity regimes. The wetland areas are of great importance to the bay's nutrient cycle and marine food web. The specific material flow and ecological community changes cannot be predicted.

Eastern Great South Bay. Eastern Great South Bay is a highly productive system. The ecological community yields large populations of commercially and recreationally important fish and shellfish. Among the most significant resources are hard clams and winter flounder The area exhibits great sensitivity to long-term changes in freshwater inflows, rainfalls and wind patterns. The system appears to be delicately balanced and quite vulnerable to many sorts of changes. The system has a natural variability, which can be expected to increase or decrease depending on pollutant inputs. Major increases in system viability can be expected to be negative in impact. Among the events that could seriously alter or destabilize the ecosystem are natural climatic and predator-prey cycles, and changes in inlet configuration, streamflow, patterns of nutrient inflow, and sediment makeup.

To minimize changes in inlet configuration, monitoring of the hydrodynamics and periodic dredging are required. Implementation of such a program is an acknowledgement that maintenance of the current ecological community is more desirable than allowing natural evolution of the bay ecosystem to occur. Construction of a new inlet as suggested in [(K) (b)] is undesirable from an ecological standpoint because it is impossible to predict what community shifts would be imposed. The community shifts thus imposed might even include establishment of new, undesirable predator-prey links.

To minimize excess nutrient inputs, measures [(K) (a)] and [(K) (c)] have been proposed. [(K) (a) (iii)] and [(K) (c)] are both needed. [(K) (a) (ii)] is probably preferable to [(K) (a) (i)] because of water table considerations. However, the level of sewering is a critical factor in choosing between the two alternatives. The strict limiting of the extent of sewering with marine surface discharge in Zone VI is ecologically necessary because of the risks imposed if the water table is lowered, although tradeoffs are involved. It is uncertain whether the combination of inundation requirements for wetland plant growth and freshwater inputs for maintenance of Great South Bay salinity regimes will be met by any recharge or flow augmentation scheme. Thus, the marine ecosystem is likely to degrade under comprehensive sewering of Zone VI. However, even with sewering some nitrates will be contributed by groundwater underflow, unless there are strict controls on non-point sources. Thus, careful and extensive land use controls rather than comprehensive sewering are the measures that are environmentally preferable. The studies currently being proposed by Nassau and Suffolk Counties concerning South Shore stream flows are likely to cover these environmental matters in considerably finer detail. Such studies should carefully weigh the uncertainty imposed by water table lowering before any further sewering in Zones V, VI or VII is approved.

Western Great South Bay. These waters are transitional in nature and may require some combination of measures presented under options (K) and (L) Sewering this portion of Zone VII imposes the same risks described for Zone VI and should be avoided for those areas not already sewered. These waters are characterized by considerably higher tidal exchange than the bays to the east. They lie directly south of a densely developed region of Long Island. At present, the ability of the western bays to disperse pollutant loads is offset by the excessively high loads currently entering those waters. The major nutrient loading is contributed by effluent from the Bay Park facility. Thus, implementation of measure [(L) (a) (i)] alone will have very significant environmental benefits. Implementation of measures [(L) (a)] and [(L) (b)] will act to protect the valuable resources of these bays and are recommended. If measures [(L) (a)] and [(L) (b)] are fully implemented, groundwater nitrogen inflow will not be of major concern, since the bays will be able to maintain stable nutrient levels by flushing.

4.4 Aggregate Economic Costs

It is impossible to accurately quantify all of the real costs—monetary, indirect and opportunity— of liquid waste disposal systems for the Nassau-Suffolk Region, or for any area. There are costs that can be directly or accurately quantified. Among those are the costs for equipment for water quality monitoring, treatment plants, disposal facilities, pumps, lines, etc. However, accurate comparison of the true economic effect of alternatives for wastewater treatment, requires the incorporation of estimates for opportunity costs as well as for any unquantifiable externalities that are imposed upon the area involved It is very difficult to predict what might have happened in the future had not a particular regulation been imposed or a certain

treatment plant built. Perhaps a flourishing business with employment benefits, profits to the owner, tax revenue, and an increased "quality of life" accruing to the community is prevented from opening. It is extremely difficult to predict the expected return on the aforesaid business opportunity, just as it is extremely difficult to assign a dollar value to the "increased quality of life." However, these effects are all real benefits (or disbenefits) to the community and affect the actual desirability of the option that would cause such changes. Many other examples of opportunity costs being imposed by a particular liquid waste treatment strategy can be constructed. The important point is that while an economically and socially efficient choice of treatment strategies must take opportunity costs and externalities into account, there is no accepted, iron-clad method to reduce such costs to a form where they can be directly compared with other costs.

4.4.1 Discussion of Cost Uncertainties. Costs for various components of the Nassau-Suffolk Wastewater Quality Management Program have been estimated (NSRPB, 1978[1]). However, assembling those component costs into aggregate costs is difficult, because many of the cost estimates represent rough order approximations and many options simply defy quantification. Inability to cost out all available options has a tendency to focus attention on those elements for which cost data is known. This often results in decisions weighted toward the known costs while other, equally significant options, may be ignored or dismissed out of hand. It is the purpose of this section to explain the difficulties of specifying certain aspects of cost and to give the reader an understanding of the potential magnitude of unknown costs.

4.4.1.1 Plan Options by Hydrogeologic Zones. Table 4–37 presents a matrix of the various cost elements associated with the options considered by the NSRPB. The cost elements are displayed according to the relative accuracy that can be expected from estimates of the element's cost. The "hardest" estimates can be developed for those cost elements listed as "straight engineering" type costs. Estimates become increasingly "soft" as the reader moves to the right on this matrix and are "softest" for those elements for which the estimation involves specifiying opportunity costs.

The "hardness" of the cost estimates is dependent on the procedure used to estimate them. The procedures for estimating each element are discussed below, by cost type.

Straight Engineering Costs. Straight engineering costs are cost estimates for equipment and operations and maintenance for which the equipment required can be fully specified. Equipment for water quality monitoring at the specific locations; for pumping volume monitoring of irrigation wells required for IV B, C, D and E, as well as the equipment required for additional treatment and disposal facilities can all be completely specified, and cost estimates can be generated using standard cost estimating techniques. These techniques generally yield estimates accurate to within ± 25 percent.

Engineering with Speculation. Costs in this category are similar to those in the first category; cost estimates are based on full specifications of the equipment needed. However, the amount and size of equipment required is only estimated, because it is subject to change over the lengthy planning period involved. The cost for sewering a region once it attains a certain population density (X dwelling units per gross acre) is dependent on (1) how much of the region becomes populated with X dwelling units per gross acre; (2) in what years each of the sewered areas attained such densities; and (3) water consumption rates. Because of the potential for error in forecasting population growth, and water consumption rates, sewering costs are therefore subject to larger tolerances than harder "straight engineering" costs.

Similarly, the other element in this category—relocating water supply wells— is subject to the localized growth in water supply demand. This will determine the number of wells required and their locations.

Speculative Cost. Costs in this category are incurred only if certain conditions occur Therefore, costs for these elements may be as low as zero, but in certain cases they may also be very high. All of the cost elements in this category are contingent on environmental degradation below threshold levels that the other elements seek to preclude. Careful planning should include contingencies such as the proposed additional monitoring if water quality problems arise, contingency water treatment if water supply sources fall below acceptable quality, and contingency pumping plans (that may increase water supply units) should water demand and quality jeopardize water supply.

Difficult to Estimate. Cost elements that fall into this category relate to untested, presently not clearly detailed programs. This would include, for example, educational programs to encourage animal waste control, or possibly other measures in the event that educational programs failed to achieve desired results.

Opportunity Cost. The most difficult elements to estimate are those relating to opportunity costs. For these elements, costs are not dollars spent for equipment and operation, but rather are reflected as savings or revenue foregone because of the loss of opportunity to accrue them. For example, land use controls (*e.g.*, buffer zones or stricter controls forbidding certain forms of development) may prevent an entrepreneur from opening up a certain business in an area. The municipality loses the revenue as well as the employment potential that might have been gained from this business. The entrepreneur may also lose the profits he might have earned by opening in the area. It is extremely difficult to predict the expected return on the foregone business opportunities because the value of the business opportunity is not clear. The problem is further aggravated by the fact that opportunity costs are borne by various groups, not just the municipality. In the example above, the entrepreneurs incur opportunity costs, as do workers who may have prospective jobs foreclosed to them.

[1]Nasau-Suffolk Regional Planning Board, 1. Section H: Municipal Waste Treatment Systems Needs, 2. Section L: Urban and Industrial Stormwater System Needs.

Table 4–37

NATURE OF COST UNCERTAINTIES FOR HYDROGEOLOGIC ZONE ALTERNATIVES

Areawide Alternatives		Straight Engineering	Engineering with Speculation	Difficult to Estimate	Speculative
		Expanded Industrial Waste Disposal regulations Structural Runoff Controls Provide for treatment of Hazardous Wastes Provide Sludge Disposal Alternatives Require Nitrogen Removal for Inland Treatment Plants	Promote Water Conservation Storage and Transport of Chemical Products Regulations Minimize Pollution from Site Preparation Reduce Reliance on Landfills	Septic Tank Maintenance Prohibit Use of Chemical Cleaners	Restrict the Use of Fertilizers Nonstructural Runoff Controls Reduce Animal Wastes Minimize Population Density
Hydrogeologic Zone – Specfic Alternatives					
Zone	Alternative				
I	A	Permit no Additional Sewering	Strictly Control On-site Systems	Strictly Regulate Site Management Practices	Specify Acceptable Lot Size
	B	Sewering			
	C	Sewering			
	D	Sewering			
II	A	Route Wastes to Cedar Creek Require Wellhead Treatment		Water Importation	
III	A	Permit No Additional Sewering	Strictly Control On-site Systems	Strictly Regulate Site Management Practices	Specify Acceptable Lot Size
	B		Monitoring Program		Land Use Controls
	C	Sewering			
IV,	A	Sewering			Water Importating
V	B	Permit no Additional Sewering	Strictly Control On-site Systems	Strictly Regulate Site Management Practices	Specify Acceptable Lot Size
	C	Sewering			
	D	Sewering			
	E	Sewering			
VI	A	Permit no Additional Sewering	Strictly Control On-site Systems	Strictly Regulate Site Management Practices	Specify Acceptable Lot Size
	B	Sewering			
	C	Sewering			
	D			Construct and Maintain New Inlet	
VII,	A	Sewering			
VIII	B	Sewering			
	C	Sewering			

Excluding landfills from various areas will create costs reflected in the higher costs for landfilled waste disposal. Additional transportation to landfills located outside a zone from which landfills are excluded, will increase labor (hours for driving) as well as vehicle O & M costs (gas, oil, tune-ups, replacements). It may also preclude local control of landfills by towns within zones excluding landfills.

Excluding the development of water supply wells similarly increases water supply costs. Wells will have to be developed outside of certain zones, thus requiring additional piping and pumping costs.

A fertilizer management program may reduce a farmer's output or raise his costs by forcing him to use more expensive alternative fertilizers. Reduced profit will also reduce income tax revenues.

4.4.1.2 Plan Options by Surface Water Bodies. Table 4—38 presents the elements of the NSRPB plan options for surface water bodies. Here again, the elements are displayed according to the accuracy with which their costs can be estimated. The problems of estimating costs for these elements are subsumed in the previous discussion.

4.4.2 Estimates of "Hard" Cost Components for Representative Alternative Plans. In costing alternatives, it is necessary to quantify as many of the cost components as can be accurately and objectively derived, and to then rely on human value judgements in assigning a relative value to those costs that cannot be quantified. One still remains on shaky ground. This section will present representative calculations on the quantifiable costs for three different wastewater treatment alternatives for Nassau and Suffolk Counties. In addition, those aspects that are basically unquantifiable will be identified and discussed briefly, while the task of placing a value judgement on their relative costs will be left to the 201 level studies.

The present worth cost data has been taken by ERCO from estimates by Roy F. Weston in *Nassau County Wastewater Management,* October 1977. The average (levelized) annual cost for the three alternatives was obtained by dividing the present worth by 11.129, which is the appropriate conversion factor for calculations using a twenty year planning period and a discount rate of 6.375 percent.

Of the annual costs to be incurred, capital costs are subsidized by both the Federal Government and the State of New York, and operating and maintenance (O & M) costs are subsidized by the State. Because the available data did not specify the projected net cost to the counties, it was necessary to select a subsidy rate that would reflect both the capital and O & M subsidies as well as the fact that O & M costs are incurred throughout the period and are thus subject to the discount rate of 6.375 percent. A subsidy rate of 75 percent was estimated for purposes of analysis.

To obtain the average annual cost to the county as a percentage of the tax structure, the estimate of the average annual cost is divided by an estimate of the tax revenues for Nassau and Suffolk Counties. Ideally, this

Table 4—38

NATURE OF COST UNCERTAINTIES FOR SURFACE WATER ALTERNATIVES

Water Body	Alternative	Straight Engineering	Engineering with Speculation	Difficult to Estimate	Speculative
Manhasset Bay	(a) (i)	Nitrogen Removal			
	(a) (ii)	Move Outfall			
	(a) (iii)	Divert to Cedar Creek			
	(a) (iv)	Divert to Port Washington			
	(a) (v)				No Action
Hempstead Harbor	(a) (i)	Nitrogen Removal			
	(a) (ii)	Move Outfall			
	(a) (iii)	Divert to Glen Cove, Port Washington, or Cedar Creek			
	(a) (iv)				No Action
	(b)		Maintain and Abate Industrial discharges to Glen Cove Creek		
Oyster Bay	(a) (i)	Retain Present Treatment			
	(a) (ii)	Divert to Cedar Creek			
	(a) (iii)	Nitrogen Removal			
	(a) (iv)	Divert to Glen Cove			

Table 4—38 . . . Cont'd

Water Body	Alternative	Straight Engineering	Engineering with Speculation	Difficult to Estimate	Speculative
Huntington Bay	(a) (i)	Nitrogen Removal			
	(a) (ii)	Move Outfall			
	(a) (iii)		Tertiary Treatment and Recharge		
	(a) (iv)	Divert to Regional Site			
Port Jefferson Harbor	(a) (i)	Secondary Treatment			
	(a) (ii)	Nitrogen Removal			
	(a) (iii)	Move Outfall			
Flanders Bay—Peconic Estuary	(a) (i)	Nitrogen Removal			
	(a) (ii)	Move Outfall			
	(a) (iii)	Nitrogen Removal Move Outfall			
	(a) (iv)	Move Outfall			
	(c)		Monitoring		
Mecox Bay	(a) (i)				Prohibit new discharges
	(a) (ii)	Nitrogen Removal			
	(b)			Stabilize Inlet	
	(c) (i)				Severely restrict development
Shinnecock Bay	(a) (i)				Prohibit new discharges
	(a) (ii)			Maintain Inlet	
	(b) (i)				Severely restrict development
Moriches Bay	(a) (i)				Prohibit new discharges
	(a) (ii)	Nitrogen Removal			
Great South Bay	(a) (i)	Ocean Outfall			Prohibit new discharges
	(a) (ii)		Tertiary Treatment and Recharge		Prohibit new discharges
	(a) (iii)	Nitrogen removal			
	(b)			Construct new inlet	
	(c) (v)				Prohibit new development
Western South Shore Bays	(a) (i)	Ocean outfalls			
	(a) (ii)	Divert Outfall			
	(a) (iii)		Upgrade Lawrence Treatment Facility		
Nearshore Atlantic Ocean					Strict Enforcement of Ocean Dumping Regulations
Fresh Water Bodies	(a)	Nitrogen Removal			

estimate of the tax revenue should be an estimate of the forecasted average annualized tax revenues through the twenty year planning period. However, no such estimates have been obtained. Therefore, it was necessary to use historic data for each county. For Nassau County, the tax revenue estimates were obtained from a prospectus for a recent county bond issue that included the average revenue for the period 1970–1974. This figure has been used as a measure of estimated future tax revenue, and is likely to understate tax revenues, which are presumed to grow over time. For Suffolk County, the value used for future estimated tax revenue is the 1976 tax revenue figure given by a prospectus for 1977 Southwest Sewer District Refunding Bonds.

A. *Alternative 1.*[1] One Dwelling Unit (D.U.) Per Gross Acre Sewering for All Groundwater Zones; Non-structural Non-point Controls; All Bay Discharges to Ocean or Sound.

The cost figures developed by Roy F. Weston are formulated for different scenarios. By selecting the costs that correspond to the specifications in Alternative One, a total for the quantifiable costs can be obtained. Table 4–39 presents the total quantifiable costs in both Nassau and Suffolk Counties, assuming a control strategy corresponding to Alternative One. The costs are broken down into costs for sewering and treatment, for non-structural non-point source pollution controls and for hazardous industrial waste treatment. Each of those categories is in turn expressed in terms of average (annualized) cost *to the county* as a percentage of tax revenues based on the estimates discussed earlier. A similar procedure is followed for Alternatives Eight and Twenty-one, which are presented in Tables 4–40 and 4–41 and are as follows:

B. *Alternative 8* One Dwelling Unit Per Gross Acre Sewering for All Groundwater Zones; Structural Non-point Controls; South Shore Bay Discharges to Ocean; North Shore Bay Discharges to be Secondary Treated Mid-Bay Outfalls.

C. *Alternative 21.* Strict Fertilizer Controls, Five Dwelling Units Per Gross Acre Sewering for All Groundwater Zones; Structural Non-point Controls; South Shore Bay Discharges to Ocean; North Shore Bay Discharges to be AWT Outfalls at Inner Harbor Sites.

For all four categories in each of the three alternatives, the least expensive regional option was selected. Where no regional options were given in the sources, the least expensive existing option was chosen. Therefore, it is quite possible that the costs could be higher if different strategies were adopted for some reason other than cost. Keep in mind also that the costs presented are only those costs borne by the respective counties. The remainder of the burden is covered by Federal and State Government subsidies at a rate of 75 percent of the total cost.

The calculated cost estimates exclude the costs of laterals, which may be on the order of 100 percent of other collection and treatment costs. As can be seen from Tables 4–39 to 4–41, the relative quantifiable costs for all three alternatives are fairly similar, but are more expensive for Suffolk

Table 4–39

WASTEWATER DISPOSAL FINANCIAL BURDEN[1]

Alternative One: One D.U./Gross Acre, Sewering for all Groundwater Zones, Non-structural Non-point Controls; All Bay Discharges to Ocean or Sound.

Costs To County	Millions of Dollars			
	Nassau		Suffolk	
	Average Annual	% Tax Revenue	Average Annual	% Tax Revenue
Sewering & Treatment*	7.8	3.1	31.525	27.2
Sludge Disposal (Regional Composting)**	1.8	.7	4.2	3.6
Nonstructural Non-point Control Costs†	.2	.07	.38	.33
Hazardous Industrial Waste Treatment Costs†	.1	.04	.16	.14
	9.9	3.9	36.3	31.3

**Source: Roy F. Weston and SUNY at Stony Brook, Nassau County Wastewater Management, October 1977. "Final Output of Recommended Treatment Levels and Sensitivity Runs."*

***Source: Nassau Suffolk Regional Planning Board, 208 Areawide Waste Treatment Management. Section K, "Residual Waste Control Needs," November 1977.*

†Source: Same as above except Section 1, "Urban and Industrial Stormwater Systems Needs, November 1977.

[1]Costs exclude costs of laterals which may equal the total of all other collection and treatment costs.

County than for Nassau County, where a considerable portion of the area is already sewered. The magnitude of the costs for Alternatives One, Eight and Twenty-one may range from about 3.9 to 4.3 of Nassau County's single year tax revenues, while the relevant magnitude of costs in Suffolk may range from about 30.8 to 33.6 percent of the county's single year tax revenues. In other words, if the costs implied in one of the three selected alternatives were incurred in a single year, the cost could total about four percent and 30 percent of Nassau and Suffolk's tax revenues, respectively, for that year. In fact, however, it must be realized that capital costs for water treatment purposes are typically borne through time, and in staged amounts, by means of bonding. Moreover, the gestation period of such investments requires that the construction and the cost of such projects be phased through time.

[1]Alternatives discussed in Section H of the Areawide Waste Treatment Management Plan.

Table 4—40

WASTEWATER DISPOSAL FINANCIAL BURDEN[1]

Alternative Eight: One D.U./Gross Sewering for all Groundwater Zones; Structural Non-point Controls, South Shore Bay Discharges to Ocean; North Shore Bay Discharges to be Secondary Treated Mid-Bay Outfalls.

Costs To County	Nassau Average Annual (Millions of Dollars)	Nassau % Tax Revenue	Suffolk Average Annual (Millions of Dollars)	Suffolk % Tax Revenue
Sewering & Treatment*	6.4	2.5	31.5	27.2
Sludge Disposal (Regional Composting)**	1.8	.7	4.2	3.6
Non-structural Non-point Controls†	1.7	.7	3.1	2.7
Hazardous Industrial Waste Disposal Costs†	.1	.04	.16	.14
	10.0	3.9	38.95	33.64

Source: Roy F. Weston and SUNY at Stony Brook, Nassau County Wastewater Management, October 1977. "Final Output of Recommended Treatment Levels and Sensitivity Runs."

***Source: Nassau Suffolk Regional Planning Board, 208 Areawide Waste Treatment Management. Section K, "Residual Waste Control Needs," November 1977.*

†Source: Same as above except Section 1, "Urban and Industrial Stormwater Systems Needs, November 1977.

[1]Costs exclude costs of laterals which may equal the total of all other collection and treatment costs.

4.4.2.1 Uncertainties in the Costs. The costs given here should be taken as order of magnitude costs only. A number of factors contribute to this, including the following:

1. The costs are estimates and involve basic uncertainties in their formulation, as do all estimates of future costs.

2. The capital costs have been amortized over a twenty year life span and with a 6.375 percent discount rate. Changing the period of time or the discount rate will change the average annual cost as well.

3. The tax revenues are estimated from actual historic revenue data. Thus, they most likely understate the tax revenues that are expected to increase with time as the area grows.

4. The costs used are for the least expensive of the regional plan estimates. If other waste treatment options are adopted, the cost would increase correspondingly.

Table 4—41

WASTEWATER DISPOSAL FINANCIAL BURDEN[1]

Alternative Twenty-one: Strict Fertilizer Controls, 5 D.U./Acre Sewering for all Groundwater Zones; Structural Non-point Controls, South Shore Bay Discharges to Ocean; North Shore Bay Discharges to be AWT Outfalls at Inner Harbor Sites.

Costs To County	Nassau Average Annual (Millions of Dollars)	Nassau % Tax Revenue	Suffolk Average Annual (Millions of Dollars)	Suffolk % Tax Revenue
Sewering & Treatment*	7.2	2.9	28.3	24.4
Sludge Disposal (Regional Composting)**	1.8	.7	4.2	3.6
Non-structural Non-point Controls†	1.7	.7	3.1	2.7
Hazardous Industrial Waste Disposal Costs†	.1	.04	.16	.14
	10.8	4.3	35.76	30.84

Source: Roy F. Weston and SUNY at Stony Brook, Nassau County Wastewater Management, October 1977. "Final Output of Recommended Treatment Levels and Sensitivity Runs."

***Source: Nassau Suffolk Regional Planning Board, 208 Areawide Waste Treatment Management. Section K, "Residual Waste Control Needs," November 1977.*

†Source: Same as above except Section 1, "Urban and Industrial Stormwater Systems Needs, November 1977.

[1]Costs exclude costs of laterals which may equal the total of all other collection and treatment costs.

It should be evident, then, that care must be taken when utilizing any of these figures for comparison of the alternatives. It should also be clear that other factors play a part in any decision involving any choice of waste treatment alternatives.

4.4.2.2 Unquantifiable Costs. Some of the other important factors to consider come under the rubric of opportunity costs. For these elements, costs are not dollars spent for equipment and operation, but rather savings or revenues foregone because of the loss of opportunity to accrue them. For example, land use controls (*e.g.*, buffer zones or stricter controls forbidding certain forms of development) may cause the loss of business opportunities

or other alternatives that would have resulted in benefits for the community Thus, the cost of that land use control is the direct cost of implementing the control *plus* the foregone benefits that would have resulted had the control not been implemented. It is clear that foregone future benefits are virtually impossible to predict, and that it is even more difficult to place a dollar figure on their social and dollar value. However, they embody a cost to society and must not be dismissed out of hand as trivial or inconsequential. Opportunity costs can neither be accurately quantified nor ignored. Therefore, intelligent estimates must be made about the magnitude of the opportunity cost involved and some measure of a subjective judgment must occur as to which alternatives will be chosen. The scope of this report does not extend to such a task, it will be left to the policymakers.

4.4.3 Secondary Impacts of Pretreatment. Pretreatment requirements can be expected to induce secondary economic effects. Adequate pretreatment will be very costly for some industrial dischargers who generate residuals for which simple removal technologies have not been developed. The economic burdens to industrial dischargers will be very unevenly distributed depending on the match of the state-of-the-art of wastewater engineering to particular waste streams. Small industries can be expected to suffer a high burden, percentage-wise. Detailed economic analyses will be required as part of the special studies.

4.5 Overall Impacts and Discussion

4.5.1 Aggregate Bi-county Impacts. This section takes an Island-wide view of the various measures that were discussed in 4.2 to 4.16 on a bay-by-bay and zone-by-zone basis. This Island-wide view lends itself to consideration of intermedia pollutant tradeoffs. Such tradeoffs include the following: groundwater-surface water, surfacewater-solid waste, and groundwater-wetland quality. These tradeoffs are presented in terms of net residual loadings to the various media. (Presented for seven alternatives: Tables 4–42 to 4–48.)

The residuals loadings have been calculated by use of a residuals allocation procedure developed by ERCO (Beck and Post, 1978) Values of eight variables are calculated for eight bays, eight groundwater zones, Long Island Sound and the Atlantic Ocean. In many cases the values are only order-of-magnitude estimates. However, these estimates are useful for the study of Island-wide patterns and intermedia tradeoffs. This residuals allocation procedure provides a summary and overview of the detailed studies, models and analyses that have constituted the Nassau-Suffolk 208. The values of variables have been specified using data from many of the 208 technical reports.[1]

Twenty-two Island-wide control strategies were considered using this procedure. These twenty-two alternatives cover a wide range of approaches including sewering (one dwelling unit per acre sewering Island-wide), non-structural groundwater nitrogen control with selective sewering (five dwelling units per gross acre sewering Island-wide), recharge of effluent, ocean disposal of all effluents, and no action. The complete list of alternatives is given in Table 4–49.

The tradeoffs fall into several groups. First, choice of sewering at low densities is expected to lower groundwater nitrogen; add more surface nitrogen; decrease streamflow, unless recharge completely mitigates the effect; and generate additional solid waste. Choice of ocean outfalls preserves bay conditions at the expense of Long Island Sound or ocean nitrogen loading. Choice of recharge may introduce various contaminants into the groundwater, but mitigates streamflow decreases and improves bay nitrogen conditions.

Organics are not included in the residuals allocations. This is because there is no basis for formulating estimates. Inventories of sources of organic chemical contaminants are still being assembled. Thus any load estimates would be pure guesswork. An assessment of relative contribution of domestic versus industrial loads does not exist. If organic chemicals follow the pattern of other contaminants, non-point and domestic disposal sources can be expected to be proportionately important. Chlorinated effluents may be a dominant load. Due to the uncertainty concerning all sources, the plan elements presented in Section Three can only be assumed to provide control of several specific sources of organic contaminants Other important sources, such as runoff recharge basins, are not yet included in the plan. Thus, due to the nature of the health risks imposed by the organic chemicals, further work including source inventories and analyses, ambient monitoring, and technology research, is of high priority from an environmental viewpoint.

Air pollutants are also not included in the residual allocation summaries. The major potential for air pollution is in the disposal of treatment plant sludges. The sludge loading numbers give a general picture of air pollution potential if incineration is the selected disposal method. However, there are many alternatives for sludge disposal Composting and land application involve a minimum of air pollution. Pyrolysis contributes a smaller suite of air residuals than incineration, although the fine particulates contributed by pyrolysis are particularly troublesome. Thus, from an air pollution standpoint, composting and land application are favored approaches.

As can be seen from the residuals loading allocation tables comparing the 22 options, there is no clearly environmentally preferable strategy. Certain classes of risks will have to be tolerated in order to minimize others that are deemed more critical. Among the water quality problems least reversible, and therefore of greatest concern, are high organic chemical

[1] Major sources:
Nitrogen and Coliform: Point source loads for 1995 at one dwelling unit per acre by Weston (1977a). Non-point source loads to bays by Tetra Tech. Non-point source loads to groundwater by Porter *et al.* (1978).
Sludge: 1995 loads for one dwelling unit per acre by Weston (1977b).
Streamflows: ERCO judgements based on Miller and Sgambat (1977a).
Metals: Point Sources, Weston (1977c); *Non-point Sources,* Weston (1977d).

Table 4–42

ALTERNATIVE 1: 1 D.U./GROSS ACRE SEWERING FOR ALL GROUNDWATER ZONES; NON-STRUCTURAL NON-POINT CONTROLS: ALL BAY DISCHARGES TO OCEAN OR SOUND

	Surface Bays								Groundwater Zones							
	Manhasset	Hempstead Harbor	Oyster Bay	Huntington/Northport	Port Jefferson	Peconic/Flanders	Suffolk South Shore	Nassau South Shore	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI	Zone VII	Zone VIII
Nitrogen:																
—surface (lbs/day)	671	1,150	1,290	1,420	612	264	6,350	4,540								
—groundwater (lbs/acrs/yr)									165	165	175	200	125	165	165	200
Total Coliform (Organisms/day)	5×10^{13}	7×10^{13}	1×10^{14}	1×10^{14}	5×10^{13}	6×10^{12}	2×10^{14}	4×10^{14}	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$
Water Table (Change (Δ feet)	0	0	0	0	0	0	0	0	0	0	0	–1	–2.5	–2.5	–2.5	–2.5
Sludge (dry lbs/yr)	0	0	0	0	0	0	0	0	0	0	99,000	35,000	0	140,000	373,000	453,000

	Total Surface Water	Total Groundwater
Cu (lbs/yr)	52,000	42,000
Cr (lbs/yr)	110,000	97,000
Pb (lbs/yr)	290,000	81,000
Ni (lbs/yr)	100,000	75,000

contaminant levels in groundwater, nitrate contamination of groundwater, changes in stream and wetland water levels, and changes in bay salinity patterns. The final choices will rest with the policymakers.

4.5.2 Discussion of Sewering Density and Groundwater Nitrates. This section addresses the relationship between groundwater nitrate levels and sewering practices. In the following subsections analyses of nitrate data are reviewed, observations on interpretation of the data are given, control measure implications are discussed, and the position of nitrate concerns in the general context of intermedia environmental tradeoffs is presented. There is no optimal solution. The environmental tradeoffs are many and each tradeoff is complex. This section seeks to point out the positive and negative impacts of sewering. It is hoped that the planner, armed with this knowledge, will use sewering properly—as only one of many tools to be employed in the complex task of balancing the numerous environmental demands.

There are many public health and ecological objectives that must be weighed against the nitrate standard. In such a complex Water Quality Management Plan, it would be dangerous to base large portions of the Plan on one variable—dangerous in the sense that other variables may not be addressed. The real environmental objective function has many dimensions. Hence, it is environmentally unsound to proceed with comprehensive sewering (one dwelling unit per gross acre), or indeed even less extensive sewering plans (two dwelling units per gross acre or three dwelling units per gross acre

Table 4–43

ALTERNATIVE 8: ONE D.U./ACRE SEWERING FOR ALL GROUNDWATER ZONES; STRUCTURAL NON-POINT CONTROLS; SOUTH SHORE BAY DISCHARGES TO OCEAN; NORTH SHORE BAY DISCHARGES TO BE SECONDARY TREATED MID-BAY OUTFALLS

	Surface Bays								Groundwater Zones							
	Manhasset	Hempstead Harbor	Oyster Bay	Huntington/Northport	Port Jefferson	Peconic/Flanders	Suffolk South Shore	Nassau South Shore	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI	Zone VII	Zone VIII
Nitrogen:																
–surface (lbs/day)	5,730	4,110	2,360	9,650	2,660	7,250	5,910	4,180								
–groundwater (lbs/acre/yr)									165	165	175	200	125	165	165	200
Total Coliform (organisms/day)	3×10^{13}	5×10^{13}	7×10^{13}	8×10^{13}	3×10^{13}	4×10^{12}	1×10^{14}	2×10^{14}	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$
Water Table Change (Δ feet)	0	0	0	0	0	0	0	0	0	0	0	–1	–2.5	–2.5	–2.5	–2.5
Sludge (dry lbs/yr)	0	0	0	0	0	0	0	0	99,000	35,000	0	140,000	373,000	453,000	0	0

	Total Surface Water	Total Groundwater
Cu (lbs/yr)	29,400	24,000
Cr (lbs/yr)	63,800	54,800
Pb (lbs/yr)	164,000	44,500
Ni (lbs/yr)	56,900	42,400

Island-wide sewering), which are mainly justifiable only with respect to groundwater nitrogen. Selective sewering is certainly justified. Certain areas with high groundwater elevations, areas with very high population densities (over five dwelling units per gross acre, above which it becomes clear that non-point controls will in very few cases be sufficient) (Weston, 1977a; 1976) and certain other areas that may be identified by monitoring will require sewering; further collection of monitoring data is needed.

A major objective of bi-county 201's or further areawide planning should be collection and analysis of groundwater data for various contaminants. Sewering of large areas, especially along the South Shore, is environmentally unsound with respect to the interruption of hydrological and chemical cycles. Controls of other nitrogen sources and non-structural controls of septic tank performance should be preferentially implemented. One aspect of the Water Quality Management Program should be implementation of a permanent mapping and analysis program to lay out and update nitrate and organic chemicals susceptibility zones.
organic chemicals susceptibility zones.

Finally it should be noted that a major cause of nitrate buildups in groundwater is the alteration of natural nutrient cycling by removal of natural forest and marsh ecosystems. The best control strategy is an approach that minimizes such alterations, and includes land use controls, fertilizer controls and runoff controls, such as marsh-pond systems in runoff recharge

Table 4–44

ALTERNATIVE 10: RECHARGE OF SOUTH SHORE TREATMENT PLANT EFFLUENTS, (SECONDARY TREATMENT) MAXIMUM LAND USE CONTROLS AND NON-STRUCTURAL CONTROLS IN GROUNDWATER ZONE III, NORTH SHORE BAY DISCHARGES TO BE SECONDARY TREATED MID-BAY OUTFALLS, 1 D.U./GROSS ACRE SEWERING

	Surface Bays								Groundwater Zones							
	Manhasset	Hempstead Harbor	Oyster Bay	Huntington/Northport	Port Jefferson	Peconic/Flanders	Suffolk South Shore	Nassau South Shore	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI	Zone VII	Zone VIII
Nitrogen: —surface (lbs/day)	5,800	4,200	2,470	9,800	2,740	7,260	6,350	4,540								
—groundwater (lbs/acre/yr)									12,100	165	175	200	125	263	1,170	200
Total Coliform (organisms/day)	6×10^{13}	8×10^{13}	1×10^{14}	1×10^{14}	5×10^{13}	6×10^{12}	2×10^{14}	4×10^{14}	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$
Water Table Change (Δ feet)	0	0	0	0	0	0	0	0	0	0	0	−1	−2.5	−.5	−.5	−2.5
Sludge (dry lbs/yr)	0	0	0	0	0	0	0	0	0	0	99,000	35,000	0	140,000	373,000	453,000

	Total Surface Water	Total Groundwater
Cu (lbs/yr)	9,620	84,800
Cr (lbs/yr)	16,000	195,000
Pb (lbs/yr)	212,000	160,000
Ni (lbs/yr)	25,700	151,000

basins. With this approach, emphasis must be placed on implementation and enforcement of these controls, since their operability is less straightforward than that of sewering.

4.5.2.1 Review of the Data Analyses Done as Part of Water Quality Management Program Planning. Two analyses of observation well data have been done as part of the Nassau-Suffolk 208 Program.[1] One analysis is based on data from 127 samples. The samples selected conform to the following selection criteria: (a) Samples were restricted to wells from unsewered locales with population densities relatively stable over a twenty year period; (b) Samples were from depths less than 100 feet; (c) Samples were restricted to 1970 to the present. These conditions attempted to avoid the time of travel problems between population density input and well measurements. Weston arranged the data into five groups based on school districts. The results of their analysis are presented in Table 4–50.

A separate analysis was done using a larger sample of well measurements (Porter *et al.*, 1978). Porter's analysis proceeded by grouping the data according to uniform sized grid cells, which were smaller in size than the school districts used by Weston. The grid cells used, covered a larger geographic extent than Weston's school districts. Only grid cells covering areas

[1] A third analysis, by the USGS, has not yet been published or released, and is therefore not covered in detail in this discussion.

Table 4—45

ALTERNATIVE 12: 5 D.U./GROSS ACRE SEWERING FOR ALL GROUNDWATER ZONES: NON-STRUCTURAL NON-POINT CONTROLS; SOUTH SHORE BAY DISCHARGES TO OCEAN NORTH SHORE BAY DISCHARGES TO BE SECONDARY TREATED MID-BAY OUTFALLS

	Surface Bays								Groundwater Zones							
	Manhasset	Hempstead Harbor	Oyster Bay	Huntington/Northport	Port Jefferson	Peconic/Flanders	Suffolk South Shore	Nassau South Shore	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI	Zone VII	Zone VIII
Nitrogen: —surface (lbs/day)	3,240	2,680	1,880	5,610	1,670	3,760	6,350	4,540								
—groundwater (lbs/acre/yr)									290	290	300	325	250	290	290	325
Total Coliform (organisms/day)	5×10^{13}	7×10^{13}	1×10^{14}	1×10^{14}	5×10^{14}	5×10^{13}	2×10^{12}	4×10^{14}	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$
Water Table Change (Δ feet)	0	0	0	0	0	0	0	0	0	0	0	0	−.5	−.5	−.5	−.5
Sludge (dry lbs/yr)	0	0	0	0	0	0	0	0	0	0	49,500	17,500	0	70,000	187,000	227,000

	Total Surface Water	Total Groundwater
Cu (lbs/yr)	9,620	84,800
Cr (lbs/yr)	16,000	195,000
Pb (lbs/yr)	212,000	160,000
Ni (lbs/yr)	25,700	151,000

completely sewered or completely unsewered were analyzed. Results of Porter's analysis are given in Tables 4–51 and 4–52.

Both Weston and Porter analyzed their data sets by linear regression. Figure 4–3 presents the derived regression lines. (Table 3–11 presented in Section 3.5.2 is not a data table, but is, rather, a tabular presentation of the linear regression analysis performed by Porter.)

The USGS reports the following provisional findings based on their data:

"When the upper glacial aquifer is treated as a single unit over the entire period of record (1952–76), median nitrate concentrations show no difference over time or between the sewered and unsewered parts of the study area. Care must be exercised when comparing medians from one time interval to another because of bias introduced by the abandonment of wells, changes in samples (analyses) size, changes in sampling frequency, and changes due to hydrologic events (drought, wet periods).

Median ammonium concentrations (as N) of 0.01 milligrams per liter for the sewered area and 1.1 milligrams per liter for the unsewered area for the most recent time interval (1972–76) reflect an improvement in water quality in the sewered area. Of thirteen wells having long-term water quality records (fifteen years or more) in the sewered part of the study area, eight had significant decreasing trends in nitrate concentration with a median value of 0.21 milligrams per liter per year. Two wells had significant increasing

Table 4–46

Alternative 14: NO ACTION

	Surface Bays								Groundwater Zones							
	Manhasset	Hempstead Harbor	Oyster Bay	Huntington/Northport	Port Jefferson	Peconic/Flanders	Suffolk South Shore	Nassau South Shore	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI	Zone VII	Zone VIII
Nitrogen:																
—surface (lbs/day)	5,870	4,290	2,580	9,950	2,810	7,280	6,800	4,900								
—groundwater (lbs/acre/yr)									290	290	300	325	250	290	290	325
Total Coliform (organisms/day)	8×10^{13}	1×10^{14}	2×10^{14}	2×10^{14}	8×10^{13}	8×10^{12}	3×10^{14}	4×10^{14}	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$
Water Table Change (Δ feet)	0	0	0	0	0	0	0	0	0	0	0	0	<.5	<.5	< 5	<.5
Sludge (dry lbs/yr)	0	0	0	0	0	0	0	0	0	0	34,700	12,200	0	49,000	131,000	159,000

	Total Surface Water	Total Groundwater
Cu (lbs/yr)	10,700	94,000
Cr (lbs/yr)	17,800	217,000
Pb (lbs/yr)	235,000	178,000
Ni (lbs/yr)	28,500	167,000

trends and three wells showed no trends. In the unsewered area there was only one well with a long record of nitrate analyses, and this well had a significant increasing trend in nitrate concentrations.

Mean nitrate concentrations near the water table are significantly lower in the sewered area than in the unsewered area for both recent time periods (1967–71 and 1972–76). Lower concentrations of total nitrogen were also observed in stream water from the sewered area than in streams draining the unsewered area.

4.5.2.2 Interpretation of Data Analysis. As pointed out by Geraghty and Miller and Sgambat (1977a) and others, the movements and fates of nitrates introduced to the groundwater are very complex. Thus, a conclusive analysis of groundwater nitrate data is very difficult and wholly beyond the scope of the Water Quality Management Program. Review of individual well measurements as well as consideration of summarized data indicate the complexity of the nitrate distribution trends.

—Some wells have been sampled many times. Hence, some consideration of individual sites and grids is justified. Individual grid cell data from Porter's analysis shows high and low nitrate levels occurring at the full range of population levels. In some grids, high population densities seem to be accompanied by high nitrate levels; but in other grids, such a relationship cannot be discerned.

Summary statistics of Porter's data set show a net lower nitrate level

Table 4—47

ALTERNATIVE 21: STRICT FERTILIZER CONTROLS, 5 D.U./GROSS ACRE SEWERING FOR ALL GROUNDWATER ZONES; STRUCTURAL NON-POINT CONTROLS, SOUTH SHORE BAY DISCHARGES TO OCEAN; NORTH SHORE BAY DISCHARGES TO BE AWT OUTFALLS AT INNER HARBOR SITES

	Surface Bays								Groundwater Zones							
	Manhasset	Hempstead Harbor	Oyster Bay	Huntington/Northport	Port Jefferson	Peconic/Flanders	Suffolk South Shore	Nassau South Shore	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI	Zone VII	Zone VIII
Nitrogen: —surface (lbs/day)	862	1,210	1,230	1,690	640	604	5,910	4,180								
—groundwater (lbs/acre/yr)									275	275	225	225	225	275	275	275
Total Coliform (organisms/day)	$3x10^{13}$	$5x10^{14}$	$7x10^{13}$	$8x10^{13}$	$3x10^{13}$	$4x10^{12}$	$1x10^{14}$	$2x10^{14}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$
Water Table Change (Δ feet)	0	0	0	0	0	0	0	0	0	0	0	0	−.5	−.5	−.5	−.5
Sludge (dry lbs/yr)	0	0	0	0	0	0	0	0	0	0	49,500	17,500	0	70,000	187,000	227,000

	Total Surface Water	Total Groundwater
Cu (lbs/yr)	5,430	48,000
Cr (lbs/yr)	9,050	110,000
Pb (lbs/yr)	119,000	89,000
Ni (lbs/yr)	14,500	84,800

in Upper Glacial groundwater in sewered grids as opposed to unsewered grids. However, the information provided does not fully eliminate the possible effects of sewering from other density-related factors. Some of the other factors contributing to the lower nitrate levels may be (a) less fertilizer use in higher density areas; (b) changed runoff-recharge patterns due to impervious surfaces in densely populated areas; (c) less vegetation, with associated organic cycles and root zone activity. (d) changing land uses and, (e) geologic characteristics. The unobserved mean difference in groundwater nitrate levels between sewered and unsewered areas is 1.3 milligrams per liter for a 6.8 persons per acre difference in population density.

—Porter attempts to take into account variability of nitrate concentrations over time and by locale. His analysis of such variability led to selection of a mean of six milligrams per liter NO_3 as N as a guideline number for achieving 90 percent compliance with the ten milligrams per liter standard.

—Porter's regression analysis indicates a statistically significant correlation of a high order. However, Porter has eliminated two data points on the basis of a plausibility screen before running his analysis and these observations may reduce the statistical significance of his result.

—Weston's regression analysis is statistically significant at the 95 percent level. The zero population point used in the Weston analysis was taken from a different set of data and does not conform to the screening

Table 4–48

ALTERNATIVE 22: 5 D.U./GROSS ACRE SEWERING FOR ZONES III, IV, V, VIII;
1 D.U./GROSS ACRE SEWERING FOR ZONES I, II, VI, VII: SECONDARY MID-BAY DISCHARGES ON THE NORTH SHORE;
OCEAN OUTFALL ON THE SOUTH SHORE, NON-STRUCTURAL NON-POINT CONTROLS

	Surface Bays								Groundwater Zones							
	Manhasset	Hempstead Harbor	Oyster Bay	Huntington/Northport	Port Jefferson	Peconic/Flanders	Suffolk South Shore	Nassau South Shore	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI	Zone VII	Zone VIII
Nitrogen: —surface (lbs/day)	3,240	2,680	1,880	5,610	1,670	3,760	6,350	4,540								
—groundwater (lbs/acre/yr)									290	290	100	200	125	290	290	200
Total Coliform (organisms/day)	7×10^{13}	1×10^{14}	1×10^{14}	5×10^{14}	6×10^{12}	2×10^{14}	4×10^{14}	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$	$<10^{10}$
Water Table Change (Δ feet)	0	0	0	0	0	0	0	0	0	0	0	−1	−2.5	−2.5	−2.5	−.5
Sludge (dry lbs/yr)	0	0	0	0	0	0	0	0	0	0	49,500	17,500	0	140,000	373,000	227,000

	Total Surface Water	Total Groundwater
Cu (lbs/yr)	9,620	84,800
Cr (lbs/yr)	16,000	195,000
Pb (lbs/yr)	212,000	160,000
Ni (lbs/yr)	25,700	151,000

criteria previously discussed. It is possible that Weston's data base did not cover a wide enough range of population densities and their zero population point did not actually represent "natural" conditions. The sensitivity of groundwater nitrate concentrations to sewering density numbers in populated areas from a zero population data point may not be a wholly relevant analysis.

Since the purpose of the analysis is to compare sewered versus unsewered areas, the arguments in favor of including "natural" conditions or a "wide" range of population densities may not be particularly relevant. The unsewered areas of concern may also have high population densities. At least two interpretations of the Weston and Porter data are possible: (A) there may, in fact, be a rough cause-effect relationship between population density and groundwater nitrates, or (B) there may be a hyberbolic relationship between the two variables, such that at low populations densities groundwater nitrogen is low, and at densities greater than one half to one dwelling unit per gross acre, nitrate levels are high, they do not increase linearly, and may not be closely related to on-lot systems density. (See Figure 4–4.)

—All data is from Upper Glacial wells. Thus, the data analysis does not present conditions of Magothy water supplies. The time horizon for travel of sampled waters to waters tapped for supply may be five to 200 years. Thus, the efficacy of acting on the basis of an Upper Glacial pollution thresh-

Table 4–49

SUMMARY OF ALTERNATIVES CONSIDERED

Alternative	Description
(1)	1 D.U./Gross acre sewering for all grounwater zones; non-structural non-point controls; all bay discharges to ocean and Sound.
(2)	1 D.U./Gross acre sewering for all groundwater zones, non-structural non-point controls; south shore discharges to ocean; north shore bay discharges to be secondary treated; mid-bay outfalls.
(3)	1 D.U./Gross acre sewering for all groundwater zones; non-structural non-point controls; south shore bay discharges to ocean; north shore bay discharges to be AWT outfalls at the present inner harbor locations.
(4)–(6)	2 D.U./Gross acre sewering for all groundwater zones; the same set of alternatives as (1)–(3) in all other respects.
(7)–(9)	Structural non-point controls; the same set of alternatives as (1)–(3) in all other respects.
(10)	Recharge for south shore treatmnet plants; maximum land use and non-structural controls in Groundwater Zone III; secondary treatment and mid-bay outfalls for north shore bays.
(11)–(13)	5 D.U./Gross acre sewering for all groundwater zones; the same set of alternatives as (7)–(9) in all other respects.
(14)	No action.
(15)–(17)	5 D.U./Gross acre sewering for all groundwater zones; the same set of alternatives as (7)–(9) in all other respects.
(18)	Maximum land use and non-structural controls for Groundwater Zone III; otherwise the same alternatives as (22).
(19)–(21)	Strict fertilizer controls; otherwise the same alternatives as (15)–(18).
(22)	5 D.U./Gross acre sewering for Zones III, VIII, IV, V: 1 D.U./Gross acre sewering for Zones I, II, VI, VII; secondary treatment and mid-bay discharge on the north shore and ocean outfalls on the south shore.

old is somewhat uncertain. On the basis of nondegradation arguments, one would take non-point control measures with or without sewering. On the basis of expected net dollar returns on investment through time, expensive control measures may not be called for due to future technological advances in the state of the art which may make nitrate removal a less costly technique as well as possible economic changes.

Table 4–50

FINAL DATA SET INDICATING THE RELATIONSHIP BETWEEN POPULATION DENSITY AND RESULTING NITRATE CONTAMINATION BY SCHOOL DISTRICT

School District	Average Population Density Per Acre	Average NO_3–N Concentration 1970–Present
Westbury	8.0	11.3
Hicksville	11.2	9.4
Island Trees	12.4	13.9
East Meadow	10.5	10.2
Levittown	14.5	8.9
Initial Boundary Condition[1]	0.0	1.0

[1] *An initial boundary condition representing no population was chosen as 1.0 mg NO_3–N/l for the following reasons:*
a. The concentrations of nitrogen in precipitation is approximately 1.0 mg/l.
b. Streams draining undeveloped areas have concentrations of nitrogen close to 1.0 mg/l.
c. Data from wells in rural Suffolk have concentrations less than 1.0 mg/l.
d. The regression analysis shown in Figure 1 has an intercept of 1.99 mg/l.
Source: Weston (1977a) and Section H of the Areawide Waste Treatment Management Plan.

Table 4–51

POPULATION DENSITIES AND AVERAGE MEDIAN NITRATE-NITROGEN CONCENTRATIONS IN WATER FROM WELLS SCREENED IN THE UPPER GLACIAL AQUIFER 1972–76 IN GRID CELLS WHICH ARE ENTIRELY UNSEWERED[1]

Grid Cell No.	Persons/Acre	Average Median (mg/l)
2	1.5	2.5
55	3.3	6.6
66	0.9	1.9
71	1.5	1.5
81	9.5	19.0
82	4.2	3.1
84	0.7	1.5
104	4.4	2.3
105	10.9	9.6
119	1.6	5.0
120	6.3	9.8
123	11.9	2.3
133	1.3	1.2
140	12.8	13.0
154	2.1	3.2
157	16.6	8.4
174	8.5	7.5
Overall average	5.8	5.8

[1] *Source: Porter et al. (1978).*

Table 4—52

POPULATION DENSITIES AND AVERAGE MEDIAN NITRATE-NITROGEN CONCENTRATIONS IN WATER FROM WELLS SCREENED IN THE UPPER GLACIAL AQUIFER 1972-76 IN GRID CELLS WHICH ARE ENTIRELY SEWERED.[1]

Grid Cell No.	Persons/Acre	Average Median (Mg/l)
18	6.4	5.6
19	12.2	5.9
29	9.1	4.4
30	13.7	1.4
31	11.8	7.2
33	14.1	3.9
34	12.2	5.8
43	10.2	6.8
44	11.0	4.2
46	13.0	4.8
48	14.5	2.6
59	10.7	3.6
60	16.8	2.7
61	9.6	2.0
63	12.4	1.6
75	27.2	7.0
76	12.5	6.7
93	16.5	3.2
94	13.2	1.4
143	9.0	4.9
159	11.2	9.4
Overall Average	12.7	4.5

[1]*Source: Porter et al., (1978).*

—USGS analysis of streams suggests that unsewered areas at a given density contribute more nitrogen to surface waters than sewered areas. However, lack of stream ecology surveys limits the usefulness of that result.

—USGS aggregate analyses of Upper Glacial groundwater data gave no conclusive indication of differences in nitrogen levels between sewered and unsewered areas.

4.5.2.3 Control Measures Implications. Public Health standards (Section 4.1.1.3) dictate that nitrate-nitrogen levels remain below ten milligrams per liter in water supplies. For the 208 Program, this translates to maintenance of the Magothy Aquifer NO_3 concentrations below ten milligrams per liter or treatment at the wellhead. The Bi-county 208 Program has interpreted the standard level as a tenth percentile rather than an absolute standard. This interpretation appears reasonable. Based on that standard, and assuming treatment at the wellhead is ruled out as the primary basis of control, the analysis of well data suggests a need for widespread controls of nitrate levels. Significant violations of the standards over a twenty year period can be predicted.

The Porter well data show that sewering reduces nitrate levels. The data also shows that in many locales, the relationship of population density to nitrate levels is tenuous or nonexistent. Hence, only other controls such as fertilizer regulations, animal waste ordinances, and marsh-pond systems in recharge basins can be expected to reduce nitrate levels in those locales.

A nitrogen budget of the bi-county area by Porter *et al.* (1978) showed the major role of non-point nitrogen sources (see Table 4—53). Detailed nutrient studies of natural ecosystems have shown the important role of vegetation in recycling nitrates from rainfall and some runoff. The lack of

Table 4—53

GROSS SUMMARY OF ESTIMATED SOURCES AND FATE OF NITROGEN IN THE BI-COUNTY REGION. (BASED ON 1975 AND 1976 DATA).[1]

Source	Nitrogen Initial Load	(tons/yr.) Load to groundwater	Comment on Sink
Wastewater			
On-site systems	8500	4300	(Denitrification, etc.)
Sewers & sewage treatment			
Sewer leakage	500	200	(Denitrification, etc.)
Effluent discharge to ground	200	100	(Denitrification, etc.)
Effluent discharge to marine bays	4200	—	(Discharge to sea)
	13400	4100	
Fertilizers			
Farm (Inc. sod farms)	4000	1000	(Crop removal)
Turf (Inc. households, golf courses, etc.)	9300	5600	(Volatilization & Denit.)
Animals (primarily dogs & cats)	1600	800	(Volatilization & Denit.)
Ducks	600	300	(Volatilization & Denit.)
	15500	7700	
Precipitation	4000	3700	(By difference from totals)
Totals	32900	16000*	(Totals estimated by water/nitrogen model)

[1]*When using this table it should be noted that the numbers represent regional averages and do not refer to specific sites.*

**Assuming an annual recharge of about 500 billion gallons, the resulting concentrations in the leachate equals about 6.8 mg/l.*

Source: Porter et al. (1978).

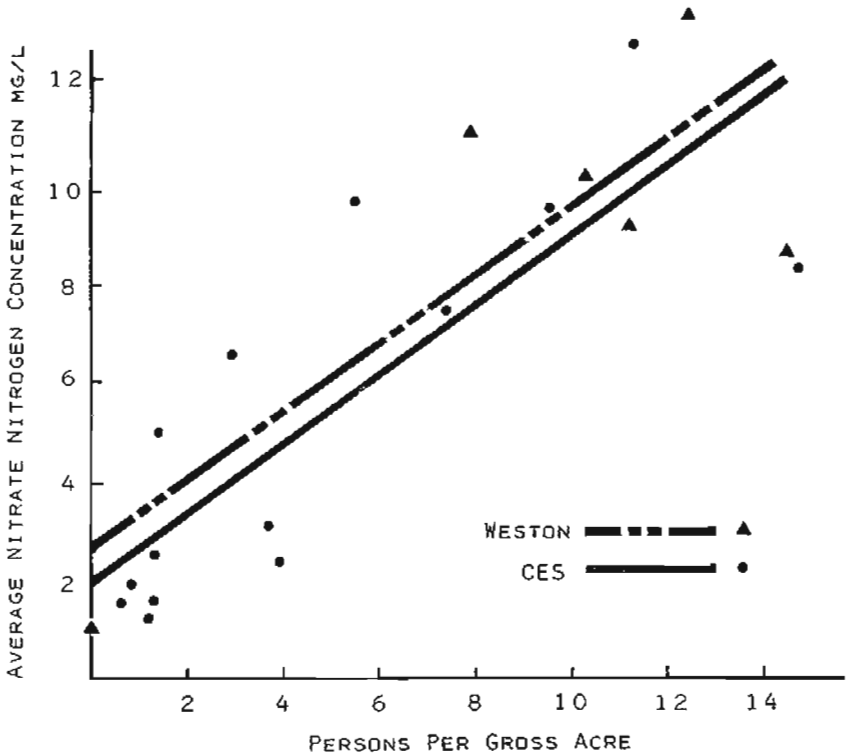


FIGURE 4–3 *Analyses of Two Independent Studies Relating Groundwater Quality to Population Density*

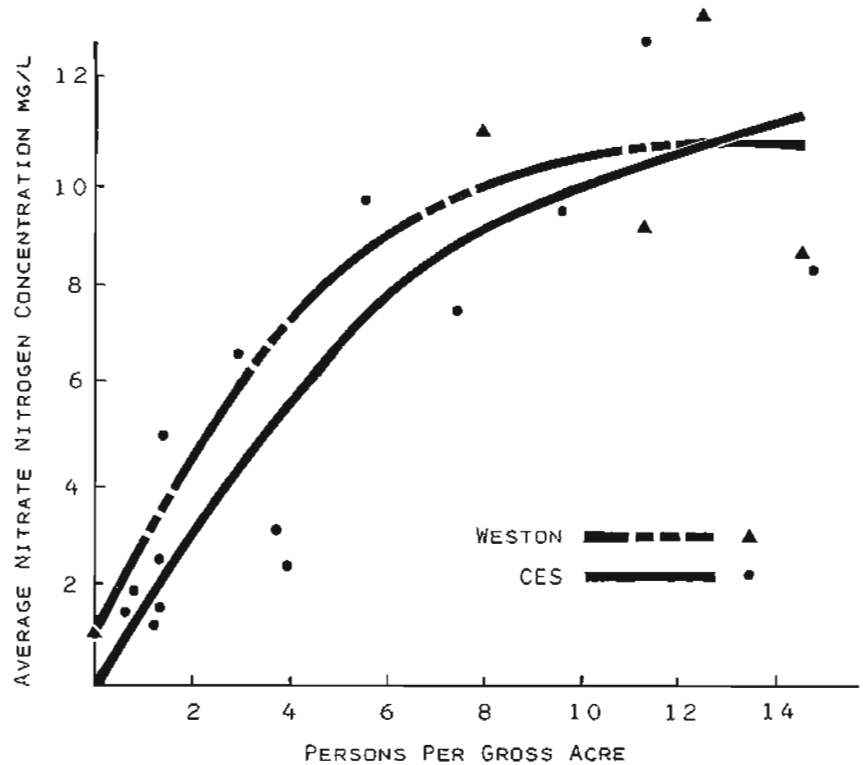


FIGURE 4–4 *Alternative Interpretation of Two Independent Studies Relating Groundwater Quality to Population Density*

natural vegetaion in the residential and urban areas of the Bi-county Region coupled with augmentation of nitrogen loads to groundwater has altered the dynamics of the natural cycles. Measures such as fertilizer controls, which reduce the nitrate loads to be cycled by grasses and crops; land use controls that preserve natural ecosystems; runoff holding ponds and marsh-ponds in recharge basins, which simulate natural ecosystem functions; and animal waste controls and street cleaning, which remove waste from artifical ecologically inactive areas can partially compensate for reduction of natural treatment of runoff and rainwater. Such measures can be expected to significantly reduce nitrate loads to groundwater.

4.5.2.4 Intermedia Tradeoffs. Acceptable groundwater nitrate levels (with associated secondary benefits) is only one of the numerous objectives enumerated in Section 4.1. The following are among the negative impacts of sewering with marine discharges: (1) reduction of streamflows and wetland inundation levels as already observed in southwestern Nassau County; (2) increase in sewage flows that must then be disposed of to bays, oceans or groundwater. Since nitrates also impose a threat to ocean waters, the net result of ocean outfalls is the transfer of a problem from bay to oceans rather than its elimination; (3) increase in sludge quantities. Increased sludge quantities may cause negative air quality impact if the sludge is incinerated, co-incinerated or pyrolyzed. (The net effect may be positive if sludge is composted); (4) induced growth may occur in those areas not already fully developed. Urban Systems, Inc. (1974) performed a detailed study that demonstrated this impact. The aggregate residuals allocation model discussed in 4.5.1 showed that comprehensive sewering was generally not a dominant option for pairwise tradeoff analyses.

4.5.2.5 Environmental Judgment with Respect to Sewering Strategy. The many tradeoffs associated with choices for groundwater protection have been carefully and critically studied. These have been considered quantitatively and analytically when possible. This has included use of statistical, graphical and cost-benefit tools. Such investigations have been summarized in this chapter in the various data tables and graphical presentations. In many cases, important aspects of the evaluation have only admitted to qualitative analysis. This has been due to lack of monitoring data or of understanding

of environmental functions. Qualitative evaluation has been in the form of expert judgment based on the literature and on ecological, chemical and hydraulic principals. Those have been presented in this chapter by way of textual explanations and argument.

Based on both quantitative and qualitative evaluation, an environmentally preferred course of action has emerged. This course involves the following:

1. Selection of nonsewering options as a general guideline.

2. Emphasis on providing the regulatory, monitoring and enforcement tools required to implement nonsewering options.

3. Selected sewering in areas where (a) on-site system failures will occur and development is allowed, (b) locally high population densities (over five dwelling units per gross acre) occur, and (c) other areas as indicated by monitoring results. The need for such selected sewering must be clearly demonstrated by 201 studies.

4. Allocate sufficient funds and develop a detailed management plan to adequately implement the watershed management approach in Zone III.

5. Strictly enforce all nonsewering controls, sewer in areas of on-lot system failures, and avoid other sewering to minimize disruption of the water balance. Closely monitor bay N levels in Zones VI and VII. Emphasize land use controls and preservation of buffer zones around water bodies and strictly preserve wetlands to minimize disruption of nitrogen cycling.

6. Only sewer in cases of on-lot system failures or if groundwater flow to bays is clearly demonstrated to present local surface water problems in Zone VIII. Given the range of tradeoff availables, this is the ecologically most sound approach to those zones.

4.5.3 The Major Tradeoffs Involved in Selection of This Course of Action.

1. The choice not to sewer at one dwelling unit per acre, two dwelling units per acre or three dwelling units per acre will allow continuation of nitrate leaching to glacial groundwater in some areas due to on-lot systems. Depending on how the data is interpreted, it appears that domestic nitrate sources will affect mean groundwater nitrate concentrations unfavorably by one to five milligrams per liter This will involve secondary impacts on bay nitrate levels for Zone VI.

2. Strictly enforced fertilizer controls, on-lot systems maintenance, animal waste controls and land use controls will reduce nitrate leaching to Glacial groundwater in some areas. If these controls work, nitrogen balances suggest this will lower mean groundwater nitrate concentrations by three to four milligrams per liter.

3. There is some uncertainty as to how effectively the nonsewering controls can be implemented. This uncertainty gives an error bracket to the figures given in point two above such that the controls may result in as low as only one milligram per liter reduction if they are poorly regulated and enforced, and may result in up to a five milligram per liter reduction if the plan is implemented in a first-class model fashion.

4. Selection of nonsewering options will greatly reduce the needs for stream augmentation and recharge. Stream augmentation (with shallow recharge, if feasible), would be a critical part of an acceptable sewering strategy. At present, there is great uncertainty associated with whether or not stream augmentation would work. Changes in inundation levels of wetlands of only a few inches will probably significantly degrade the quality of wetland habitats (see 4.1.2.2), changes in stream flows can be expected to change salinity conditions in Great South Bay.

5. Selection of nonsewering strategies would greatly reduce needs for treatment plant expansion and sludge handlign facilities. It would eliminate the need for AWT/mid-bay outfalls in bays presently surrounded by unsewered areas and in Port Jefferson Harbor and in Oyster Bay. Based on the above tradeoffs and uncertainties, it is judged that properly implemented nonsewering plan elements, with selective sewering, can be reasonably expected to have results ranging from significant lowering to slight decreases in groundwater nitrates. Comparing this with expected stream flow and marsh inundation declines and increased sewage and sludge loads, the nonsewering options are generally judged environmentally dominant. If sewering options were selected, no further sewering of Zones VI, VII and VIII (except for small treatment facilities involving local recharge of advanced treated effluent) should be undertaken until stream augmentatio/shallow recharge is implemented in the Southwest Sewer District and its effectivness is studied.

4.5.4 Concluding Remarks. Several of the key findings of this environmental assessment are repeated here. They serve as a summary of the environmental portion of the Water Quality Management Plan:

1. *Organic Contamination* of the aquifer is a critical concern. An acceptable control plan could not be drawn up for the Water Quality Management Plan due to lack of an inventory of sources. Immediate study of organics distribution and formulation of such a plan is required.

2. *Hazardous Wastes* cannot be considered an exportable residual. The proposed measures in the Water Quality Management Plan are adequate with respect to the 208 but not with respect to ultimate disposal of hazardous wastes. However, this is mentioned more as a comment on EPA policy rather than as a concludsion relating to the Water Quality Management Program.

3. *Non-point Controls* are implementable and could control a large segment of the residuals of concern. The proposed measures are adequate. Of particular importance are preservation of buffer zones, fertilizer controls, structural measures to treat runoff to bays, and marsh-pond type systems recharge basins, and controls of industrial disposal practices.

4.*Sewering* has numerous environmental drawbacks, as noted in 4.2.12 and 4.5.2.4 and should only be selectively implemented.

5. *Great South Bay's Marine Resources* will be rapidly degraded if the strict control measures proposed are not implemented.

6. *Manhasset Bay and Hempstead Harbor* cannot be expected to improve in quality except for local harbor areas until western Long Island Sound problems are corrected.

7 *Nutrient Nitrogen/Phosphorus Ratios* will be impacted if nitrogen removal wastewater treatment plants are installed without complementary phosphorus removal. This may cause adverse changes in the marine food web.

8. *The Ocean is Not an Infinite Sink.* Reliance on ocean disposal of sewage and pretreated hazardous wastes may have long term deleterious effects. This is a comment on EPA policy and not of the Water Quality Management Program.

9. *Sludge Disposal* alternatives vary widely in their impacts. Composting, land application, thermal drying are all environmentally beneficial while pyrolysis has significant energy benefits. All other alternatives should be avoided.

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Section 5 Citizen Participation

5.0 Introduction

This section is written in two parts. The first part, 5.0–5.5 discusses several generalized approaches to citizen participation, the particular method used in this 208 Study, some of the problems experienced during the conduct of the Program, and a recital of a specific success achieved by the citizens that proved the efficacy of having an active Citizen Advisory Committee (CAC).

The second part, 5.6–5.11, was written by the CAC and is their appraisal of the planning alternatives prepared by the 208 Study.

Governmental decisionmaking in the United States is generally based on the notion that in a federated republic the elected representatives shall act as surrogates for the citizens. The ballot box serves as the arbiter of how well the 'voice of the people' is heard. Even communities with strong attachments to the colonial home-rule town meeting format honor the concept of citizen participation in theory—not in practice. Of course, special interest groups have had access to the process by the use of lobbying, or in more limited instances seeking recourse through litigation. Either of these means is substantially limited to those individuals or organizations with sufficient financial support to wage a successful campaign.

The Johnson Administration formalized the concepts of 'participatory democracy' by mandating citizen participation in much of the domestic legislation.

A recital of the decade's short history of these efforts is one of limited success. Governmental access was made possible to a small number of publicly or politically oriented individuals who were locked out of the traditional political routes to power.

Despite some of the early creakings and groanings of disenchanted citizens, frustrated technicians and concerned politicians, the Congress has been increasingly mindful of the benefits to democratic mythos if workable citizen participation could be achieved. A strong factor was the need to recognize and respond to the growth of consumer, environmental and social planning advocacy organizations. The common thread linking these diverse groups in common allegiance was their adversary posture towards government. The common credo was simple. Each of the loose constituencies affected by governmental actions, or inactions, relative to their interests, argues that they are not able to secure relief because the government represents the "establishment" rather than the citizenry. A solution to such unresponsiveness was to use public interest lawyers to direct litigation against governmental programs and actions.

An obvious alternative to such confrontation politics is to render government more responsive by greater citizen involvement. This choice appears to be the conscious committment of Congress, specifically in domestic legislation relating to community planning, environmental and social issues.

5.1 Participation Models

The regulations prepared to implement the 1972 Amendments to the FWPC Act mandated citizen input in Section 208 planning efforts. The regulations do not, however, describe or define how such participation is to be structured, selected or operated. Unfortunately, there were no earlier examples to rely on.

Historically, professional planners have often acted as the surrogates for the public interest. In this model, technical discretion is assumed to define and prescribe the means of planning actions, but not the ends. This invariably resulted in 'shelved' planning proposals.

A second and perhaps more successful one is one in which the planners select and define the means, and also assume the responsibility of clarifying the ends. In this instance the planner presumes to know the needs of the public, but also the manner in which these needs are to be fulfilled. British town planning and implementation is a notable example of this approach.

A third and more sophisticated model involves the planner in the role of arbiter or mediator, whereby the planner has the discretion to set forth the means and to recommend the ends—so long as a feedback mechanism is operational between the planners and the actual providers and consumers during the plan formulation. In this case the planner mediates between the governmental power structure and the diverse interests among the body politic.

Since planning is essentially a governmental function, it must provide a broad and desirable rationale for attracting and holding the support of political leaders, appointed officials and the general citizenry. The appeal must be broad to cover the multitude of aspirations of such diverse groups. Obviously, the process itself, aside from the technical aspects, is basically a political activity.

5.2 Organizational Activities

The Nassau-Suffolk Regional Planning Board at the onset faced the issue of how best to meet the requirements for citizen participation. The literature and our own experiences were reviewed. It was soon evident that a new approach was needed. The earlier examples of limited or appointed citizen representation could not provide the broad inputs required for a program as complex, as costly, and as potentially unpopular as we expected wastewater management planning to be. The only guidelines were that the effort had to be as open and representative as possible. This meant that some of the approaches such as the appointment of select and elite "citizen" representatives or the hiring of a consultant to "organize the public" were to be avoided. Instead, the Board advertised widely in the press and radio media that this new program was in the organizational stage and that anyone interested in the issues of maintaining the quality of the potable and swimming waters of Long Island should attend an informational session. In addition, over 300 letters were sent to anyone who had ever contacted the Board for information about any matter related to water conservation, pollution, and/or wastewater management. In particular, the Board strove to identify those respondents whose views were antagonistic to prior governmental programs. All local governments were similarly notified about the impending project. At the conclusion of the open meeting attended by over 100 people, approximately 60 persons volunteered to participate.

At the organizational meeting the staff briefly outlined the purposes, duration and anticipated outputs of the program. The citizens were informed that the Board would prefer to have the chairman of the Nassau-Suffolk Regional Marine Resources Council serve as the non-voting chairman for the CAC. This was to insure impartiality in the conduct of the meetings and to avoid jurisdictional maneuvering over the position. The citizens were informed that the rest was entirely up to them. After a brief discussion they concluded that they would prefer a structured organization rather than an open-ended one. They agreed to meet every second week and to form subcommittees as necessary with additional meetings to occur as required. Within one month's time, the formal structure was accomplished. Ten categories of representation were selected. They include: the academic community, agriculture, business and industry, civic associations, disadvantaged citizens, environmental/conservation, government, labor, the Long Island Water Conference, and recreation. Committees were set up in each of these categories from the representatives who agreed to convene a caucus for each grouping on a regional basis, for the purpose of having each group vote for two voting members and alternates for each category. This was accomplished within one month's time. In concept the CAC had the freedom to establish its agenda, prepare and publish a newsletter on 208 activities, and to react and furnish input into the technical work conducted by the Technical Advisory Committee (TAC) as the program was carried out. The CAC, in order to foster the widest possible public information program, also agreed to inform their constituents on a regular basis as to the progress of the planning effort. In theory, the CAC should provide the widest possible dissemination of findings, and receive feedback from the general community. However, as important as *citizen participation is, it must* be kept in mind that the concept of *universal* civic participation should not be over-romanticized nor be expected to be achieved. Anyone with experience with any type of voluntary organization soon realizes that a relatively small number participate in the decisionmaking role beyond the selection of officers. This is but one of the problems inherent in the very nature of participatory democracy. As the activities of the CAC began to mesh with those of the TAC, other problems soon became apparent.

5.3 General Problems

The CAC, being representative of a broad variety of interests and differing levels of technical competence, gave rise to a set of circumstances that surfaced to the frustration of citizens and technicians alike. For example, in

order to assure a working partnership between the TAC and the CAC, it was agreed by the TAC to furnish all technical materials prepared by consultants or staff to the CAC as the material was developed. Theoretically, this was to serve two purposes: to bring the knowledge level of the CAC abreast of the activities of the TAC; and also to receive commentary and input from the citizens' point of view.

It was soon discerned that there was no happy medium in the manner of presentation. Initially, the technicians presented their findings in common language which was resented by those citizens with technical backgrounds who felt they were being talked down to. In response, further presentations were given identical to those presented to the TAC. This produced objections from the non-technicians on the CAC. There also arose a set of problems having to do with role consciousness. Many of the citizen participants joined the CAC because of their very deep and abiding concern with water conservation and wastewater management. They perceived themselves to be knowledgeable and, in fact, were, in most instances. Therefore, there was some chagrin and frustration with the TAC's scientific approach in trying to build the case 'one brick' at a time. Some of the citizens felt that the desired solutions were obvious. Other impatience was evidence of the fear that the technicians would merely produce a "plumbers approach" to wastewater management. They did not quite trust governmental technicians to be truly comprehensive, and to consider the broadest array of alternatives. In fairness, the TAC had as many misgivings about citizen participation as the citizens had about them.

As the program moved foward, another more subtle problem began to appear. The very matter of working together tended to produce an element of co-optation. The TAC perhaps over-reacted in its desire to indicate that nothing was being held back, and strong signs of growing trust between the two groups began to emerge. The potential danger in this growing harmony was that one of the prime roles of the CAC, namely to be objective critics, might have been weakened. This possibility of co-optation, however, was successfully resisted by the citizens.

The process of trying to meld so many personalities into a productive and positive process should not be construed negatively despite the recital of problems. On balance, the problems have been minimal in contrast to the merits and benefits that have already occurred. One of the more noteworthy examples follows.

5.4 A Success Story

Shortly after the inception of the 208 Program on Long Island, the CAC raised the question of why viral studies were not included within the approved scope of services. They were informed by the Director. that in fact the initial application to EPA did include such work prior to the formal establishment of the Program. This segment was not approved, since viral studies were considered to be of a research rather than applied status due to the relative embryonic state of the art. Thus, they were ineligible according to the guidelines for the program which prohibited research projects.

The concerns voiced by the citizens, who in part joined the Program to promote recharge as a viable alternative to ocean disposal of sewage effluents, included the essential need to understand and assess the potential constraints against recharge.

They did not accept the EPA ruling that viral sampling and analysis was properly categorized as research, and therefore beyond the scope of the Long Island program. They demanded that discussions be held by the CAC and representatives from EPA to demonstrate their support of the expurgated viral section of the original application. A sub-committee was formed to meet with the two County Health Commissioners in the hope of securing professional concurrence and support. These activities took place during June and July, 1975.

By July 7, 1975, the sub-committee reported to the CAC that strong support was guaranteed. They further recommended that the CAC request the scope of services be amended to include virus studies and that funds be ear-marked for this purpose. The resolution adopted by them was forwarded to the TAC who responded favorably, subject to approval by EPA. However, it was stressed that the chances for approval appeared slim.

The CAC then invited Dr. James Vaughn, a noted virologist from the Brookhaven National Laboratory, to address the group. He accepted, and in his presentation he discussed the state of the art referring to work in other parts of the country, and further elaborated on the analytical processes used at the Laboratory to concentrate viruses. At the conclusion of his talk the CAC by resolution directed their chairman to request that a formal application to be submitted to EPA.

As a result of their vigorous pursuit of the issue, the EPA agreed to conduct limited viral investigations. This response was received by August 4, 1975. By the following week Dr. Vaughn submitted a proposal to the TAC, with a cost estimate of $60,000. After a number of working sessions between Dr. Vaughn and the TAC with continuous feedback and response from the CAC, and subsequently similar meetings with the TAC/CAC and EPA, a formal application was submitted to EPA on March 12, 1976. An affirmative response was quickly received from EPA on April 27, 1976.

It is absolutely clear that the motivating force in securing approval for this integral portion of the 208 Study must be attributed to the strident efforts of the CAC. Subsequent to this experience, additional modifications have been made to the program at the initiative of the CAC. This included investigations of the presence of heavy metals and trace organics in the aquifers of Long Island. Beyond any question the citizens dared to challenge Federal rulings, and succeeded in doing the undoable. This accomplishment alone merited the difficult marriage between technicians and citizens.

5.5 Conclusion

Planning, as carried out in the context of this discussion, involves mediation between diverse groups and individuals who seek to influence land use and other policy decisions. Planning technicians conduct such mediation within the governmental framework and among the public at large. Thus, planning must be understood to be fundamentally a political activity. It is political in the following ways: It is a governmental process presumably set up to formulate and execute policy on land use activities. Administratively, most planning agencies are part of the executive branch of government. The interactions between planners and private citizens require mediation and compromise—the very essence of politics.

This reality is not necessarily negative. The crass aspects of partisan politics do not have to be the controlling factor. To the contrary, partisanship should be strenuously avoided. Politics herein, is held to be the conduct of the public business in non-partisan fashion, or perhaps more accurately stated, multi-partisan fashion. However it is viewed, planning will be more successful if it is conducted *with* the public involved, rather than *for* the people. The correctness of including public participation in the planning process, as demonstrated by the experiences on Long Island, is seen in several ways. Staff and citizenry have more access to the interests of the general public. This is invaluable for goal formulation, project design, and in selecting the most suitable plans. It should promote greater identification and hopefully a 'pride of authorship' on the part of the public with the plan. It may also help to mobilize resources and support by fostering mutual trust and understanding, particularly in instances where tradeoffs have to be made. In addition, continuous evaluation of the plan and its implementation will be encouraged by all who had a role in the plan's formulation.

Hence, public participation makes the planning process more responsive, more democratic, and often more comprehensive.

5.6 CAC Organization

"Public participation in the development, revision, and enforcement of any . . . plan or program established . . . under this Act (Federal Water Pollution Control Act Amendments of 1972) shall be provided for, encouraged, and assisted by the Administrator (of the U.S. Environmental Protection Agency) and the states." This quotation from Section 101(e) of the FWPCA is not only a statutory mandate that public participation be an integral part of water quality planning, but an opportunity as well for citizens to have a voice in the development and implementation of local wastewater management policies and decisions.

Thus, one of the first steps taken in the Nassau-Suffolk 208 Study was the estbalishment of a means whereby citizens could play a meaningful role in the planning process. This resulted in the creation of a Citizen Advisory Committee, the activities and views of which are the subject of this discussion.

It was decided to establish voting membership positions for ten different interest groups and constituencies as follows:

- —*Academia* (representatives of area colleges and universities)
- —*Business* (representatives of the business-industrial community)
- —*Citizen Associations* (representatives of such organizations as the League of Women Voters)
- —*Environmental Conservation* (representatives of such organizations as the Audubon Society)
- —*Local Government* (elected and appointed representatives of town and village governments, including planning departments)
- —*Labor* (representatives of organized labor unions)
- —*Recreation* (representatives of such recreational interests and activities as boating and fishing)
- —*Disadvantaged and retired citizens* (representatives of such organizations as the Long Island Council of Churches)
- —*Long Island Water Conference* (representatives of the water supply purveyors)
- —*Agriculture* (representatives of the Long Island Farm Bureau)

Each constituency selected two voting representatives and two alternates, with the exception of the Water Conference, which was allocated one voting representative plus two alternates.

The CAC Chairman was appointed by the Nassau-Suffolk Regional Planning Board and a Vice-Chairman was elected by the voting membership. Neither officer was granted voting privilege.

All CAC meetings were conducted in accordance with recognized parliamentary procedure. A quorum was understood to mean twelve voting members or designated alternates for policy issues and ten for non-policy matters. Non-voting members, of which there were about 25 at each meeting, were granted full floor privileges.

The CAC designated the first and third Mondays of each month at 5:00 p.m. in the Conference Room of the Dennison Building in Hauppauge as the time and location of regular meetings. A total of 75 meetings, most encompassing four hours, were held during the 30-month duration of the Study. Each meeting included a half-hour meal break with food provided by the Nassau-Suffolk Regional Planning Board. This break served as a "cooling off" period and informal discussion.

5.7 CAC Activities and Accomplishments

From the beginning, the CAC made its presence felt. It scrutinized every aspect of the Study and insisted on being kept informed of all developments.

1. The CAC reviewed the workplan which had been prepared by the Nassau-Suffolk Regional Planning Board and made meaningful suggestions relative to the direction and emphasis of the Study.

2. Concerned about the environmental and economic impact of any plan that might be proposed, the CAC helped draft the RFP (Request for Proposal) for the environmental/economic consultant.
3. The CAC questioned why the workplan failed to include a study to evaluate the presence of viruses in water and wastewater. The CAC argued that a lack of knowledge about viruses would limit the number of management alternatives, such as recharge, which could be considered. The CAC, with the help of the Regional Planning Board and the Technical Advisory Committee, was able to convince the U. S. Environmental Protection Agency to authorize and fund a viral study.
4. In a related matter, the CAC stressed the need for the analysis of samples for trace organics and heavy metals. Again the CAC succeeded in having these contaminants included in the sampling program.
5. The relationship of the 208 Areawide Planning Program to the 201 facilities planning provisions was yet another issue on which the CAC requested clarification. Concerned that the 201 Studies underway might contradict the recommendations of the 208 Plan being formulated, the CAC urged, without success, a moratorium on all 201 Studies until oublication of the 208 Plan.
6. Throughout the 208 Study, the CAC requested and received various briefings from the technical consultants. Representatives of the CAC also attended meetings of the Technical Advisory Committee as observers, reporting back to the CAC.
7. Recognizing the need to keep the public abreast of the 208 Study and to encourage greater participation, the CAC initiated a public information effort early in the Program. Five newsletters, published at regular intervals, were compiled and distributed throughout the Region to local government units, planning boards and community groups. To assist in public understanding of the Plan, the CAC organized a speakers' bureau and prepared educational materials to be used at group presentations including a taped slide program and an informational flyer.
8. As the findings of the technical consultants were compiled, the draft reports were reviewed and discussed by the CAC and comments were forwarded to the authors. As a result of this evaluation, substantial changes were made in several of the interim reports.
9. The CAC also spent several meetings evaluating the concept and recommendations of the actual Plan. In connection with this, the CAC drafted and adopted a series of policy resolutions stating the consensus of the membership on key issues.
10. During the course of the 208 Study, Suffolk County considered discontinuing the annual funding of the groundwater monitoring program conducted by the U. S. Geological Survey. Recognizing the importance of this data for future wastewater management decisions, the CAC urged County officials to restore the funds.
11. Concern over the construction of sewage facilities in the Southwest Sewer District prompted the CAC to urge the funding of a stream augmentation feasibility study for mitigating the impact of reduced streamflows resulting from a lower water table. The CAC, on several occasions, voiced concern about the magnitude of the SWSD project.

5.8 Acknowledgements

The effective participation of citizens in the Nassau-Suffolk 208 Study through the Citizen Advisory Committee has been made possible through the support and efforts of numerous parties which the CAC hereby acknowledges with grateful appreciation.

—*The U. S. Environmental Protection Agency,* especially the Region II office, which funded the study, encouraged public participation and responded to CAC requests for clarification of policy.

—*The New York State Department of Environmental Conservation* which encouraged and supported citizen participation and responded to CAC requests for information and policy clarification.

—*The Nassau-Suffolk Regional Planning Board and staff* for actively encouraging and supporting independent citizen participation; for granting the CAC freedom to organize and function as its members desired; for providing funds to publish newsletters, reproduce articles and carry out a public information program; for arranging presentations to the CAC by technical consultants; for accepting and implementing suggestions made by the CAC; and for making available to the CAC the drafts of all reports and the Plan for evaluation.

—*The technical consultants and the Technical Advisory Committee* for attending CAC meetings to report on their work and to discuss issues.

5.9 CAC Operations: Evaluation and Recommendations

5.9.1 Organization. From an organizational viewpoint, the CAC has generally functioned smoothly and effectively. The designation of voting members representing various constituencies has worked well. The formalizing of committee membership and the instituting of a regular meeting schedule has facilitated good attendance and continuity. It also ensured balanced, broad-based input in a manner that prevented domination by any one interest group. Based on this experience, it is recommended that future citizen participation efforts be formalized in the form of a committee with

membership established on broad-based constituency representation.

5.9.2 Project Deadline. Under the terms of the Federal grant, the deadline for completion of the 208 Plan was December 31, 1977. As this deadline approached, activity intensified, hundreds of pages of technical reports were presented to the CAC for immediate review and comment. With the holiday season beginning in late November, it became very difficult for many CAC members to find the time to attend meetings and to do the necessary reading because of other commitments on their time. The setting of a deadline at a less busy time of the year would have permitted a more thorough and relaxed evaluation of the reports.

5.9.3 Citizen-Government Relations. Throughout the duration of the 208 Study, relations between the citizens serving on the CAC and their government as represented by the agencies involved in the 208 Study have varied from strongly adversary to various degrees of agreement and cooperation. In the final analysis , however, the citizens gained a better understanding of the complexities and frustrations experienced by government bureaucracies which has led to an increased respect for government. Concurrently, the CAC, through the interest and cooperation of its members, gained the appreciation and respect of the government agencies. Based on this successful and mutually beneficial arrangement, it is recommended that citizen advisory committees in general, and this CAC in particular, be continued for the purpose of providing input on future wastewater management decisions in the Nassau-Suffolk Region.

5.10 CAC Policy Positions

Out of the CAC discussions of the past two years there has evolved a consensus on numerous water quality and wastewater management concerns which the CAC has documented in 32 policy recommendations encompassing administrative, research and management issues. The following statements contain the essence of these recommendations. The full text of the concerns and recommendations appears in Section 5.11.

5.10.1 Administration

1. The design of wastewater strategies, the analysis of both monitoring data and strategies, as well as the design of stream augmentation methodologies, should be performed by a bi-county agency. Since the Nassau-Suffolk Regional Planning Board has a staff with both the administrative and technical proficiency to perform water quality management studies, this agency should not only be charged with the above mentioned duties but also be designated as the lead agency for present and future bi-county studies.

2. The NSRPB should seek additional funding to provide cost data for the alternate management strategies in each water quality management zone. In addition, all 201 Studies should be required to include cost-benefit analysis for all alternate strategies. Furthermore, 201 Studies should not be initiated until the final acceptance of the 208 Plan.

3. The provision for meaningful citizen input into water quality management studies should be provided for from the initial stages through a broadly constituted Citizen Advisory Committee. Similarly, any subsequent studies, such as the selection of a wastewater management strategy for a specific area, should receive the same scrutiny by the CAC.

5.10.2 Research

1. In the course of the Bi-county 208 Study, it has been determined that sewering addresses only a portion of the point and/or non-point contaminants entering surface and groundwaters. It is also recognized that nitrogen should be only one of many contaminants considered in water management strategies. Therefore, additional data on other parameters such as virus, metals and trace organics must be gathered and evaluated while research into the actual implications of nitrogen in drinking water must be pursued.

2. These point and non-point source contaminants are not unique to the Nassau-Suffolk Region and therefore water quality and wastewater management studies performed in this region can be applied on a National scale. Since there is a wealth of pre-exisitng data on the Nassau-Suffolk aquifers and surface waters, and this area includes a wide variety of land uses ranging from rural to urban, further Federal funding to expand this data base is recommended.

5.10.3 Management

1. The management of water supply in Nassau and Suffolk Counties should be designed to preclude both the importation and exportation of water. This can be accomplished by managing this regional resource on the basis of the innovative concept of water quality management zones as specified in the Plan. Water management strategies that require the preservation of wetlands and/or Magothy recharge areas as open space should provide for governmental purchase as a fee simple or lesser interest. In addition, a comprehensive land use management program should be Federally funded and developed.

2. Self-sufficiency would be further assured by: (1) providing for the maintenance of existing and future collection systems, treatment plants and on-site systems by dedicated funds; (2) adopting technical specifications and inspection procedures for petroleum and chemical storage tanks; and (3) by the implementation of water conservation measures, wastewater and solid waste reduction methods, and surface water runoff reduction and treatment measures.

5.11 Wastewater Management Concerns and Policy Recommendations

The following is the full text of the 32 key wastewater management concerns identified by the Citizen Advisory Committee and the policy recommendations adopted by a majority of the voting members.

5.11.1 Administration. This encompasses those concerns and recommendations that pertain to the implementation of wastewater management plans, to funding of studies and abatement projects, and to public participation in future management decisions.

1. Concern: An agency that has facility construction and operating authority would increase in size and power from wastewater management decisions that favor the solutions that are implemented by the agency.

Recommendation: The design of wastewater management studies, the analysis of data, the analysis of strategies, and the recommendation of solutions should preferably be done by an agency with only planning authority and never should be done by an agency with wastewater treatment facilities construction and operating authority.

2. Concern: Many structural and non-structural strategies are available that singly or in combination can reduce the volume of pollutants or prevent pollutants from entering the groundwater. However, funding formulas that are area-specific and strategy-specific exclude from active consideration many acceptable strategies.

Recommendation: Funding formulas to implement water quality and wastewater management strategies should equitably reflect the district and regional benefits that accrue and be goal-oriented rather than specific-strategy oriented. A specific strategy that should be examined pursuant to this recommendation follows: A management decision should be made by the responsible 208 management agency as to whether the resources of the bi-county area can be better spent to restore the quality of waters where the nitrogen concentrations exceed ten milligrams per liter such that the resulting nitrogen concentrations meet the ten milligrams per liter standard, or whether those resources should be spent to prevent degradation of high quality groundwaters.

3. Concern: Any effort by Nassau County to unilaterally reduce pollutant levels in North Shore bays near New York City will be frustrated by the high ambient pollutant levels in western Long Island Sound caused by present wastewater disposal practices.

Recommendation: USEPA and NYC are requested to give appropriate consideration to the environmental benefits that will accrue to Nassau's bays as the determination of priorities is made for the various water pollution control projects.

4. Concern: The technical complexity of wastewater management studies, the necessity for background information, and the completion of essential phases of the study prior to the end of the study generally render any technical, procedural or substantive recommendations, however meritorious, made at the conclusion of the study either difficult to integrate or too late to consider.

Recommendation: The provision for meaningful citizen input into water quality management studies should be provided for from the initial stages through a broadly constituted Citizen Advisory Committee (CAC). Similarly, any subsequent studies, such as the selection of a wastewater management strategy for a specific area, should receive the same scrutiny by the CAC.

5. Concern: The recommendations of the 208 Study can be avoided if any 201 facilities study is started prior to the adoption of the 208 Plan.

Recommendation: No additional 201 Studies should be initiated until the final acceptance of the 208 Plan.

6. Concern: Economic cost data is an essential component for a balanced evaluation of alternative wastewater management strategies. The lack of cost data enhances the likelihood of 208 recommendations not being adopted.

Recommendation: The NSRPB should seek additional funding to provide economic cost data for the various alternative wastewater management strategies in each water quality management zone. Any 201 Studies should always have a benefit/cost analysis for all alternative systems and strategies.

7. Concern: The NSRPB has developed a staff with the administrative and technical proficiency to competently manage Water Quality Management Studies (WQMS) and the NSRPB has cooperated in allowing the CAC to participate in the 208 WQMS.

Recommendation: The NSRPB should be designated as the lead management agency for any future WQMS in Nassau-Suffolk.

8. Concern: An agency that has wastewater facility construction and operating authority would be put into the position of being required to evaluate its own effectiveness and competence if that agency also has a monitoring responsibility.

Recommendation: The responsibility for monitoring wastewater quality should not be in the same agency that has facilities construction and operating authority.

9. Concern: The proper management of the environment requires that water quality be managed in coordination with air quality, wildlife, agriculture, recreation, aesthetics,

economic development and energy facilities.

Recommendation: A comprehensive land use management program similar to the Federally funded program for the coastal zone should be developed for inland areas.

10. Concern: The water quality in the aquifers that underlie Nassau-Suffolk varies from unusable, due to contamination by pollutants, to pristine.

Recommendation: Economic growth in Nassau-Suffolk can best be accomodated by managing land uses according to water quality management zones.

5.11.2 Research. This encompasses those concerns and recommendations pertaining to the need for additional studies, sampling/analysis programs, and research.

11. Concern: New research into the health effects of nitrogen in drinking water may require the adoption of more restrictive standards. Therefore, in areas of the groundwater system where nitrogen concentrations are presently less than the present standard of ten milligrams per liter, an effort should be made to maintain lower concentrations.

Recommendation: A technological feasibility study should be made to determine whether the wellhead treatment of water can reduce nitrates to the same level as highest quality water from an aquifer whose recharge areas are undisturbed by housing and agriculture. Until technology achieves such a level of proficiency, in areas of the groundwater system where nitrogen concentrations are presently less than the present standard of ten milligrams per liter, an effort should be made, within the constraints of economic and social factors, to maintain those lower concentrations.

A specific strategy which should be examined is the efficacy of preserving the native vegetative cover in the Magothy recharge areas.

Recommendation: A program for the long term systematic collection and analysis of data on nitrates, chlorides, trace organics, heavy metals, viruses and other pollutants in ground and surface waters should be implemented. The analysis of the data should include the source of each pollutant.

13. Concern: The application of fertilizers and pesticides in agricultural and residential uses may result in a certain amount of leaching of these compounds into the soil and/or runoff into surface waters.

Recommendation: A study should be made to determine the degree of degradation of ground and surface waters that can be attributed to the application of fertilizers and pesticides. Appropriate controls, which are responsive to the scope of the problem and give adequate consideration to the relevant local and regional environmental, economic and social factors, should be implemented.

14. Concern: Certain household, commercial and industrial chemicals, which are disposed of in wastewater or lagoons, are incompatible with quality groundwater.

Recommendation: An inventory of household, commercial and industrial chemicals should be compiled, and the impact of the chemicals on the groundwater should be assessed. Any recommended controls should be evaluated in terms of the relevant environmental, economic and social factors. Research to determine the public health effects of these chemicals should be accelerated in order to establish standards in the near future.

15. Concern: The chloride in de-icing salts that are spread on roads is a groundwater pollutant.

Recommendation: Research should be started to develop environmentally acceptable methods of dealing with ice on roads. In the interim, de-icing salt should always be mixed with aggregates before application, and standards should be set in order that the amount spread will not be in excess of the amount required to do the job.

16. Concern: Stormwater runoff from impermeable surfaces into groundwater and surface water bodies is a major source of pollution.

Recommendation: A pilot program should be developed for decreasing the quantity, as well as the contaminant level of stormwater runoff, if feasible.

17. Concern: The results of certain types of water quality and wastewater management research that is performed in Nassau-Suffolk can be applied to other areas of the country with similar conditions.

Recommendation: The wealth of information on Nassau-Suffolk's aquifers, and the variety of terrestrial activity from rural to urban, should be exploited by a Federally funded program to research pressing water quality problems, such as the transport and fate of trace organics, heavy metals and viruses in the groundwater.

18. Concern: The magnitude of the water quality management decisions, which are based upon the EPA standard for nitrogen in drinking water (ten milligrams per liter), is disproportionate to the confidence that can be placed

in the validity of the standard.

Recommendation: Research into the public health effects of nitrogen in drinking water should be actively pursued.

19. Concern: Improperly constructed or inadequately maintained wells are a potential source of aquifer contamination.

Recommendation: A study should be made to determine if existing wells are a substantial source of aquifer contamination and if the continuation of their present condition will render that portion of the aquifer unsuitable for its present or planned use. If the results are affirmative, then a program should be implemented to correct the conditions.

20. Concern: Commuter automobile use is a significant source of groundwater pollutants.

Recommendation: The degree of environmental degradation attributable to commuter automobile traffic should be determined, and a correspondingly appropriate combination of economic incentives and disincentives should be devised to encourage the use of mass transit systems.

21. Concern: Large quantities of stormwater runoff that transport de-icing sand, oil, grease, fertilizer and sediments are piped directly into stream and bay waters.

Recommendation: A program should be implemented to retrofit with sediment traps the existing stormwater drains that discharge into surface waters. In the interim, wherever practicable, the existing accumulated polluted sediments, which are located at the discharge point of the stormwater drain, should be removed to preclude their dispersion into the adjacent water body.

22. Concern: The environmental changes that will be brought about by the lowering of the water table in the Southwest Sewer District (SWSD), due to the use of a marine outfall, will have a moderate to severe adverse impact on freshwater wetlands, on inland stream-dependent water-related recreation, and on the Great South Bay hard clam fishery.

Recommendation: While acknowledging that the SWSD is an accomplished fact, a study should be made to devise and evaluate strategies, such as stream augmentation, that will counter the effects caused by the water table decline and decrease in average level and flow of our streams and rivers.

23. Concern: Many new concepts are being developed in laboratories to treat domestic wastewater However, these new technological innovations cannot be considered for use on a large scale until properly conducted small scale field tests provide the basic engineering and cost data.

Recommendation: A Federally funded program to run small field evaluations of innovative wastewater treatment systems should be implemented.

5.11.3 Management. This encompasses those concerns and recommendations pertaining to the legal, institutional, scientific and technical means for implementing wastewater management plans.

24. Concern: The present practice of each public water supply purveyor supplying the entire potable water demand of its customers from wells within its district boundaries will, if continued, decrease the safe yield of the aquifer.

Recommendation: Water supplies in Nassau and Suffolk should be developed with the objective of maximizing the long term safe yield of the aquifer.

25. Concern: The conservation of potable water can reduce the volume of wastewater and decrease the drawdown rate on the potable aquifer.

Recommendation: Potable water should be conserved by initiating a public information program and revising industry standards and building codes that lead to wasteful water practices. Water pricing schedules should be revised to encourage water conservation. A study should be implemented to determine the feasibility of using grey water for industrial and limited commercial uses. Use of shallow wells in a degraded aquifer should be encouraged for irrigation, industrial, fire fighting and other compatible uses.

26. Concern Current solid waste disposal practices are wasteful of resources, and are a source of leachate.

Recommendation: Municipal composting, recycling, beverage container reuse and other techniques for the reduction of the volume of solid waste should be encouraged with suitable incentives. Water quality monitoring in the vicinity of existing and closed landfills should be conducted, and an assessment should be made of the necessity of implementing interim abatement measures.

27. Concern: The quality of water, rather than the quantity of water, is the relevant problem for the supplying of potable water from Nassau and Suffolk's aquifers.

Recommendation: It is preferable to dispose of treated sewage effluent in areas where flow lines do not enter a potable aquifer unless the effluent is of equal or better quality than the affected aquifer and within the limits of health

standards.

28. Concern: The vast reservoir of potable water that underlies Nassau and Suffolk Counties will through wise management meet all future demands which are predicted for this area.

Recommendation: The management of water supply and wastewater in Nassau and Suffolk Counties should be designed so that the bi-county area need not import any of its potable water supplies from outside of the two counties.

29. Concern: Sewering addresses only some of the sources of pollutants in Nassau and Suffolk's groundwater. Contaminants other than nitrates may be more detrimental to public health.

Recommendation: Nitrogen should be only one of the many contaminants (such as organic and heavy metals) that are considered in water management decisionmaking, and a variety of management alternatives should be considered as abatement techniques.

30. Concern The proper maintenance of both existing and future sewage collection and treatment systems, and on-site systems is essential for protecting the quality of ground and surface waters.

Recommendation: The maintenance of both existing and future sewage collection systems and treatment plants and on-site systems should be required and provided for by dedicated funds.

31. Concern The role that wetlands and Magothy recharge areas have in surface water and drinking water quality is knowledge that was not known when these lands were first sold to private owners.

Recommendation: Water quality management strategies that require the preservation of wetlands and Magothy recharge areas as open space should provide as a matter of course for government purchase of a fee simple or lesser interest in the property.

32. Concern: The storage of petroleum products in underground tanks is a potential and, in some cases, an actual source of groundwater pollution.

Recommendation: Technical specifications for underground petroleum storage tanks should be adopted, and all existing tanks should be routinely inspected to determine their integrity. The frequency of the inspections should be based upon the determined likelihood of tank failure and the water quality management zone in which the tank is located.

Section 6 Preferred Plan Alternatives

6.0 Introduction

As indicated in the previous sections, the 208 Program has identified Long Island's wastewater management needs and the relevant structural and non-structural alternatives that may be used to ameliorate them. A large number of wastewater management alternatives were defined, all having as their general objective the development of a comprehensive management plan for the treatment and disposal of waste in order to protect the public health and natural resources of the Nassau-Suffolk 208 Region.

During the course of the planning process leading up to the development of the Plan, alternatives were subjected to constant evaluation in terms of engineering and economic feasibility, probable environmental effects and legal or regulatory requirements. Where any alternative or set of alternatives was found to violate environmental, economic, engineering or legal constraints, it was eliminated or modified.

It is well known that the groundwater and marine surface waters of the Bi-county Region were strongly interdependent, as far as quality and quantity were concerned, but that waste management alternatives could conveniently be defined in terms of protecting one or the other. This led to the division of the bi-county land area into a number of hydrogeologic zones distinguished by differences in groundwater flow regime and degree of development. Furthermore, the marine surface waters were divisible into segments having different physical characteristics, tidal flushing patterns, freshwater inputs, and so forth. Waste management alternatives tailored to their specific conditions and requirements were then postulated for each zone and segment.

Water quality problems in Nassau-Suffolk are generally a function of the density of residential development and of the nature of some of the industrial activity. Generally, ground and surface waters are or have been most severely impacted in those areas occupied by the greatest number of persons. Some of these areas are now sewered and groundwater quality appears to be improving.

Long Island's continued ability to meet the regional demand for potable water and for water-based recreation opportunities and commercial fisheries will depend to a great extent on the measures taken to prevent further degradation or to improve the quality of the aquifers, streams and bays.

Inasmuch as the management of domestic and industrial wastes is a primary concern, most of the recommendations for the construction of sewers, or the installation of monitoring wells, are related to existing or proposed residential densities, and to industrial areas.

However, sources of pollution other than sewage must also be controlled in order to achieve and maintain improved water quality. Sources such as stormwater runoff, fertilizers, animal wastes and landfills contribute to the overall problem, and steps must must be taken to mitigate their effects. Since these and other non-point pollution sources are not specific to any locality, measures for mitigation are identified as "Areawide Recommendations."

In Section 6.1, the Areawide Recommendations are presented, under eight main headings. Next, in Section 6.2, the array of alternatives for each of the hydrogeologic zones and surface water segments is briefly discussed. In order to provide guidance to present and future 201 Studies in the Region, the 208 Program has related the hydrogeological zone and surface water recommendations to detailed study areas. A map of the detailed study areas was overlaid on the zone and segment maps in order to identify those portions of the various zones and segments located within each study area. It was then possible to develop individual waste treatment management plans for the study areas, and these are presented in Section 6.3. Together, they constitute the areawide plan.

Finally, inter-jurisdictional matters are discussed in Section 6.4, and recommendations for future studies in Section 6.5.

6.1 Areawide Recommendations

The following recommendations should be regarded as applicable throughout the bi-county area wherever the pollutant problems addressed by the proposed measures or practices occur. The recommendations, which have been selected from the more extensive list presented in Section Three and in Section J of the Areawide Waste Treatment Management Plan, focus on key non-point problems: control of stormwater runoff, the functioning of on-lot disposal systems; the use of fertilizers; landfills; animal wastes; on-site industrial waste handling and water conservation.

For the most part, the proposed measures are non-structural in nature and call for the institution or continuation and expansion of Best Management Practices. Furthermore, certain measures require development and demonstration, in order to determine their efficacy. Measures requiring such further study, *e.g.*, marsh-pond treatment, on-lot subsurface denitrification systems, etc., are discussed in Section 6.5.2.

6.1.1 Control Stormwater Runoff. The 208 investigations have indicated that stormwater runoff is a major contributor of non-point pollution to Long Island's surface waters and groundwaters. Best Management Practices should be employed to reduce the volume and velocity of runoff and the consequent diminution of its erosive and transport capabilities. To the extent feasible, surface runoff should be intercepted and disposed of as close as possible to the source. Best Management Practices, including proper grading and the maintenance of vegetation, and/or structural systems should be employed to minimize the volume of runoff and the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters. Recharge basins may need to be modified, where feasible, to improve the removal of nutrients, metals and organic chemicals in stormwater runoff that contribute to groundwater contamination. Inasmuch as the practicality and cost-effectiveness of most of the techniques for the treatment of runoff have not yet been determined, the establishmnet and operation of several pilot projects is recommended. Further investigation and testing of street vacuuming and the use of natural or man-made detention systems, with marsh-pond treatment and/or disinfection, are proposed.

Land clearance and development tend to accelerate runoff and erosion when the protective vegetal cover of the land is removed. The use of Best Management Practices during clearance, building construction, and site restoration should be required in order to avoid increased runoff and sediment transport from the site.

6.1.2 Ensure the Proper Functioning of On-Lot Waste Disposal Systems.

a. *Provide for Routine Maintenance of On-Site Disposal Systems.* Provision should be made for routine pumping and maintencance of the on-lot systems in order to extend the service life of the leaching facility and to ensure its continued efficacy. Local or county government should be responsible for the provision of scavenger waste treatment and disposal facilities. The numbers and locations of such facilities should be determined at a 201 level of study.

County sponsored public education to encourage voluntary implementation is recommended. The promulgation of legislation mandating routine pumping and maintenance is not proposed at this time.

b. *Prohibit the Use of Certain Chemcial Cleaners in On-Lot Systems.* If organic solvents and other chemical agents contain ingredients which might reasonably be expected to impair groundwater quality, their use for cleaning or extending the service life of on-lot sewage disposal systems should be prohibited or controlled. A program to identify such products is presently being conducted by Nassau County Health Department and Suffolk County Departments of Health Services and Environmental Control, and should be continued and emphasized. This should be coupled with specific county legislation banning the local sale of these products within Nassau and Suffolk Counties.

6.1.3 Reduce the Use of Fertilizers. Since fertilizers are one of the largest sources of nitrogen applied to the land surface, they constitute a significant potential source of ground and surface water impairment. Pending further study to better define fertilizer impact on water quality, public education should, and regulation may, be employed to limit, or possibly eliminate, the use of all or specific types of fertilizers. Best Management Practices, some of which may also pertain to agriculture, include modification of application rates, discontinuance of reliance on fast-acting inorganic fertilizers, and promotion of low-maintenance lawns, which would require both less fertilizer and less consumptive use of water.

6.1.4 Minimize Pollution from Landfills.

a. *Reduce Reliance on Landfilling.* Landfills are not a viable long-term solution to Long Island's solid waste disposal problems. Resource recovery systems, at the regional or sub-regional level, are recommended. Feasible methods should be evaluated for local cost-effectivness and ability to avoid groundwater impairment. Methods for the co-disposal of sewage sludge and solid waste should also be considered. The continued burial of wastes in landfills, with the exception of non-putrescible, or non-polluting matter, should be minimized or discontinued, especially in hydrogeological zones that are particularly sensitive. It should be noted however, that if land is unavailable in the less sensitive zones and safeguards can be assured that will effectively control the production of leachate and the impairment of the groundwater, landfills may be considered for the more sensitive zones.

b. *Improve Existing Landfills.* Existing and completed landfills should be upgraded in order to effectively control infiltration and direct runoff to surface waters. Methods used should include top covering with impermeable barriers, positive grading with erosion control, and other stormwater diversion systems.

6.1.5 Reduce and Control Animal Waste. In order to minimize the ad-

verse effects of animal wastes on surface waters, a number of Best Management Practices are recommended. These are the following:

i. Repeal dog curbing ordinances, and promote dog waste clean-up ordinances. Also, encourage dog population control.

ii. Closely regulate the stabling of horses and other large domestic animals in residential areas. Their numbers should be limited, and the methods of storing and handling of their wastes should be strictly controlled.

iii. Prohibit the sale of White Pekin ducks as pets. This practice has resulted in interbreeding with wild species, and the establishment of a semi-wild duck population on inland lakes and ponds. It is necessary that this population be gradually eliminated.

6.1.6 Strengthen and Enforce Regulations Pertaining to Industrial Wastes, Product Storage and Transportation, and Residuals.

a. *Expand Regulations and Enforcement Regarding the Disposal of Industrial Wastes.* Where industrial wastes are discharged to municipal sewer systems, strict enforcement of sewer use ordinances should be insured. Suffolk County is revising its sewer use ordinance to conform to applicable State and Federal guidelines. This revision will be implemented by October, 1978; Nassau County has already adopted such an ordinance. These County ordinances should be the model for all other municipalities or sewer districts within each respective county, and as such should be adopted by each of these entities. Each municipality or sewer district should be responsible for the enforcement of the ordinances and should maintain an adequate staff for such enforcement.

Present regulations covering the discharge of industrial wastes to the ground should be expanded to include greater coverage of specific contaminants and to prescribe allowable discharge levels. This applies primarily to organic chemicals and heavy metals.

b. *Regulate the Storage and Transportation of Chemical Products.* Permits and other controls should be required for the storage and transportation of chemical products that pose a threat to either the groundwater or surface water. The regulations should cover prescribed practices, safety requirements, inspection of equipment and contingency plans for interim storage and clean-up. The county agencies should be responsible for enforcing the permit regulations and control measures; the individual operator should be responsible for maintaining records and monitoring. In addition to industrial chemicals, these products include chemical wastes and sludges, de-icing salts and petroleum products. Salt storage facilities should be designed to prevent leachate contamination of groundwater.

Particular emphasis should be placed on the regulation of gasoline storage facilities at automobile service stations and, to a lesser degree, home heating oil storage tanks. Criteria should be developed and enforced to ensure the integrity of all storage facilities. The 208 Study has recognized these two types of facilities as major potential pollutant sources, but has not been able to define the precise magnitude of the problem.

c. *Provide for the Treatment of Hazardous Wastes.* The industries in the Nassau-Suffolk Region and the wastewater treatment processes they employ generate two kinds of hazardous wastes: small volumes of strong, toxic industrial wastes and industrial waste treatment sludges.

In view of the environmental sensitivity of the study area, continued disposal of these types of hazardous wastes outside of the area should be encouraged. However, if this disposal option is not available in the future, treatment facilities or landfills for the disposal of hazardous wastes will have to be provided in the bi-county area. The 208 recommendation is for a regional hazardous waste treatment facility for both counties. If a single facility cannot be implemented, individual county facilities are then recommended.

Treatment facilities should, wherever possible, be located at a sewage treatment plant with an ocean outfall. The effluent from the hazardous waste treatment facility should be disposed of to the outfall, not to the plant influent. The outfall disposal will provide a temporary discharge in the event of a hazardous waste facility upset.

If a hazardous waste treatment facility cannot be located at a sewage treatment plant with an ocean outfall, it can be located somewhere in the area served by the plant, and can discharge *treated* effluent to the sewer system. Effluent monitoring must then be intensive so that in the event of a plant or process upset, a slug of toxic waste can be prevented from reaching the downstream treatment plant.

If a hazardous waste treatment plant is not connected to a treatment plant ocean outfall, and is located in the deep-flow aquifer recharge area, special provisions must be made to contain any waste spillage. The wastes must not be allowed to percolate into the ground. Consequently, impermeable retention lagoons must be provided, large enough to take the entire plant inventory, in the event of a radical plant failure.

The hazardous waste treatment facilities should provide treatment for both organic and inorganic wastes where feasible. Radioactive wastes should not be handled at the facilities.

6.1.7 Promote Water Conservation. Water conservation is a matter of importance on Long Island for several reasons. First, a reduction in the amount of water use would help reduce the degree of water level declines in the bi-county area. This might also reduce losses in streamflow and underflow to the bays in some areas. Furthermore, in certain cases, lower pumpage from high yield public supply wells as a result of water conservation may help to minimize alteration of natural-flow systems and subsequent migration of contaminants to the deeper aquifer. Moreover, using less water would achieve savings in energy required to pump and heat it. It would also reduce flow to individual disposal systems, which could reduce failures. Finally, in areas requiring sewers, lower water use might permit the development of smaller sewage treatment facilities. Concerted public information programs, and the promotion of flow-reduction devices, can aid in reducing wastage. Recreational, residential and institutional lawn irrigation should be minimized by

the modification of automatic, clock-operated systems to systems that sense the moisture content in the root zone. Public education programs should discourage the use of water-intensive Bluegrass lawns and should encourage the planting of Fescue grasses, which require less water

Agricultural irrigation water management boards should be organized in the Towns of Brookhaven, Riverhead and Southold. These boards should examine agricultural, residential and recreational irrigation water demands and uses, and should develop water priorities during periods of drought and for areas with saltwater intrusion problems. Irrigation water management plans identifying crop needs and the soil/water holding capacity should be prepared for agricultural operations and lawn areas exceeding five acres. Trickle irrigation and efficient sprinkler irrigation should be encouraged.

6.1.8 Provde Alternatives to Ocean Disposal of Municipal Treatment Plant Sludge. The major municipal treatment plant sludge processing and disposal approaches that appear viable in the Nassau-Suffolk Region include composting, landfilling, land application, incineration, co-incineration with solid waste, pyrolysis and thermal drying. (These approaches also apply to the sludge from scavenger waste treatment plants.) It has been found that any of the conventional approaches can be implemented in the Nassau-Suffolk area without significant environmental degradation if normal safeguards are taken. Final sludge disposal options should be selected after 201 level detail studies have been conducted, since the final decision should be based upon cost-effectiveness and environmental impact. The 208 has determined that the conventional approaches are regionally acceptable.

Land based sludge disposal options (land application, composting) must be accompanied by monitoring or other control programs to insure against contamination of groundwater with heavy metals, inorganic and organic chemicals, and pathogens. This is particularly important in hydrogeologic zones I, II and III. Land-based disposal options will require strict enforcement of industrial pre-treatment requirements to minimize the amount of toxic materials in municipal treatment plant sludges.

6.2 Recommendations By Hydrogeologic Zone And Surface Water Element

6.2.1 General. Section 6.2 contains a summary table (Table 6—1) indicating the preferred alternatives for each of the eight hydrogeologic zones and the eleven bays described in Sections 3.2 and 3.5, together with brief discussions of recommended groundwater monitoring, the maintenance of groundwater levels, the siting, construction and management of landfills, and the expansion of public water supply systems.

The preferred alternatives for the hydrogeologic zones and surface water elements address public health objectives. The alternatives selected for the hydrogeologic zones characterized by a deep flow system are expected to minimize contaminant concentrations in the primary water supply acquifer, the Magothy, and in the deep Glacial aquifer in northwestern Nassau; those selected for the zones characterized by a shallow flow system are expected to protect the as yet uncontaminated portions of the Glacial aquifer and permit the restoration of previously degraded sectors. The alternatives selected for the surface water elements are expected to minimize coliform levels and maintain dissolved oxygen levels in recreational and shellfish waters.

The pollutants of greatest concern are nutrients, organic chemicals, heavy metals, coliform bacteria and viruses. Nitrogen was selected as the key pollutant for the purpose of developing and selecting alternative waste management options. It is found in most of the important pollutant sources, such as domestic sewage and fertilizers; is analyzed for routinely in all water samples (both potable and waste); and has been identified everywhere in the surface and groundwaters of the Bi-county Region. The selection of nitrogen as a key parameter does not diminish the need for the monitoring of other contaminants, nor does it preclude the possible need for additional treatment measures. A discussion of nitrogen as the key pollutant is to be found in Section 3.2.

The preferred alternatives also address natural resource objectives. These include the maintenance of adequate groundwater levels in order to preclude abnormal changes in stream levels that could affect critical environments or endanger coastal ecosystems, and to assure a sufficient potable water supply. They also include the maintenance of nutrient levels that will minimize eutrophication, and will assure conformance with dissolved oxygen standards and waste load allocations.

Collection and treatment as used in Table 6—1 refers to a variety of possible communal collection systems such as gravity lines, pressure or vacuum. The method of treatment may employ conventional secondary/tertiary, marsh-pond, spray irrigation or other method. This does not preclude the use of innovative on-site treatment systems (*e.g.*, with denitrification capability) in areas, which are candidates for sewering, as such systems are proven to be cost-effective. Note that items listed in Table 6—1 as "Non-Structural Recommendations" may, in part, have structural components. Note also that the order of presentation of recommendations in Table 6—1 does not imply any ranking or prioritization.

6.2.2 Recommended Monitoring of Groundwater Quality. In any area that depends exclusively on groundwater for its potable supply, the wastewater management alternative or alternatives should be accompanied by an extensive program of ambient water quality monitoring. The program described below can provide timely notice of existing and developing problems and of the effectiveness of various countermeasures.

This is a particularly attractive and necessary approach for assessing the effects of diffuse sources of contamination, such as on-lot sewage disposal systems, fertilizers, and stormwater, which cannot be easily monitored using a discharge permit type approach. The present monitoring of ambient shallow groundwater quality in both the unsewered and sewered areas depends on an insufficient number of widely spaced wells. Some wells are shallow, but many are deep (greater than 50 feet below the water table). In general, these deeper

Table 6–1

NASSAU-SUFFOLK 208 STUDY WASTE MANAGEMENT RECOMMENDATIONS BY HYDROGEOLOGIC ZONE AND SURFACE WATER ELEMENT

Hydrogeologic Zone/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
Zone I Deep aquifer recharge area. This zone is a primary source of public water supply.	Central and northern Nassau and portions of western Suffolk.	1. In developed areas not presently sewered or scheduled for sewering, plans for collection and treatment where the current density is nine or more persons (three dwelling units) per gross acre should be initiated. 2. At densities less than nine persons (three dwelling units) per gross acre, institute a monitoring program to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where area-average nitrate-nitrogen levels are six milligrams per liter or greater or other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, provide collection and treatment. 3. As currently vacant land is developed, provide collection and treatment at a density of approximately two dwelling units per acre (20,000 square foot lot size). 4. Divert the sewage flow from the C. W. Post College to the Cedar Creek STP or recharge to groundwater following advanced wastewater treatment, with nitrogen removal. 5. The 208 Study has not identified a need, within the twenty year planning period, for groundwater recharge in this area for the purpose of preserving drinking water supply. However, the importance of maintaining the flow and water quality of streams may require action to mitigate the impact of reduced groundwater levels attributable to sewering with marine discharge. 6. In areas that are completely sewered, regulations mandating the hook-up of private disposal systems to district collection systems should be strictly enforced.	1. Minimize population density by encouraging large lot development (one dwelling unit/ one or more acres), where possible, to protect the groundwater from future pollutant loadings. 2. Prohibit the establishment of new landfills, and the expansion of existing ones. Upgrade existing landfills, where possible, to minimize further groundwater contamination. 3. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface and groundwaters. 4. Provide for routine maintenance of on-site disposal systems. 5. Reduce the use of fertilizers on turf. Promote the use of low-maintenance lawns. 6. Strengthen and enforce regulations pertaining to industrial waste disposal, product storage and transportation of residuals. 7. Prohibit the use of certain chemical cleaners in on-lot systems.
Zone II Deep aquifer recharge area. An area of existing water quality problems.	East central Nassau	1. This area is, or will be, essentially completely sewered. Present plans generally conform to recommended 208 guidelines.	1. Prohibit the establishment of new landfills, and the expansion of existing ones. Upgrade existing landfills, where possible, to minimize further groundwater contamination. 2. Reduce the use of fertilizers on turf. Promote the use of low-maintenance lawns. 3. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals, and bacteria to surface and ground waters. 4. Strengthen and enforce regulations pertaining to industrial waste disposal, product storage and transportation of residuals.

Table 6—1 . . . Cont'd.

Hydrogeologic Zone/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
Zone III Deep aquifer recharge area. Exceptionally high water quality and high potential yields.	East central Suffolk	1 Require collection and treatment at densities of one or more dwelling units per acre in those areas where large lot development and the preservation of existing large land holdings are infeasible due to existing or planned development. 2. Require advanced wastewater treatment with nitrogen removal for treatment plants recharging effluent to ground or surface waters.	1. Land use controls should be the primary method for protecting this valuable groundwater resource. Where residential development is allowed, require large lot development (two acre zoning or greater). Encourage the preservation of existing large land holdings. 2. Establish a groundwater monitoring program to provide early indication of water quality problems and to permit timely institution of corrective measures. 3. Prohibit the establishment of new landfills, and the expansion of existing ones. Upgrade existing landfills, where possible, to minimize further groundwater contamination. 4. Provide for routine maintenance of on-site disposal systems. 5. Reduce the use of fertilizers on turf. Promote the use of low-maintenance lawns. 6. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface and ground waters. 7. Strengthen and enforce regulations pertaining to industrial waste disposal, product storage and transportation of residuals. 8. Prohibit the use of certain chemical cleaners in on-lot systems.
Zone IV Local water quality problems, but potential for groundwater development, particularly on the South Fork; significant agricultural input.	North Fork and eastern part of South Fork	1. In developed areas not presently sewered, plans for collection and treatment should be initiated where the current density is nine or more persons (three dwelling units) per gross acre. 2. At densities less than nine persons (three dwelling units) per gross acre, institute a monitoring program to determine the quality of the water-table aquifer and the efficacy of the non-point source controls. Where area-average nitrate-nitrogen levels are six milligrams per liter or greater or other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, provide collection and treatment. 3. Provide collection and treatment in those areas where on-lot systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other conditions.	1. Minimize population density by encouraging large lot development (one dwelling unit per one or more acres) where possible, to protect the groundwater and surface waters from future pollutant loadings, and to provide additional protection for existing marsh and wetland areas. 2. Control the establishment of new landfills, and the expansion of existing ones. Upgrade existing landfills, where possible, to minimize further groundwater contamination. In cases of extreme hardship, new landfills may be permitted if extra-ordinary measures are taken to protect surface and ground water. 3. Reduce excessive use of irrigation water, to minimize saltwater intrusion.

Table 6–1 . . . Cont'd.

Hydrogeologic Zone/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
Zone IV cont'd.		4. Provide collection and treatment in those areas where contaminated underflow may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards. 5. As currently vacant land is developed, provide collection and treatment at the present Suffolk County Department of Health Services approved density of approximately two dwelling units per acre (20,000 square foot lot size).	4. Optimize pumping patterns, to minimize saltwater upconing. 5. Optimize the timing of fertilizer application, to reduce nitrate contamination from agriculture. 6. Prohibit the use of certain chemical cleaners in on-lot systems. 7. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface and ground waters. 8. Provide for routine maintenance of on-site disposal systems.
Zone V Local water quality problems, but potential for groundwater development; little agricultural input.	Western South Fork	1 In developed areas not presently sewered, plans for collection and treatment should be initiated where the current density is nine or more persons (three dwelling units) per gross acre. 2. At densities less than nine persons (three dwelling units) per gross acre, institute a monitoring program to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where area-average nitrate-nitrogen levels are six milligrams per liter or greater or other contaminants are in excess of groundwater standards, and where the pollution may resonably be expected to result from on-lot systems, provide collection and treatment. 3. Provide collection and treatment in those areas where on-lot systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other conditions. 4. As currently vacant land is developed, provide collection and treatment at the present Suffolk County Department of Health Services approved density of approximately two dwelling units per acre (20,000 square foot lot size). 5. Provide collection and treatment in those areas where contaminated underflow may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards.	1. Minimize population density by encouraging large lot development (one dwelling unit per one or more acres) where possible, to protect the groundwater and surface waters from future pollutant loadings, and to provide additional protection for existing marsh and wetland areas. 2. Control the establishment of new landfills, and the expansion of existing ones. Upgrade existing landfills, where possible, to minimize further groundwater contamination. In cases of extreme hardship, new landfills may be permitted if extraordinary measures are taken to protect surface and ground water. 3. Optimize pumping patterns to minimize saltwater upconing. 4. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface and ground waters. 5. Prohibit the use of certain chemical cleaners in on-lot systems. 6. Reduce the use of fertilizers on turf. Promote the use of low-maintenance lawns.
Zone VI Generally shallow groundwater levels, with horizontal flow, which has impact on surface water.	South central Suffolk	1. Due to the impact of groundwater underflow and stream flow in this area on the sensitive eastern Great South Bay, collection and treatment is required at densities of one or more dwelling units per acre. 2. Require advanced wastewater treatment with nitrogen removal for treatment plants recharging effluent to ground or surface waters.	1. Minimize population density by encouraging large lot development (one dwelling unit per two or more acres) where possible, to protect the groundwater and surface water from future pollutant loadings, and to provide additional protection for existing marsh and wetland areas.

Table 6—1 ... Cont'd.

Hydrogeologic Zone/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
Zone VI cont'd.		3. Provide collection and treatment in those areas where contaminated groundwater may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards. 4. Provide collection and treatment in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.	2. New landfills should be permitted under current New York State policy, provided the site is landward of the primary coastal zone and the depth to groundwater is sufficient to ensure an adequate unsaturated zone below the bottom of the landfill. (The primary coastal zone extends landward for 1,000 feet or to the ten foot elevation, whichever includes the greater distance from the shoreline or from any stream flowing into marine waters.) 3. Stress the future implementation of storm-water runoff controls, if proven feasible, in order to assist in upgrading surface water quality to increase open shellfishing areas. 4. Provide for routine maintenance of on-site disposal systems. 5. Reduce the use of fertilizers on turf. Promote the use of low-maintenance lawns. 6. Control animal populations and animal waste disposal. 7. Prohibit, or severely restrict, all further development in shoreline areas. Establish adequate buffer zones around wetlands. Assign priority to public acquisition, based on the protection of groundwater quality and natural resources. 8. Prohibit the use of certain chemical cleaners in on-lot systems.
Zone VII Generally shallow horizontal groundwater flows.	Southern Nassau and southwestern Suffolk.	1 This area is, or will be, essentially completely sewered. Present plans generally conform to recommended 208 guidelines. 2. In developed areas not presently sewered or scheduled for sewering, plans for collection and treatment where the current density is nine or more persons (three dwelling units) per gross acre should be initiated. 3. Provide collection and treatment in those areas where on-lot systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other conditions. 4. Provide collection and treatment in those areas where contaminated groundwater may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards.	1. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface and ground waters. 2. New landfills should be permitted under current New York State policy, provided the site is landward of the primary coastal zone and the depth to groundwater is sufficient to ensure an adequate unsaturated zone below the bottom of the landfill. (The primary coastal zone extends landward for 1,000 feet or to the ten foot elevation, whichever includes the greater distance from the shoreline or from any stream flowing into marine waters.).

Table 6–1 . . . Cont'd.

Hydrogeologic Zone/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
Zone VII cont'd.		5. The 208 Study has not identified a need, within the twenty year planning period, for groundwater recharge in this area for the purpose of preserving drinking water supply. However, the importance of maintaining the flow and water quality of streams may require action to mitigate the impact of reduced groundwater levels attributable to sewering, with marine surface water discharges.	3. Reduce the use of fertilizers on turf. Promote the use of low-maintenance lawns.
Zone VIII Generally shallow horizontal groundwater flows.	Most of the area bordering Long Island Sound, from Hempstead Harbor to Wading River.	1. Provide collection and treatment in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations. 2. Provide collection and treatment in those areas where contaminated groundwater may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards.	1. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals, and bacteria to surface and ground water. 2. New landfills should be permitted under current New York State policy, provided the site is landward of the primary coastal zone and the depth to groundwater is sufficient to ensure an adequate unsaturated zone below the bottom of the landfill. (See Zone VII.) 3. Provide for routine maintenance of on-site disposal systems.

Surface Water Elements/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
A. Manhasset Bay Important recreational harbor (Dominated by the influence of Western Long Island Sound, which has been impaired by New York City discharges.)	Northwestern Nassau	1. Based upon preliminary economic and environmental analyses, the diversion of sewage flows from GNSD, Village of Great Neck, and Port Washington, to the Cedar Creek treatment facility is the recommended alternative. 2. If the cost of flow diversion significantly outweighs environmental benefits, the next preferred option would be to consolidate the existing treatment plants into a sub-regional facility. 3. If (1) and (2) above are not feasible, and the present configuration remains as is, then the individual facilities will require either nitrogen removal if the present discharge location is retained, or a mid-bay discharge, if the present level of treatment is maintained. Of these two options, a mid-bay outfall is recommended due to improved dispersion characteristics of the receiving waters, and reduced costs.	1. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters. 2. Enforce existing regulations concerning waste discharge from boats. The towns and/or counties should provide pumpout stations at all facilities owned and/or operated by them. In addition, "no-discharge" zones should be designated in all areas open to shellfishing and contiguous to bathing beaches. 3. Control animal population and animal waste disposal.

Table 6—1 . . . Cont'd.

Surface Water Elements/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
B. Hempstead Harbor Major commercial harbor, with considerable recreation. (Dominated by the influence of Western Long Island Sound, which has been impaired by New York City discharges.)	Northern Nassau	1 Based upon preliminary economic and environmental analyses, the diversion of sewage flows from Roslyn Sewage Treatment Plant to the Cedar Creek treatment facility is the recommended alternative. The Glen Cove treatment plant is excluded from this alternative because it is being reconstructed and upgraded. 2. If the cost of flow diversion significantly outweighs environmental benefits, the next preferred option would be to consolidate the existing plants into a sub-regional facility in the recommended Northwest study area. 3. If (1) and (2) above are not feasible, and the present configuration remains as is, then the individual facilities will require either nitrogen removal if the present discharge location is retained, or a mid-bay discharge, if the present level of treatment is maintained. Of these two options, a mid-harbor outfall is recommended due to improved dispersion characteristics of the receiving waters, and reduced costs.	1. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters. 2. Encourage the relocation of the solid waste handling and landfilling operations in, and adjacent to the Port Washington Sand Pits, to a site outside the coastal zone, at such time as a feasible alternative is available. 3. Control animal populations and animal waste disposal.
C. Oyster Bay Recreational harbor, and important commercial shellfishing area.	Northeastern Nassau	1. Based upon preliminary economic and environmental analyses, the diversion of sewage flows from the Oyster Bay Treatment Plant to the Cedar Creek treatment facility is the recommended alternative. 2. If it is determined that Bayville should be served by its own sewage treatment facility, then final effluent disposal should be to Long Island Sound. 3. If the cost of flow diversion significantly outweighs environmental benefits, the next preferred option would be to consolidate the existing treatment plants into a sub-regional facility in the Northeast study area. 4. Based upon water quality analysis, the Oyster Bay plant, may retain its present treatment level and discharge location without significantly impairing the receiving waters; however, this does not preclude the possibility of diversion to either the Cedar Creek treatment plant or to a sub-regional facility.	1. Due to the valuable shellfishing industry, the extensive wetlands and the excellent water quality in Oyster Bay, non-point source controls to alleviate impact on surface waters should be emphasized. 2. Prohibit, or severely restrict, all further development in shoreline areas. Establish adequate buffer zones around wetlands. Assign priority to public acquisition, based on the protection of groundwater quality and natural resources. 3. Enforce existing regulations concerning waste discharge from boats. The towns and/or counties should provide pumpout stations at all facilities owned and/or operated by them. In addition, "no-discharge" zones should be disignated in all areas open to shellfishing; and contiguous to bathing beaches. 4. Control animal populations and animal waste disposal.
D. Huntington Bay Complex bay system, includes natural, as well as highly developed shorefronts.	Northwestern Suffolk	1 On the basis of preliminary environmental analysis and projected flow, it is recommended that if the Huntington Sewage Treatment Plant is utilized as either a regional or sub-regional facility, secondary treatment with mid-bay effluent discharge appears preferable to AWT and effluent discharge at the present location in Huntington Harbor.	1. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals, and bacteria to surface waters.

Table 6–1 . . . Cont'd.

Surface Water Elements/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
D. Huntington Bay cont'd.		2. If the sub-regional alternative is selected, utilize the Huntington and Northport Village STPs.	2. Enforce existing regulations concerning waste discharge from boats. The towns and/or counties should provide pumpout stations at all facilities owned and/or operated by them. In addition, "no-discharge" zones should be designated in all areas open to shellfishing and contiguous to bathing beaches. 3. Control animal populations and animal waste disposal.
E. Port Jefferson Harbor Major industrial, commercial and recreational harbor. Ferry terminal.	Central Suffolk, North Shore	1. There is a 201 study currently underway in this area and the 208 has not selected a recommended alternative for sewage treatment and disposal It is required that the 201 study select the number and location of facilities by evaluating combinations of existing facilities and other suitable sites. 2. Surface water discharge shall not exceed the waste load allocations established by the 208 study.	1. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters. 2. Enforce existing regulations concerning waste discharge from boats. The towns and/or counties should provide pumpout stations at all facilities owned and/or operated by them. In addition, "no-discharge" zones should be designated in all areas open to shellfishing and contiguous to bathing beaches. 3. Control animal populations and animal waste disposal
F. Flanders Bay–Peconic Estuary Drains agricultural and natural areas. Hamlet of Riverhead located on the Estuary.	Riverhead–Brookhaven–Southampton Towns	1. Move the Riverhead STP discharge to a location outside the Estuary 2. The 201 study currently underway should evaluate the regional, sub-regional and small plants alternatives discussed in Section 3.5. Provide for further monitoring, specifically for dissolved oxygen nutrients and chlorophyll *a* to better define and select one of the point source control alternatives. 3. Require that duck farms' treatment facilities conform to compliance schedules which will call for zero discharge by 1983. 4. No additional loading should be allowed from the Brookhaven National Laboratory Sewage Treatment Plant or from the Grumman Sewage Treatment Plant.	1. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters. 2. Prohibit, or severely restrict, all further development in shoreline areas. Establish adequate buffer zones around wetlands. Assign priority to public acquisition, based on the protection of groundwater quality and natural resources. 3. Determine the impact of duck sludges as a source of nutrients and bacteria, and the feasibility of their removal. 4. Enforce existing regulations concerning waste discharge from boats. The towns and/or counties should provide pumpout stations at all facilities owned and/or operated by them. In addition, "no-discharge" zones should be designated in all areas open to shellfishing and contiguous to bathing beaches.

Table 6–1 . . . Cont'd.

Surface Water Elements/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
G. Mecox Bay Small bay, with ephemeral connection to the Atlantic Ocean.	Atlantic shore, Town of Southampton	1. Prohibit new point source discharge to the bay. 2. Provide nitrogen removal, or complete effluent recycling, for duck farm discharges located in the drainage area.	1. Prohibit, or severely restrict, all further development in shoreline areas. Establish adequate buffer zones around wetlands. Assign priority to public acquisition, based on the protection of groundwater quality and natural resources. 2. Reduce the use of fertilizers on turf. Promote the use of low-maintenance lawns. 3. Determine the impact of duck sludges as a source of nutrients and bacteria and the feasibility of their removal. 4. Determine the desirability of stabilizing the inlet from the Atlantic Ocean to provide adequate flushing and dispersion.
H. Shinnecock Bay Shallow bar-built estuary, important commercial and sport fishing facilities.	Between Shinnecock Inlet and Shinnecock Canal, Town of Southampton.	1 Prohibit new point source discharges to the bay. 2. Maintain the ocean inlet to provide adequate flushing and dispersion.	1. Prohibit, or severely restrict, all further development in shoreline areas. Establish adequate buffer zones around wetlands. Assign priority to public acquisition, based on the protection of groundwater quality and natural resources. 2. Provide for the routine maintenance of on-site disposal systems. 3. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters. 4. Enforce existing regulations concerning waste discharge from boats. The towns and/or counties should provide pumpout stations at all facilities owned and/or operated by them. In addition, "no-discharge" zones should be designated in all areas open to shellfishing and contiguous to bathing beaches.
I. Moriches Bay Shallow bar-built estuary, with unstable ocean inlet. Extremely sensitive to groundwater inflow quality.	South shore, between Shinnecock ahd Great South Bays.	1 Prohibit new point source discharges to the bay. 2. Provide nitrogen or complete effluent removal from duck farms located in the drainage area. 3. Maintain the ocean inlet to provide adequate flushing and dispersion. 4. Determine the impact of duck sludge on bay water quality.	1. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters. 2. Determine the impact of duck sludges as a source of nutrients and bacteria and the feasibility of their removal.

Table 6—1 . . . Cont'd.

Surface Water Elements/ Characteristics	Location	Structural Recommendations	Non-Structural Recommendations (Can have structural elements)
I. Moriches Bay cont'd.		5. If duck sludge is *not* the controlling influence on bay water quality, and if the maintenance of the ocean inlet does *not* provide the desired improvement, then collect and treat at one or more D.U./acre.	3. Control animal populations and animal waste disposal. 4. Enforce existing regulations concerning waste discharge from boats. The towns and/or counties should provide pumpout stations at all facilities owned and/or operated by them. In addition, "no-discharge" zones should be designated in all areas open to shellfishing and contiguous to bathing beaches.
J. Great South Bay Shallow bay, western portion generally well flushed, eastern portion poorly flushed. Major commercial shellfishing area.	Between the Barrier Beach and the Towns of Babylon, Islip and Brookhaven.	1. Prohibit new point source discharges into Eastern Great South Bay and recharge tertiary treated effluent. 2. Provide nitrogen removal for the Patchogue Sewage Treatment Plant.	1 Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters. 2. Control animal populations and animal waste disposal. 3. Reduce the use of fertilizers on turf. Promote the use of low-maintenance lawns. 4. Require nitrogen removal for treatment plants recharging effluent. 5. Prohibit any new development along streams and shorelines. Create buffer zones where possible along all water bodies and protect all remaining marine wetlands. 6. Enforce existing regulations concerning waste discharge from boats. The towns and/or counties should provide pumpout stations at all facilities owned and/or operated by them. In addition, "no-discharge" zones should be designated in all areas open to shellfishing and contiguous to bathing beaches.
K. Western South Shore Bays Relatively well-flushed but sensitive to high pollutant loads.	Between the Barrier Beach and the Towns of Hempstead and Oyster Bay.	1. Locate the Bay Park sewage plant outfall offshore. 2. Divert the Long Beach sewage treatment plant effluent to the proposed Bay Park ocean outfall. 3. Initiate a study to determine whether the Lawrence treatment facility discharge violates water quality standards in Bannister Creek. If so, the discharge options should be as follows: a. Institute AWT with effluent discharge at the present location. b. Continue present treatment with effluent discharge to Reynolds Channel, and c. Divert sewage to the Bay Park treatment facility. 4. Terminate the operation of the Freeport treatment plant and divert the flow to the Cedar Creek facility by December 31, 1979, as presently scheduled.	1. Control stormwater runoff to minimize the transport of sediments, nutrients, metals, organic chemicals and bacteria to surface waters. 2. Institute legislation to control animal populations and animal waste disposal. 3. Enforce existing regulations concerning waste discharge from boats. The towns and/or counties should provide pumpout stations at all facilities owned and/or operated by them. In addition, "no-discharge" zones should be designated in all areas open to shellfishing and contiguous to bathing beaches.

wells are not designed to answer specific types of wastewater management questions.

Present wastewater management decisions concerning non-point sources are based primarily on population density. This is a very easy criterion to use because the distribution of population is readily ascertainable. However, the problem of trying to predict concentrations of various chemicals in groundwater on the basis of present population densities or land uses is a multi-variate one that is not easily solved in a region of varied, changing land use. The application of lawn fertilizer, for instance, is a major source of nitrogen and may be related not only to population density but to other factors such as homeowner income in a particular neighborhood. Predictions of the concentrations of constituents other than nitrate on the basis of population density is even more tenuous because of a general lack of data, particularly for organic chemicals. For instance, the input of organic chemicals may be partially related to certain types of industrial discharges, the use of organic solvents in cesspools, or to the traffic volume in a given area. In fact, because of the complexity of sources over space and time, and because of differences in the soil media, a strictly deterministic basis for wastewater management decisions may not be feasible. There must be some mechanism that allows for the actual monitoring of the groundwater system. Such a program may well result in the discovery of new water quality relationships or trends that were not previously anticipated.

One alternative is to install a number of shallow water table monitor wells throughout the two counties. These wells would provide data on any constituent desired, and permit the making of decisions on the basis of actual data, rather than on the basis of predicted or assumed values. Samples from wells screened in the upper ten feet of the saturated sediments will generally represent water that has percolated from the land surface recently, since it takes months to possibly several years for contaminants in recharging water to reach this shallow zone, depending on depth and soil characteristics. In addition, this water usually originates in the area immediately upgradient from the well and consequently reflects conditions in that area. Groundwater quality near the water table often represents a worst case situation, since, as the water travels further within the system, contaminants may be diluted and may be attenuated by adsorption on soil particles. For these reasons, adverse water quality conditions measured in these wells can be related to recent land use and/or wastewater disposal practices in the vicinity of the well, and appropriate abatement measures can be taken.

In its simplest form, a grid system would be established throughout the water management zone of interest. A coarse grid, with relatively large spacings between wells, would be established in those areas that appear to be least affected by human activities. Areas of dense residential development, agricultural use, or industrial development would be covered with a fine grid of relatively closely spaced wells. In planning this initial set of wells, sources of nitrate and organic chemicals should be given primary consideration. As water quality data is obtained from these wells it may become apparent that a particular area is receiving contaminants even though it may be located in a coarser section of the grid. This area would then be investigated and additional monitor wells would be drilled. In this way, new information gathered from the wells would be used to refine the monitoring system. As the program continues, the correlation between the presence of certain contaminants in groundwater and different types of land use or population density might become clear. Initially, the present knowledge of contaminant loading from various sources would be used in establishing the location and spacing of the wells. A model can be used to predict a mean concentration of nitrogen in soil water, below the root zone, for each of the land use grid cells used by the NSRPB. This information, along with water quality data from exising wells, would help determine the number of wells needed in any one area. Results of the monitoring could, in turn, help to refine the assumptions made in this model. Thus, two approaches, modeling and the collection of data indicating actual water quality conditions, could be used conjunctively to assess the groundwater quality on a continuing basis.

The number of wells in any particular land use area should be determined with statistical inference in mind. For example, there is usually considerable spatial variability of nitrate in contaminated groundwater, and therefore a sufficient number of samples and wells are necessary before significance can be established. Variation of nitrate in uncontaminated areas is low and fewer samples may be necessary to satisfy the monitoring objectives there. It is expected that many of the approximately 190 Suffolk County DEC and USGS wells, and perhaps a few Nassau County wells could be utilized in this program. Additional wells, perhaps between 50 and 100 wells per county, would be necessary to complete the new system. In addition to the installation of the wells, it will be necessary to carefully describe and catalog the land use in the vicinity, especially upgradient of each well. In this way, water quality data could be related back to these land uses.

Of equal importance to the design of the system is the continuing evaluation and review of the data. In addition to an assessment of existing conditions, shallow monitoring wells can be used to determine trends of a variety of constituents over time. This would be particularly important in areas of changing land use where trends would give an indication of effects of recent development. These wells could also be used to monitor the results of recent large scale sewering, such as that in Sewage Disposal District Three in Nassau, or to supplement the existing monitoring well system of the Southwest Sewer District in Suffolk.

6.2.3 Maintenance of Stream Base Flow and Surface Water Elevations. Fluctuations in groundwater levels (and potentiometric surfaces), stream base flow and surface water elevations have been observed over the past 40 years. These fluctuations result from natural dry/wet year precipitation cycles, and also from groundwater pumping and operation of non-recharging sewage collection systems.

The 208 Study has not identified a need for areawide groundwater recharge of wastewater treatment plant effluent for the purpose of maintaining drinking water supply. On a regional basis, adequate quantity can be sustained over the entire planning period of twenty years by implementing recommended wastewater and water supply management practices. However, the maintenance of groundwater levels is important and should be addressed. The decline in water levels, which will occur by applying the 208 sewering criteria, and recharge limitations must be analyzed on an individual basis.

While a decline in groundwater level is generally not detrimental to water supply, it can significantly reduce stream base flow and surface waterbody elevations. These reductions can adversely impact water dependent vegetation and ecosystems. In eastern Great South Bay, the limited tidal exchange causes stream base flow to be extremely important in maintaining the bay salinity patterns. Other Long Island bays are not as sensitive to stream base flow or groundwater underflow.

In order to thoroughly ascertain the effects of proper maintenance of streamflow levels, it is recommended that streamflow augmentation studies be conducted by both Nassau and Suffolk Counties, as presently planned. The studies should continue to be comprehensive in nature and deal with the need for augmentation, beneficial impacts, available methods and cost-effectiveness.

It may be feasible to mitigate the effects of groundwater level decline on surface waters without maintaining present average groundwater levels. Information gained from the streamflow augmentation needs studies for the Nassau Sewage Disposal Districts Two and Three and the Suffolk County Southwest Sewer District should be incorporated into the 208 Plan when the studies are completed.

A major concern of the 208 is the potential contamination of the groundwater supply by organic chemicals and other pollutants in the event of system failure, poor operation or other, unforeseen occurrences. It is the recommendation of the 208 to carefully evaluate the results of the Cedar Creek recharge project in terms of process performance, reliability and effluent quality, and then decide if a decision on recharge safety can be reached. It is a further recommendation to continue the sampling and analytical program started under 208, of the impact on groundwater quality of effluent recharge from a secondary treatment plant. The Program should be expanded in terms of the number and depth of sampling wells and frequency of sampling.

6.2.4 Recommendations for the Siting, Construction and Management of Landfills. Over the long term, the primary emphasis should be on resource recovery methods for the disposition of most residual wastes. Because of the inherent public health and environmental hazards, especially groundwater pollution, the continued burial of residual wastes in landfills can no longer serve as the Region's primary disposal method. However, some landfills will still be required for (1) the disposal of the relatively small amounts of inert residues remaining after the resource recovery process, (2) non-recoverable and non-putrescible wastes, such as concrete rubble and demolition wastes, and (3) the untreated solid wastes that are generated in rural or resort areas located too far from the resource recovery plants to justify shipment, and in quantities that are too small to warrant the establishment of a resource recovery facility. Various other methods, among them separation, leaf composting, electrical or steam generation, must be evaluated by local and regional agencies for applicability. Smaller political jurisdictions should combine to optimize cost-effectiveness.

The New York State Department of Environmental Conservation's regional policy based in part on the conclusions of the Oyster Bay—Plainview Landfill hearings strongly favors resource recovery for the Region and will require "a thorough examination of alternatives before approving new landfills on Long Island, particularly when they are to be located in areas where the groundwater situation is especially sensitive." (NYSDEC, 1977, Proceedings for the TOB Solid Waste Management Facility, Plainview, N.Y.)

The conclusion does not eliminate landfilling as a means of disposal in the Region, nor rule out the possibility that fail-safe leachate containment systems may be devised, which could allow for the future landfilling in all zones. In the interim, however, DEC's policy will (1) deter the development of large scale landfill sites, issuing only short term permits (three years or less); (2) strictly enforce the newly revised Rules and Regulations of Part 360; and (3) aggressively persuade refuse collecting jurisdictions to evaluate and implement, where justified, resource recovery alternatives.

In considering the following residual waste disposal recommendations for each of the hydrogeological zones, the reader should be aware that the zone boundaries as depicted in Figure 3—2 are merely approximations, and that further investigation is required before their precise location can be determined. It would, therefore, be prudent for any jurisdiction considering the siting of a new landfill to first carefully study the hydrogeology of the area to determine the applicable zone recommendations before proceeding further. Recommendations:

Zone I

1. Existing or abandoned landfills should be covered with impermeable barriers and properly graded to prevent stormwater infiltration, where feasible. Venting or methane recovery should also be considered to prevent lateral subsoil movement of decomposition gases, which will occur subsequent to capping.

2. New sanitary landfills and landfills for the disposition of inert types of wastes should be prohibited. Likewise, any other solid waste treatment or disposal facility that might discharge process water to the ground, treated or untreated, should be discouraged from siting in this zone.

Zone II

Even though the groundwaters in this zone have been impaired by past activities, the following recommendations should be implemented to prevent continued degradation, since the zone is within the Magothy recharge area:

1. All existing solid waste facilities, with the exception of controlled composting sites and landfills that dispose of inert wastes, should be graded and top-lined with an impervious barrier to prevent stormwater infiltration. Gas venting systems must also be installed to prevent lateral distribution to areas off site.

2. Whenever an existing landfill is extended into a previously unused area, that area should be double-lined and provided with dual piping systems. Provision should be made for (a) the removal of leachate from the primary liner and (b) monitoring and removal of any leachate that might penetrate the primary liner and accumulate on the secondary liner.

3. New sanitary landfills for the disposal of garbage should be prohibited.

4. Waste and quench waters from other solid waste facilities should be pretreated to conform to sewer use ordinances and then discharged to a municipal facility.

Zone III

The groundwater in this zone is of excellent quality and must be retained for future public water supply.

1. There should be an immediate discontinuance of obsolete operational practices in existing landfills. Older sections of the site should be graded and covered with an impermeable liner to prevent stormwater infiltration and generation of leachate.

The landfill should be redesigned to incorporate the latest techniques for the prevention of groundwater contamination (*i.e.*, double liner—dual leachate collection piping) unless it can be demonstrated that suitable natural barriers exist.

2. New sanitary landfills and landfills for the disposition of inert types of wastes should be prohibited. Likewise, any other solid waste treatment or disposal facility that might discharge process water to the ground, treated or untreated, should be discouraged from siting in this zone.

3. Solid wastes generated within this zone should be transported to established waste disposal facilities or landfills located in zones where future sources of drinking water will not be jeopardized.

Zone IV

Heavy agricultural land use in this zone has contaminated the groundwaters with excessive levels of nitrates, and the zone is underlain at various depths with saltwater. The following recommendations should be considered:

1. Where it can be demonstrated that groundwater movement is away from existing or future public water supply resources, the operation of existing landfills should be allowed, in accordance with Part 360. Where leachate might be expected to impact the zone's water resources, existing landfills should be modified, as indicated for Zone II.

2. Where the establishment of new landfills or the expansion of existing landfills cannot be avoided, they should be so sited as to impact already degraded areas. Thus new landfills could be sited downflow of existing landfills where groundwater may already be contaminated and favorable groundwater flow conditions exist, and away from drinking water supply wells. However, proper grading should be incorporated to minimize stormwater infiltration. The establishment of new landfills in a groundwater resource area or immediately adjacent to surface waters should be prohibited.

3. Other types of solid waste facilities that discharge wastewaters may be permitted, provided that they have treatment facilities capable of meeting New York State's groundwater discharge criteria. No type of solid waste facility that requires a wastewater discharge should be permitted in a water resource area.

4. Inasmuch as Shelter Island is isolated and therefore dependent on the local groundwater supply, protection of that supply is particularly important. It should be noted that the cost of importing water may exceed the cost of exporting degradable domestic and commercial solid wastes.

It is recommended that on Shelter Island all landfilling of degradable solid waste be immediately discontinued and the waste exported to a suitable facility elsewhere in Zone IV or Zone V. Because it is impossible to totally segregate wastes that will not have an impact on the quality of the Region's groundwater, it is recommended that inert solid waste be contained in a lined disposal facility. In addition, the site should be graded to minimize stormwater infiltration.

Zone V

The recommendations for Zone IV also apply throughout all of Zone V.

Zone VI

The recommendations for a zone that provides recharge into the shallow groundwater system may place additional constraints on existing landfilling operations beyond those provided in NYSDEC Rules and Regulations Part 360. New facilities should not be sited in the primary coastal zone or in areas with high groundwater levels. Surface runoff and leachate should be contained and treated to prevent contravention of groundwater standards.

Zone VII

The recommendations for this zone, which also recharges to the shallow groundwater system, are the same as for Zone VI.

Zone VIII

This zone, located on the North Shore, is hydrogeologically similar to Zones VI and VII. Therefore, the recommendations that apply to those zones also apply to Zone VIII.

6.2.5 Expansion of Public Water Supply Systems. In those hydrogeologic zones where population densities are presently very low and groundwater is near pristine (*e.g.*, Zone III), the concept of "monitoring ambient groundwater quality . . . as a basis for wastewater management decisions," has been adopted as an integral part of the policy of maintaining low population density. In those areas, residences are usually served by individual or private wells. It is also generally true that groundwater quality measured in

observation wells screened in the upper ten or twenty feet of the water table aquifer would represent a worse case situation, and most likely reflect the most recent land use and waste disposal practices.

Since it is axiomatic that the major premise for making wastewater mangement decisions, whether they be structural or non-structural controls or monitoring programs, is the protection of the public health, it appears that one of the first responses to a measured degradation in groundwater quality in the water table aquifer should be the extension of public water supply facilities. The rigidly controlled construction standards, and the frequency of quality control monitoring by the public water purveyors, are substantial public heath protective measures in themselves.

6.3 Recommendations By Detailed Study Areas

6.3.1 Detailed Study Areas. The Bi-county Region has been divided into a number of detailed study areas, largely on the basis of surface drainage basins. (See Figure 2–3). Nine of these areas have already been designated in whole or in part as 201 study areas, one is awaiting designation, and the remainder are potential 201 areas.

201 study areas were designated pursuant to Title II of the Federal Water Pollution Control Act (FWPCA), which provides assistance to localities for the development and implementation of waste treatment works. In general, Section 201 has provided financial assistance through a three-tiered program, consisting of alternatives evaluation, detailed project plans and actual construction. Recent amendments (1977) to the FWPCA require applicants for 201 assistance to consider a broad range of alternatives, which may provide for water reclamation and reuse, the need for sewers, improved techniques for waste treatment and various land disposal methods.

Since the hydrogeologic zones are distinguished from each other by their groundwater flow regimes, their boundaries do not coincide with those of the detailed study areas. However, the Areawide Waste Treatment Management Plan has to be based on the latter, rather than the hydrogeologic zones, because the 201 Programs represent the most practical means whereby the management recommendations arising from the 208 Program can be implemented.

6.3.2 Integration of Hydrogeologic Zones and Detailed Study Areas. Figure 6–1 provides a graphic display of the relationship between (1) the detailed study areas and 201 Areas where so designated (each is defined in detail in Section H of the Plan; (2) the potential sewer service areas based on a density of two or more dwelling units per acre and (3) the hydrogeologic zones. The wastewater planning districts are shown as they appear in other 208 outputs, and detailed summary information has been presented for them. The boundaries shown represent the currently anticipated geographic implementation boundaries. It is recommended that the currently designated 201 Programs be implemented according to the boundaries shown in Figure 6–1. An implementation schedule is given in Section Seven. (See Section M of the Areawide Waste Treatment Management Plan.)

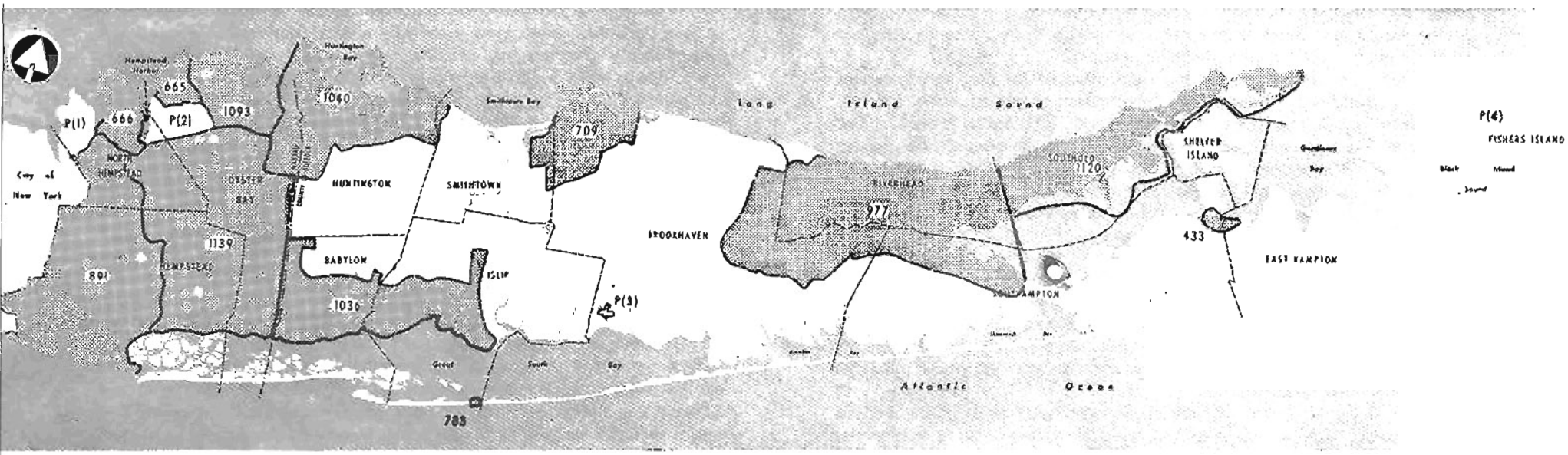
Figure 6–1 illustrates the relationships for one of several sewering options that may be adopted in the future. (See Sections 3.3 and 3.5 for a discussion of the various options.) As previously indicated, sewering at densities of one or more dwelling units per gross acre represents a maximum sewering approach. Sewering at densities of two or more dwelling units per gross acre in areas of high groundwater or low soil permeability and of three or more dwelling units per gross acre elsewhere represents a minimal sewering approach. Sewering at densities of approximately two dwelling units per gross acre, or lot sizes of less than 20,000 square feet for new developments, represents an intermediate approach and reflects current sewering policy in Suffolk County. The three pieces of information have been graphically combined to demonstrate how they should be analyzed and interpreted at a more detailed 201 level of study. The 201 Studies should take cognizance of the regional implications identified at the 208 level of study and interpret and apply the implications at the more detailed level of study.

Within each 201 level study, the hydrogeologic zone boundaries should first be defined in more detail, applying the criteria that were developed in the 208 Program. A similar approach should be taken in mapping areas of different population densities for possible definition as sewer service areas. Areas of high water table and low soil permeability should also be mapped.

For each hydrogeologic zone, the 208 has recommended a specific action or set of options that may be implemented to affect regional waste management goals. These are the alternatives that each 201 Study should develop and evaluate in detail. Each 201 area overlies at least one (and usually more) hydrogeologic zones, and the zone recommendations should be applied individually to the various parts of the 201 study area.

The proposed Yaphank study area in Suffolk provides a good example of the integration procedure. The northern portion is a part of Zone VIII, the central portion includes parts of Zones I and III, and the southern portion is part of Zone VI. Therefore, a 201 Study should be guided by the recommendations provided for the appropriate zones, when selecting alternatives for the various portions of the Yaphank study area.

The North Shore planning area in Nassau County can be similarly analyzed. Those southerly portions of the area that lie in hydrogeologic Zone I should be guided by Zone I recommendations. The northern parts of the area, which lie in Zone VIII, should incorporate the recommendations made, and study the various options listed herein for Zone VIII at a 201 level of detail. The regional, sub-regional or small plants approaches as presented in Plan Section H, and summarized previously in Section 3.2, should be analyzed in a 201 Study once zone options have been identified. However, the sewage flows and cost estimates presented earlier in this Summary Report (Section 3.3), were presented for detailed study areas and not hydrogeologic zones. Therefore, they are not directly transferrable since study area and zone boundaries do not coincide. Flows, loads and cost estimates will have to be finalized at a 201 level once zone options have been selected and detailed development of alternatives has occurred.



(a) Existing and Pending 201 Study Areas

Existing 201 Study Areas

433 – Sag Harbor (V)
665 – Glen Cove (C)
666 – Port Washington
709 – Port Jefferson
783 – Ocean Beach (V)
891 – Nassau County SD No. 2
977 – Riverhead (T)
1036 – Suffolk County SWSD
1040 – Huntington (T)/Northport (V)
1093 – Oyster Bay
1120 – Southold (T)/Greenport (V)
1139 – Nassau County SD No. 3

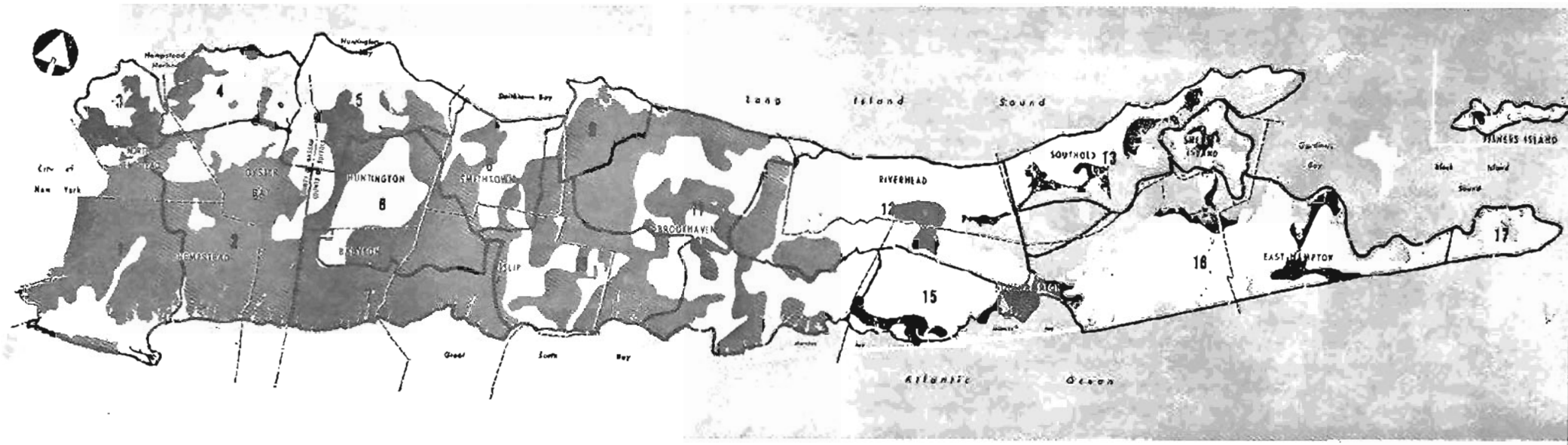
Pending 201 Study Areas

P (1) – Great Neck peninsula
P (2) – north shore undesignated
P (3) – Patchogue SD
P (4) – Fishers Island

Proposed Detailed Study Areas

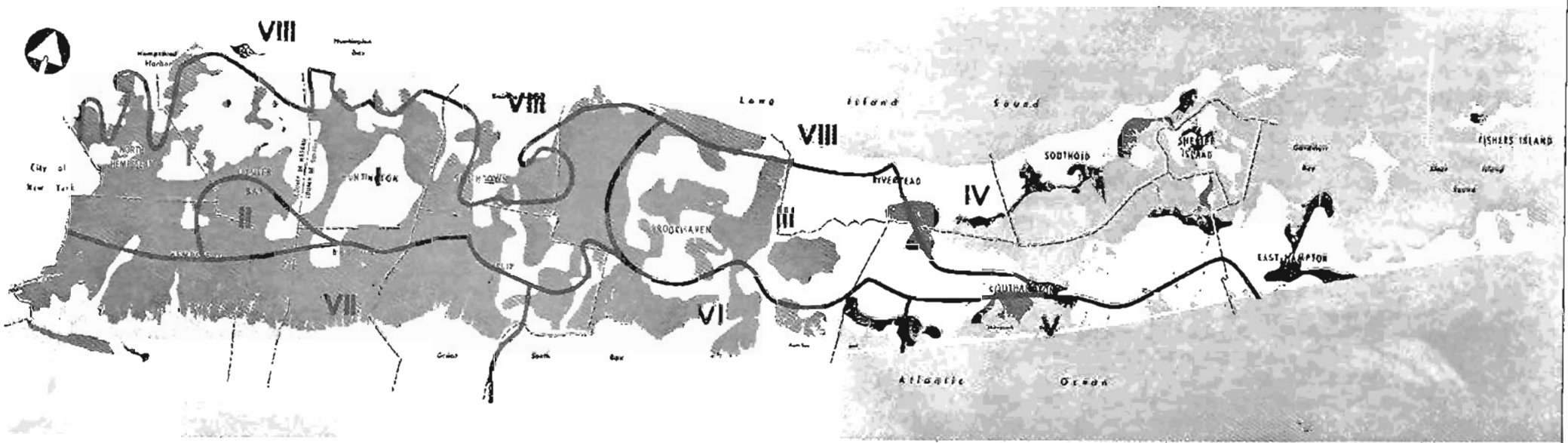
1. Southwestern NC
2. Cedar Creek
3. Northwest NC
4. Northeast NC
5. Huntington/Northport
6. West Central SC
7. Southwest SC
8. Kings Park
9. Port Jefferson
10. South Central SC
11. Yaphank
12. Riverhead
13. Southold/Greenport
14. Shelter island DD No. 14
15. Southampton DD No. 12
16. South Fork DD No. 15
17. Montauk DD No. 16
18. Fishers Island DD No. 17

FIGURE 6–1 *201 Areas, Detailed Study Areas and Hydrologeologic Zones in Relation to Development of Two or More D.U./Acre*



(b) Proposed Detailed Study Areas

All hydrogeologic zone boundaries are approximate. Further definition of groundwater flow systems at a sub-regional level is required.



(c) Hydrogeologic Zones

— Development at 2 or more D.U.'s/Acre.

Groundwater quality monitoring is an integral part of detailed study area planning, and should be routinely employed in situations where there is uncertainty as to the existing quality of the shallow groundwater, or where there is uncertainty as to trends in pollutant concentration. The use of actual groundwater quality data in making wastewater management decisions is an approach that has not been widely used on Long Island. It is a concept that recognizes the limitations of any predictive model, whether it be theoretical or empirical. The planning guidelines recommended for the hydrogeologic zones and surface water elements should be applied in developing plans for relevant portions of the detailed study areas. For example, for those portions of the detailed study areas that are characterized by deep flow recharge regimes, the following planning guidelines should be applied:

1. Guidelines for Determining the Need for Structural and Non-Structural Controls.

a. Developed Areas

Since existing data is not sufficient to delineate the spatial extent of needed sewering, and since the effectiveness of selected non-point source controls is not known, the initial minimum density for sewering in developed areas should be nine persons per gross acre (approximately three dwelling units per gross acre). This will provide current 201 facilities planning areas with a threshold density at which to initiate their planning. Statistically, at this density, a nitrate-nitrogen groundwater concentration of ten milligrams per liter may be exceeded in 40 percent of samples drawn from shallow monitoring wells in that locality.

In areas where the density is less than nine persons per gross acre, monitoring should be undertaken during the initial phase of a 201 Study. This effort should be undertaken to define the hydrogeologic system beneath the area and to determine the need for further sewering.

The detection of an average nitrate-nitrogen concentration of six milligrams per liter or greater for the individual analysis of the shallow aquifer monitoring wells during the observation period would indicate the need for control measures to reduce the nitrogen loading.

Statistically, an average value of six milligrams per liter means that a nitrate-nitrogen groundwater concentration of ten milligrams per liter may be exceeded in ten percent of the samples drawn from shallow monitoring wells in that locality.

If it is determined, following analysis, that the source of nitrogen contamination is on-lot disposal systems, the spatial extent of needed sewering will be delineated by the extent of the area where the average nitrate-nitrogen concentrations are six milligrams per liter or greater.

b. Undeveloped Areas

For planning purposes, it is desirable to take a more conservative approach regarding the utilization of structural controls because of uncertainty concerning the absolute effectiveness of best management alternatives and the added expense of installing sewers after developments are established. It is recommended that, in undeveloped areas, sewering should be implemented at a population density of six persons per gross acre, which would yield values of nitrate-nitrogen in excess of ten milligrams per liter in approximately twenty percent of the observations in shallow wells. It is assumed that, at six persons per gross acre, a large percentage of the violations can be eliminated through Best Management Practices, primarily fertilizer controls. Conversely, it may be assumed that, if non-structural controls are ineffective, or are not stringently applied, sewering may be necessary at lower population densities. At densities less than six persons per gross acre, monitoring of the water table would be undertaken to determine groundwater quality trends and to determine the future need for improved non-structural and structural controls.

At the population density of six persons per gross acre, if one were to assume a household size of 3.5 persons per dwelling unit, this would result in a density of 1.7 dwelling units per acre. Since this recommended sewering criterion for undeveloped areas is very close to the present Suffolk County standard for requiring sewers in new developments at lot sizes less than 20,000 square feet, or 1.6 dwelling units per acre, it is recommended that for planning purposes, the Suffolk County policy remain in effect for undeveloped areas. The additional groundwater quality data, which would be gathered in both 201 and other recommended Studies on the basis of varying geological conditions and population densities as discussed in the recommendations for developed areas, would possibly modify the criterion for structural pollution controls, as recommended herein, in the future.

2. Guidelines for Comprehensive Groundwater Monitoring

Comprehensive monitoring programs to provide data to be used in making wastewater management decisions for both structural and non-structural controls should be initiated or expanded.

The observation well drilling sequence, and the monitoring program should be carefully designed to provide data on representative ambient conditions in previously developed areas, and base data to evaluate trends in concentrations of contaminants in newly developed areas.

The number of wells, locations and depths, and frequency of sampling cannot be determined in a regional study. However, it appears evident that at least monthly samplings must be made for a period sufficient to characterize levels of nitrate-nitrogen and other contaminants with full consideration to the variability imposed by differences in geology, initial conditions, population density and thickness of the unsaturated zone. It is estimated that sampling would be necessary over a period of six to twelve months. The details of these programs should be based on the demonstration project described in Section 6.5.2.5.

Shallow observation wells, screened in the upper portion of the water table aquifer, would reflect, in the shortest time period, changes in water quality due to activities at the land surface, and the impact on drinking water quality in the area may be predicted, and help to assist in decision-making, especially in areas where 201 Studies are underway or planned.

6.3.3 Structural Recommendations for Nassau County Detailed Study Areas. The following are only structural recommendations for Nassau County 201 study areas. Many of the pollutants that impact groundwater and surface waters can be expected to persist regardless of the structural recommendations that are selected. For this reason, non-structural alternatives must be regarded as an essential part of any comprehensive waste water management plan. For brevity, non-structural and non-point source recommendations have not been reiterated. However, it is necessary to review Table 6—1, in Section 6.2.1, and the Areawide Recommendations in Section 6.1. and apply those recommendations listed for a particular zone to the same zone or zones included in the detailed study area.

6.3.3.1 Southwestern Nassau County Planning Area (Districts No.1 and No. 2, and the Cedarhurst, Lawrence. Long Beach and West Long Beach Sewer Districts)

Hydrogeologic Zones

Zone I

This area is completely sewered and no further sewering options exist. Regulations mandating the hook-up of private disposal systems to the district collection system should be more strictly enforced.

Zone VII

This area is essentially completely sewered and only one additional sewering option is recommended; that is, to sewer Point Lookout and the unsewered section of Lido Beach. These locations are in areas where on-lot sewage disposal systems are subject to failure and where it may reasonably be expected that these systems contribute pollutants to the surface waters.

Surface Water Elements

1. Relocate the Bay Park Treatment Plant outfall offshore to significantly reduce the nutrient and bacteria loadings to the present receiving waters, which include Hempstead Bay and Reynolds Channel.

2. Reroute the Long Beach Treatment Plant effluent to the proposed Bay Park outfall for ocean disposal. Although the background water quality at the present Long Beach outfall location is marginal, and the impact of the Long Beach discharge on the water quality is relatively minor when compared to that of Bay Park, in the long term, the most environmentally beneficial option is to divert the effluent offshore.

3. Initiate a study to determine whether the Lawrence treatment facility discharge violates water quality standards in Bannister Creek. If so, the discharge options should be as follows:

a. upgrade treatment with effluent discharge at the present location,
b. continue present treatment with effluent discharge to Reynolds Channel, and
c. divert sewage to the Bay Park treatment facility

6.3.3.2 Cedar Creek Facilities Planning Area (Sewage Disposal District No. Three)

Hydrogeologic Zones

Zone I

1. Continue present plans for sewering this area. These plans generally conform to the recommended 208 guidelines.

2. In developed areas not presently sewered or scheduled for sewering, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

3. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

4. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

Zone II

The desired goal in this zone is to upgrade groundwater quality and to ensure the continued viability of the aquifer as a source of drinking water.

1 This area is, or will be, essentially completely sewered, and no further sewering options exist. Present plans generally conform to recommended 208 guidelines.

Zone VII

1. This area is completely sewered and no further sewering options exist.

2. It is also recommended that, if sewage flow diversion from the North Shore to the South Shore is determined to be the most cost-effective option, then it should be diverted to the Cedar Creek treatment facility, since land is available at this site.

Surface Water Elements

1 Terminate the operation of the Freeport Treatment Plant and divert the flow to the Cedar Creek facility by December 31. 1979, as presently scheduled.

2. Stress the implementation of those non-point source and stormwater runoff controls proven feasible, to upgrade marine surface water quality to meet shellfishing standards.

6.3.3.3 North Shore Facilities Planning Area. It should be noted that the prioritizing of the wastewater treatment, routing and effluent disposal alternatives here in this section is not meant to exclude any of these options from further study. The ranking of the treatment alternatives under "Surface Water Elements" is based upon preliminary engineering, environmental and economic analysis, and therefore, it is recommended that all of these wastewater management options discussed below be considered viable and evaluated in greater detail in a "201" level of study.

It is recommended that the northern drainage basin of Nassau County be divided into two 201 level study areas due to drainage patterns, economies of scale, diversion potential, land use characteristics and potential for sub-regional treatment plants.

1. *The Northwest Study Area* would include the Great Neck peninsula, and the Port Washington peninsula. This would include the following sewer districts and unsewered areas: Belgrave, Great Neck, Great Neck Village, Port Washington, Roslyn, Plandome-Sands Point and Kings Point-Manhasset.

2. *The Northeast Study Area* would comprise the Oyster Bay drainage area and the eastern drainage basin of Hempstead Harbor, including Glen Cove. The study area would include the following sewer districts and unsewered areas: Glen Cove, Oyster Bay, Sea Cliff-Roslyn Harbor, Centre Island, East Norwich, Bayville and Locust Valley.

A 201 facilities planning study has recently been undertaken for Port Washington, and one for Oyster Bay will begin during 1978.

Hydrogeologic Zone

Zone I

1. In developed areas not presently sewered, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

4. Sewage flow from C. W. Post College should be diverted to the Cedar Creek treatment facility for final disposal. If the cost of diversion, however, significantly outweighs the cost of nitrogen removal, as determined in a 201 Study, then this treatment plant may continue to discharge to the ground providing it is upgraded to include nitrogen removal and to meet other applicable groundwater quality standards. This recommendation is consistent with proposed NYSDEC regulations to provide nitrogen removal where the flow exceeds 30,000 gallons per day.

Zone VIII

1. Sewer in those areas where on-lot sewage disposal systems are subject to failure and cannot be upgraded due to high groundwater table, low soil permeability, small lot size, etc.

2. Sewer in those areas where contaminated groundwater may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards. This recommendation refers specifically to parts of Plandome-Sands Point, Kings Point-Manhasset, Sea Cliff-Roslyn Harbor, Bayville and Centre Island, which existing and future studies may indicate are critical areas controlling nearby surface water quality.

Surface Water Elements

1. Based upon preliminary economic and environmental analyses, the diversion of sewage flows from the North Shore areas to the Cedar Creek treatment facility is the recommended alternative. The Glen Cove Treatment Plant, however, is excluded from this alternative because it is presently being reconstructed and upgraded.

2. If the cost of flow diversion significantly outweighs environmental benefits, the next preferred option would be to consolidate the existing treatment plants into a sub-regional facility in each recommended Northeast and Northwest study area. The reliance on a number of small treatment plants in this area may fail to capture all the economies of scale available to a larger sub-regional facility.

3. If the benefits of the preferred alternatives cannot be realized due to cost, and the present configuration remains as is, then the individual facilities will require either nitrogen removal if the present discharge location is retained, or a mid-bay discharge, if the present level of treatment is maintained. Of these two options, a mid-bay outfall is recommended due to improved dispersion characteristics of the receiving waters , and reduced costs.

4. Based upon water quality analysis, the Oyster Bay plant may retain its present treatment level and discharge location without significantly impairing the receiving water; however, this does not preclude the possibility of diversion to either the Cedar Creek Treatment Plant or to a sub-regional facility to assure minimal impact on the ecosystem in the area due to the present discharge of both nutrients and bacteria. The potential environmental benefits, achieved through diversion, make this the recommended alternative.

5. If it is determined that Bayville should be served by its own sewage treatment facility, then final effluent disposal should be to Long Island Sound.

6. The presently planned treatment level for the Glen Cove treatment facility will not achieve water quality standards in Glen Cove Creek. To insure compliance with the standards, nitrogen removal or a mid-harbor discharge is required. However, if the removal of a significant source of bacteria in the vicinity of a number of bathing beaches, and the maximum dispersion of effluent is to affected, then a mid-harbor outfall is the preferred alternative.

7. Due to the valuable shellfishing industry, the extensive wetlands and the excellent water quality in Oyster Bay, non-point source controls to alleviate impacts on surface waters should be emphasized, if proven cost-effective.

6.3.4 Structural Recommendations for Suffolk County Detailed Study Areas. The following are only structural recommendations for Suffolk County 201 study areas. Many of the pollutants that impact groundwater and surface waters can be expected to persist regardless of the structural recom-

mendations that are selected. For this reason, non-structural alternatives must be regarded as an essential part of any comprehensive waste water management plan. For brevity, non-structural and non-point source recommendations have not been reiterated. However, it is necessary to review Table 6—1, in Section 6.2.1, and the Areawide Recommendations in Section 6.1, and apply those recommendations listed for a particular zone to the same zone or zones included in the detailed study area.

6.3.4.1 Huntington/Northport Study Area. A 201 facilities planning study has recently been undertaken for this area, which includes a small portion of northeastern Nassau County. Parts of the area are presently sewered and there are three existing facilities in Suffolk and one in Nassau.

Hydrogeologic Zones

Zone I

1. In developed areas not presently sewered, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

4. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

Zone VIII

1. Sewer in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.

2. Sewer in those areas where contaminated underflow may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards.

3. A need for groundwater recharge for the purpose of maintaining water supply self-sufficiency in the Region has not been identifed by the 208 Study. This does not preclude recharge as an option in any investigation of effluent disposal methods.

Surface Water Elements

1. The following sewage treatment options require further evaluation as part of the 201 plan.

a. Regional Alternative Site
   i. Huntington Sewage Treatment Plant or
   ii. Crab Meadow
b. Sites for the Sub-Regional Alternative
   i. Huntington Sewage Treatment Plant and
   ii. Northport Village Sewage Treatment Plant
c. Small Treatment Plants—All inland treatment plants will be required to employ AWT (nitrogen removal).

2. On the basis of preliminary environmental analysis and projected flow, it is recommended that, should the Huntington Sewage Treatment Plant be utilized as either a regional or sub-regional facility, secondary treatment with mid-bay effluent discharge would be preferable to AWT and effluent discharge at the present location in Huntington Harbor.

6.3.4.2 West Central 201 Study Area. For the purposes of future investigation, this study area may be divided by the Long Island Expressway into a northern and a southern segment, due primarily to the provisions for diversion of flow of the southern portion of this 201 study area to the Southwest Sewer District (Suffolk County Sewer District No. Three).

A. *Northern Area.* This portion of the 201 area north of the L.I.E., which is largely unsewered, has five existing sewage treatment facilities.

Hydrogeologic Zones

Zone I

1. In developed areas not presently sewered, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

4. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

Further evaluation of the following options is required as part of the 201 plan for selection of the preferred sewage treatment alternative.

a. Sites for the Sub-Regional Alternative
   i. Suffolk State School and
   ii. Facility located in the eastern portion of this area.

b. Small Treatment Plants Alternative—All sewage treatment plants will be required to provide AWT (nitrogen removal).

c. Diversion to the Suffolk County Sewer District No. Three Water Pollution Control Plant (Bergen Point).

B. *Southern Area.* The portion of the 201 area south of the L.I.E. is again predominantly unsewered. There are eight existing sewage treatment facilities.

Hydrogeologic Zones

Zone I

1. In developed areas not presently sewered, plans for sewering where the current density of nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

4. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

5. This area is included in the study area of the recently initiated Flow Augmentation Needs Study, which will determine the need and, if necessary, the method of mitigating the impact of possible reduced groundwater levels and streamflow resulting from sewering at the Southwest Sewer District (S.W.S.D.). The impact of sewering in this portion of the West Central 201 study area will require further investigation.

6. Interceptor sewers of the S.W.S.D. are sized to accept sewage flow from this area north of the S.W.S.D. Therefore, the recommended means for providing sewer service to this area is to extend those interceptor sewers from the S.W.S.D. which would serve areas of Zone I in accordance with the 208 sewering criteria as substantiated by the prescribed groundwater sampling program. Furthermore, it should be noted that extensions of interceptor sewers from the S.W.S.D. to serve Zone I of the study area must pass through Zone VII. Therefore, service would also be made available to those areas of Zone VII tributary to the interceptors required for Zone I. This recommendation will require further evaluation to assess the impact of effluent disposal alternatives.

Zone VII

1. In developed areas not presently sewered, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

2. Sewer in those areas where on-lot sewage disposal systems are subject to failure and cannot be upgraded due to high groundwater table, low soil permeability, small lot size, etc.

3. Sewer in those areas where contaminated underflow may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards.

Pilgrim State Hospital.

A priority has been established for the sub-drainage area that includes Pilgrim State Hospital and AIL (Cutler Hammer) Corporation. Both of these facilities are in violation of their SPDES permits, and require upgrading. In additon, Pilgrim State provides sewage treatment services for Suffolk Community College, West Campus, and the planned Multi-Town Solid Waste Facility, which will also require extensive sewage service. Therefore, a modified 201 Study for this drainage area should begin immediately, with the results required to be consistent with the 208 recommendations for Zones I and VII of the entire West Central 201 study area.

If the 201 Study for the West Central area is begun prior to approval of the 201 facilities olan for the modified area, then the information developed should be used as input for the more comprehensive study area and further work on the modified 201 should terminate.

On the other hand, if 201 planning has not been initiated for the entire area, then the modified area should be considered eligible for necessary funding required for Step II and Step III activities. Also, this procedure would serve as a model for initiating studies for other identified problem areas.

6.3.4.3 Southwest Sewer District (Suffolk County Sewer District No. Three).

Hydrogeologic Zones

Zone VII

1. This area is, or will be, essentially completely sewered, and no further sewering options exist. Present plans generally conform to recommended 208 guidelines.

Surface Water Elements

1. Construction has begun for an ocean outfall for effluent disposal from the Bergen Point Water Pollution Control Plant. The 208 Study has verified that, at design flow, a bay discharge of secondary effluent from this facility would have resulted in unacceptable bay water quality.

2. Stress the future implementation of non-point source controls, if proven feasible, in order to assist in upgrading surface water quality to increase open shellfishing areas.

3. The recently initiated Flow Augmentation Study will determine the need and, if necessary, the method for mitigating the impact of possible reduced stream flow resulting from sewering in the S.W.S.D.

6.3.4.4 Kings Park 201 Study Area. Portions of the study area are

sewered, and there are eight existing treatment facilities.

Hydrogeologic Zones

Zone I

1. In developed areas not presently sewered, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater. or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

4. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 foot lot size).

5. The 208 Program has not identified a need for groundwater recharge in this area for the purpose of preserving the drinking water supply. However, the importance of maintaining the flow and water quality of the Nissequogue River will require the investigation of possible streamflow augmentation needs.

Zone VIII

1. Sewer in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.

2. Sewer in those areas where contaminated underflow may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards.

Surface Water Elements

1. The following sewage treatment options require further evaluation as part of the 201 facilities plan:

a. Site for Regional Alternative
   i. Kings Park Sewage Treatment Plant
b. Sites for Sub-Regional Alternative
   i. Kings Park Sewage Treatment Plant
   ii. Suffolk County Center Sewage Treatment Plant
c. Small Plants—(1) maintain and upgrade existing treatment facilities to AWT. (2) Investigate cost-effective combinations of sewage treatment plants. (3) Provide additional facilities in accordance with sewering criteria.

2. Investigate the need for streamflow augmentation for the Nissequogue River.

6.3.4.5 Port Jefferson 201 Study Area. Significant portions of this study area are presently sewered, and there are two existing treatment facilities.

Hydrogeologic Zones

Zone I

1 Due to the advanced state of 201 facilities planning for this study area, the time schedule does not allow for a substantial groundwater monitoring program. Therefore, additional sewer service beyond that provided by the existing facilities should be based on the minimum sewering guideline, except where existing groundwater data is sufficient to identify a problem area that requires sewering.

2. In developed areas not presently sewered, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

3. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

4. In any detailed study area, a monitoring program should be instituted and continued beyond the completion of Phase I of the 201 Facilities Plan in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

5. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

Zone VIII

1. Sewer in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.

2. Sewer in those areas where contaminated underflow may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards.

Surface Water Elements

1. The 208 has not selected a recommended alternative for sewage treatment and disposal. It is required that the 201 Study select the number and location of facilities by evaluating combinations of existing facilities and other suitable sites.

2. Surface water discharge shall not exceed the waste load allocations established by the 208 Study.

6.3.4.6 South Central 201 Study Area. In this study area there are numerous pockets of development that are presently sewered, and there are

thirty-one existing treatment facilities.

Hydrogeologic Zones

Zone 1

1. In developed areas not presently sewered, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

2. In addition to the planning for sewering at nine or more persons per acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre)

4. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

5. The 208 Study has not identified a need for groundwater recharge in this area for the purpose of preserving drinking water supply. However, the importance of maintaining the flow and water quality of streams in this area, especially of the Connetquot River, and the water level of Lake Ronkonkoma, will require the investigation of possible streamflow augmentation and lake level maintenance needs.

Zone III

In the areas of this zone where it is infeasible to implement the non-structural and non-point source recommendations due to existing development or land allocation of planned development, the following actions are recommended:

1. Require sewering at densities of one or more dwelling units per acre.

2. Stress implementation of those non-point source controls proven feasible, in order to protect groundwater quality.

Zone VI

1. Due to the impact of this area on the sensitive eastern Great South Bay, sewering is required at densities of one or more dwelling units per acre.

2. Stress the implementation of those non-point source controls proven feasible, in order to assist in upgrading surface water quality to protect shellfishing areas.

3. The 208 Study has not identified a need for groundwater recharge in this area for the purpose of preserving drinking water supply. However, the importance of maintaining the flow and water quality of streams in this area, especially of the Connetquot River, will require the investigation of possible streamflow augmentation needs.

Surface Water Elements

1. Duck farms are to conform to compliance schedules which require zero discharge by 1983.

2. The following sewage treatment options require further evaluation as part of the 201 facilities plan.

a. Regional Alternative Site
(To be selected)

b. Sites for the Sub-Regional Alternative
i. West of Lake Ronkonkoma
ii. Oakdale vicinity
iii. Sayville vicinity
iv. The Parkland III and S.C.S.D. No. 7 (Medford) facilities would be maintained.

c. Small Plants—(1) Maintain and upgrade existing treatment facilities to AWT (nitrogen removal). (2) Investigate cost-effective combinations of sewage treatment plants. (3) Provide additional facilities in accordance with sewering criteria for the various zones.

Village of Patchogue

A priority has been identified for the Patchogue Village Sewage Treatment Plant, which is presently in violation of its SPDES permit. The following is the recommended course of action to address this immediate need.

1 The "first-stage" 201 Study presently being conducted by the Village should consider the following:

a. Sewering those areas where on-lot sewage disposal systems are subject to failure.

b. Sewering those areas where contaminated underflow may reasonably be expected to contribute pollutants to the surface waters, which results in a contravention of the standards.

c. Upgrading the sewage treatment plant according to the recommendations in this Plan.

d. Implementing the recommendations for Zone VI of the South Central study area, where applicable.

2. If a 201 Study is begun for an area similar to the South Central Study Area before approval of the village's "first-stage" 201 facility report (estimated for April 1979), the information developed by the village should be fully incorporated into such study so as to avoid duplication of effort and the village's "first-stage" 201 Study should cease.

3. If no 201 Study is begun before approval of the village's "first-stage" 201 facility report, the village should be considered eligible for Section 201 funding for subsequent Step II and Step III work, to carry out its approved 201 facility report.

6.3.4.7 Yaphank 201 Study Area. There are numerous pockets of development in this study area that are presently sewered, and there are twenty-five existing treatment facilities.

Hydrogeologic Zones

Zone I

1. In developed areas not presently sewered, (three dwelling units per gross acre) plans for sewering where the current density is nine persons per gross acre should be initiated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre)

4. As currently vacant land is developed, sewer at present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

Zone III

1. Land use controls should be the primary method for protecting this valuable groundwater resource. Where residential development is allowed, large lot development (two acre zoning or greater) should be required. Encourage the preservation of existing large land holdings. A groundwater monitoring program should be employed to ensure timeliness of mitigation if degradation is discerned.

2. In the areas of this zone where it is infeasible to implement the preceding recommendation due to existing development of land allocation of planned development, the following actions are recommended:

a. Require sewering at densities of one or more dwelling units per acre.

b. Stress implementation of those non-point source controls proven feasible, in order to protect groundwater quality.

3. The 208 Program has not identified a need for groundwater recharge in this area for the purpose of preserving the drinking water supply However, the importance of maintaining the flow and water quality of the Carmans River will require the investigation of possible streamflow augmentation needs.

Zone VI

1. Due to the impact of this area on the sensitive eastern Great South Bay, sewering is required at densities of one or more dwelling units per acre. Sewering may also be necessary to protect Moriches Bay.

2. Stress the implementation of those non-point source controls proven feasible in order to assist in upgrading surface water quality to protect shellfishing areas.

3. The 208 Program has not identified a need for groundwater recharge in this area for the purpose of preserving the drinking water supply However, the importance of maintaining the flow and water quality of the Carmans River will require the investigation of possible streamflow augmentation needs.

Zone VIII

1. Sewer in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.

2. Sewer in those areas where contaminated underflow may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards.

Surface Water Element

1. Stabilize or upgrade the ocean inlet of Moriches Bay.

2. Duck farms are to conform to compliance schedules, which require zero discharge by 1983.

3. The following sewage treatment options require further evaluation as part of the 201 facilities plan

a. Sites for the Sub-Regional Alternative
   - i. Three sites:
     - (a) Selden Sanitary
     - (b) Suffolk County property at Horse Block Road
     - (c) Mastic Beach east of William Floyd Parkway
   - ii. Six sites:
     - (a) utilize the three sites of No.1
     - (b) Rocky Point vicinity
     - (c) Artist Lake vicinity
     - (d) Center Moriches east of Forge River

b. Small Plants
   - i. Maintain and upgrade existing treatment facilities to AWT
   - ii. Investigate cost-effective combinations of sewage treatment plants.
   - iii Provide additional facilities in accordance with sewering criteria for the various zones.

6.2.4.8 Riverhead 201 Study Area. The 201 facilities plan for the study is presently underway There are currently four treatment facilities in this area including the Town of Riverhead Sewage Treatment Plant.

Hydrogeologic Zones

Zone III

1. Land use controls should be the primary method for protecting this valuable groundwater resource. Where residential development is allowed, large lot development (two acre zoning or greater) should be required. Encourage the preservation of existing large land holdings. A groundwater monitoring program should be employed to ensure timeliness of mitigation if degradation is discerned.

2. In the areas of this zone where it is infeasible to implement recom-

mendation (1) due to existing development or land allocation of planned development, the following actions are recommended:

a. Require sewering at densities of one or more dwelling units per acre.

b. Stress implementation of those non-point source controls proven feasible, in order to protect groundwater quality.

3. The 208 Program has not identified a need for groundwater recharge in this area for the purpose of preserving the drinking water supply. However, the importance of maintaining the flow and water quality of the Peconic River will require the investigation of possible streamflow augmentation needs.

Zone IV

The desired goal is self-sufficiency in respect to water supply, therefore, recommended measures are directed towards obviating the need for importation of drinking water while maintaining the quality and quantity of the groundwater.

1. Due to the advanced state of 201 facilities planning in this study area, the time schedule does not allow for a substantial groundwater monitoring program. Therefore, additional sewer service beyond that provided by the existing facilities should be based on the minimum sewering guideline, except where existing groundwater data is sufficient to identify a problem area that requires sewering.

2. In developed areas not presently sewered, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

3. Sewer in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.

4. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

Zone VIII

1 Sewer in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.

2. Sewer in those areas where contaminated underflow may reasonably be expected to contribute pollutants to the surface waters and to result in a contravention of the standards.

Surface Water Element

1. Duck farm treatment facilities are to conform to compliance schedules, which will require zero discharge by 1983.

2. No additional waste loading should be allowed from the Brookhaven National Laboratory or Grumman Sewage Treatment Plants.

3. The Riverhead Sewage Treatment Plant discharge should be relocated out of the Peconic Estuary. Monitoring should be conducted to determine when relocation will become necessary.

4. The following treatment options are to be evaluated as part of the 201 facilities plan:

a. Site for Regional Alternative

i. Riverhead Sewage Treatment Plant—expand service area in accordance with sewering criteria

b. Sites for Sub-Regional Alternative

i. Riverhead Sewage Treatment Plant

ii. Manorville

c. Small Plants—Provide facilities as needed in accordance with sewering criteria. All sewage treatment plants with inland disposal will require AWT (nitrogen removal).

6.3.4.9 Village of Greenport/Town of Southold 201 Study Area. A 201 facilities plan is currently being initiated for this study area. There are two existing facilities.

Hydrogeologic Zones

Zone IV

The desired goal is self-sufficiency in respect to water supply, therefore, recommended measures are directed towards obviating the need for importation of drinking water while maintaining the quality and quantity of the groundwater.

1. In developed areas not presently sewered, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

4. Sewer in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.

5. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

Surface Water Elements

1. The following sewage treatment options require further evaluation as part of the 201 facilities plan:

a. Small Treatment Plants

i. Village of Greenport Sewage Treatment Plant—expand service area in accordance with sewering criteria. Investigate the need for recharge

to preclude saltwater intrusions. Recharge would require AWT (nitrogen removal).

ii. Additional sites to be selected as needed for areas which satisfy sewering criteria. All sewage treatment plants with inland disposal will require AWT (nitrogen removal).

6.3.4.10 Disposal District Fourteen—Shelter Island. There is currently one primary treatment plant serving Shelter Island Heights.

1. In developed areas not presently sewered or scheduled for sewering, plans for sewering, where the current density is nine or more persons per gross acre (three dwelling units per gross acre), should be initiated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

4. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

Surface Water Elements

1 Shelter Island Heights Sewage Treatment Plant—expand service area in accordance with sewering criteria. Upgrade facility to secondary treatment with discharge to Shelter Island Sound.

6.3.4.11 Disposal District Twelve (Western Portion of the Town of Southampton). There are two existing treatment plants in this study area.

Hydrogeologic Zones

Zone V

1. In developed areas not presently sewered or scheduled for sewering, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be initiated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

4. Sewer in those areas where on-lot sewage systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.

5. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

Zone VI

1. If duck sludge in Moriches Bay sediments proves to be the controlling factor determining bay water quality, sewering will be ineffective. If this proves not to be the case, then inlet stabilization may improve flushing to such an extent that sewering will be unnecessary. If both conditions are found not to hold, then sewering is required at densities of one or more dwelling units per acre.

2. Stress the implementation of those non-point source controls proven feasible, in order to assist in upgrading surface water quality to protect shellfishing areas.

Surface Water Elements

1 Stabilize or upgrade the existing ocean inlet to Moriches Bay.

2. If recommendation number one is ineffective, then despite the low population density projected for much of this area, the desire to maintain or upgrade the water quality of the Moriches Bay will require the evaluation of the possible need for small treatment facilities. Sites are to be selected as needed for area that satisfy sewering criteria. All sewage treatment plants with inland disposal will require AWT (nitrogen removal).

6.3.4.12 Disposal District Fifteen (Eastern Portion of the Town of Southampton and the Town of East Hampton). There are currently two treatment facilities in this study area.

Hydrogeologic Zones

Zones IV and V

1. In developed areas not presently sewered or scheduled for sewering, plans for sewering where the current density is nine or more persons per gross acre (three dwelling units per gross acre) should be inititated.

2. In addition to the planning for sewering at nine or more persons per gross acre, the implementation of non-structural controls should be initiated immediately.

3. In any detailed study area, a monitoring program should be instituted in order to determine the quality of the water table aquifer and the efficacy of the non-point source controls. Where it is found that area-average average nitrate-nitrogen levels are six milligrams per liter or greater, or when other contaminants are in excess of groundwater standards, and where the pollution may reasonably be expected to result from on-lot systems, sewering should be initiated at densities less than nine persons per gross acre (three dwelling units per gross acre).

4. Sewer in those areas where on-lot systems are subject to failure and cannot be upgraded due to soil conditions, high groundwater, small lot size and other considerations.

5. As currently vacant land is developed, sewer at the present SCDHS designated density of approximately two dwelling units per acre (less than 20,000 square foot lot size).

Surface Water Elements

1. Mecox Bay—restrict the development of shoreline areas abutting the bay.

2. The following small sewage treatment plant options should be evaluated:

a. Maintain existing facilities.

b. Extend Sag Harbor service area in accordance with sewering criteria.

c. Provide new facilities in accordance with sewering criteria.

6.3.4.13 Disposal District 16—(Montauk Area). There is one treatment facility servicing the Air Force base. Due to the low population density projected for this area, no additional sewering appears to be necessary

6.3.4.14 Disposal District 17—Fishers Island. The collection system discharges raw sewage to Long Island Sound. Therefore, it is recommended that secondary treatment be provided with Long Island Sound discharge.

6.4 Inter-Jurisdictional Recommendations

6.4.1 Western Long Island Sound. Long Island Sound conditions exert a dominant influence on water quality within Manhasset Bay and Hempstead Harbor. Western Long Island Sound waters are characterized by high levels of solids, nitrogen and bacteria. Since most of the high levels of suspended solids, nitrogen and coliform bacteria in western Long Island Sound can be traced to discharges within New York City, Long Island Sound conditions are largely beyond the control of the Nassau-Suffolk 208 Program. It is therefore the responsibility of the USEPA and NYSDEC to require the implementation of waste controls necessary to improve water quality to meet the standards specified for this surface water segment. These controls may include nitrogen removal for existing sewage treatment plants and the retention and treatment of combined sewer overflows. Pretreatment for metals and/or organic chemicals may be in order if it can be shown that toxic contaminants move from New York City into the Sound.

6.4.2 Nearshore Atlantic Ocean. it is the responsibility of the USEPA and NYSDEC to insure that necessary wastewater controls are implemented to prevent the discharge of contaminants and floatable material into the New York Bight. Such contaminants and floatables have particularly impaired the use of regional ocean bathing beaches. These regulations should apply to the control and treatment of raw or inadequately treated sewage discharges, industrial discharges and combined sewer overflows from sites located in New York City and New Jersey.

6.4.3 Western Nassau County. Jamaica Water Company is currently creating significant groundwater movement from western Nassau County to Queens. The company's heavy pumping in Queens has resulted in a significant reduction in the water levels in western Nassau. It is the responsibility of the NYSDEC to implement whatever pumping controls are necessary to prevent the continued underflow to Queens to permit the recovery of water levels and to prevent accelerated saltwater intrusion in western Nassau County.

6.5 The Need for Further Regional Studies, Demonstration Projects and Research

The 208 Program has raised numerous wastewater management questions that are of importance to Long Island and, in many cases, to the Nation as well.

The continuation of studies initiated as part of the 208 Program, including further monitoring and data analysis, is needed to provide essential information in several general areas, including hydrogeologic relationships, correlation between population density and groundwater quality, organic chemical and other contamination of groundwater, and viruses in aquatic systems.

The establishment of demonstration projects is needed to test promising pollution control techniques and to permit the further refinement and development of cost-effective, environmentally acceptable recommendations for incorporation in 208 plans as they are updated in the future. Among these are street vacuuming and sub-surface denitrification.

Research is needed to identify the intermedia impacts of air pollution on wastewater management options and of wastewater management options on air quality, and to permit an evaluation of the nitrate standard for drinking water.

The following brief descriptions indicate the general nature of the proposed studies or projects, the agency or level of government capable of undertaking responsibility for or actually performing the work, and estimated costs, where appropriate.

6.5.1 Continuation of Regional Studies

6.5.1.1 Further Definition of Groundwater Management Zones. The boundaries of the groundwater management zones shown in Figure 3—2 depend, in many cases, on a distinction between areas where recharge from the land surface generally enters either a shallow or deep flow system. In many areas, recharge to the deep flow system implies recharge to the Magothy aquifer. In the so-called shallow flow systems, the depth of flow is generally restricted to a depth of one to two hundred feet. The zone boundaries as mapped are based on existing data and are only approximate. In many cases, the distinctions between these systems is often not clear and distinct. Since a number of important wastewater management decisions may be based on these flow relationships, it is recommended that further investigations be initiated. The studies of the groundwater flow systems in and around the zone boundary lines should be conducted first on a sub-regional basis in areas where a major wastewater decision is expected in the near

future. For example, it would be desirable to investigate those regions where large-scale sewering or development is proposed.

In southwest Suffolk County, it is expected that many of the questions regarding depth, direction and rates of groundwater flow will be answered as part of the proposed stream augmentation feasibility study In order to answer the critical questions in any area, it will be necessary to drill and construct a series of wells and piezometers screened at different depths. These would be designed to (1) locate and define the extent of any confining clay layers such as the Gardiners Clay, which separate the shallow and deep aquifers; (2) map the direction of groundwater flow under existing conditions by measuring water levels at various depths, and (3) obtain water samples from various depths to see if hydrogeologic factors are providing any protection to the deeper aquifer. In addition, a number of pumping tests would be conducted at various depths to evaluate the hydraulic connection between the shallow and deep aquifer systems and to examine the effect of any confining clay layers

This approach to the definition of groundwater flow is similar to that attempted in many of the USGS Water Supply Papers of past years. However, the USGS was forced to rely on existing data that, generally, was adequate only to define gross directions of flow. Data from such an investigation could provide considerable insight as to the possible benefits or adverse effects associated with a particular wastewater decision. For instance, it would be very useful to know if groundwater contamination resulting from large-scale development of an area would be likely to affect drinking water supplies or shallow groundwater discharges to streams and bays. In addition, it would be useful to have a clear picture of what portions of the groundwater reservoir might benefit from sewering or non-point source controls.

The regional digital model developed as part of the 208 can be modified, updated and calibrated using the new information developed from the sub-regional investigations. In this way, the model may be used to aid in evaluating 201 wastewater management decisions, especially in relation to overall options for the bi-county area. The extent and cost of such an investigation would vary considerably, depending on the size and location of the area to be studied. It is estimated that for a large sub-region such as the Smithtown-Port Jefferson area, perhaps a dozen or so piezometers or well clusters would be necessary The cost of such a program, including drilling, testing and hydrogeologic investigation would probably be about $400,000 for a single sub-region. This is a small fraction of the cost of any large sewering or development program. Digital modeling, where necessary, may cost an additional $200,000. The Regional Planning Board and/or the counties should be responsible for this work.

6.5.1.2 Application of the Regional Digital Models to Evaluate Region-Wide Effects of Man-Induced Changes in Groundwater Elevations. Groundwater elevations fluctuate due to natural and man-induced changes in recharge and groundwater pumpage. Declines in groundwater levels can adversely impact water supply, fresh surface waters and groundwater level dependent ecosystems. Some research is currently planned to evaluate these impacts in selected 201 areas. However, evaluations of these impacts is needed on a regional basis.

Specific research needs include utilization of the regional digital groundwater model to determine the regional response of groundwater levels to (1) groundwater pumping alternatives, (2) changes in stormwater recharge, and (3) sewering alternatives. The results of this work should lead to recommendations for groundwater elevations. The estimated cost is $300,000. The Regional Planning Board and/or the counties should be responsible for this work.

6.5.1.3 Detailed Mapping of Land Uses, Natural Resources and Environmental Constraints for the Deep Flow Aquifer Recharge Area. Existing land use maps and tabulations for the deep flow areas, although adequate for general planning purposes, do not provide the detailed resolution most appropriate for local as opposed to areawide wastewater management. Natural resources and environmental constraints maps are currently unavailable. Maps similar to the detailed land use, natural resources and environmental constraints maps already prepared for the coastal zone are needed for further implementation of the chosen wastewater management strategies, particularly those relying on non-structural approaches to the prevention or mitigation of non-point pollution. Data collection, interpretation and mapping should be undertaken by the Nassau-Suffolk Regional Planning Board. The task is expected to take one and one half years. The estimated cost is $400,000.

6.5.1.4 Extent and Causes of Organic Chemical Contamination

a. *Inventory of Organic Chemical Sources.* Organic chemicals are an important contaminant of the Long Island aquifers. Efforts to formulate a control strategy are hampered by a lack of data concerning sources. Thus, a complete inventory is required. This inventory should cover (a) industrial point sources, (b) waste water treatment plant effluents, (c) runoff recharge, (d) landfills and hazardous waste facilities, (e) domestic non-point sources and (f) industrial non-point sources. The inventory must present estimates of mass loading per unit time for all of the contaminants occurring in groundwater at ten micrograms per liter. Nassau and Suffolk Counties should undertake this work. The counties should also continue their sampling for organic chemicals in the Magothy aquifer The estimated cost of this work is $350,000.

b. *Organic Chemical Sources—Landfills, Waste Water Treatment Plant Outfalls, Runoff Recharge Basins.* On the basis of preliminary findings, all three of the above listed pollutant sources appear to be significant with respect to organics. The three should be similarly characterized if identified by the organics source inventory Characterization of sources will require collection of a number of samples, defined by a source-specific sampling plan, with several replicates for each sample. The effort should be undertaken by

Nassau and Suffolk Counties. For each source studied, $50,000 is required.

6.5.1.5 Evaluation and Monitoring of the Movement of Heavy Metals and Organic Chemicals in the Aquifer System.

The discharge of untreated and treated industrial and domestic liquid wastes to septic tanks, cesspools and recharge basins has been an accepted disposal practice in Nassau and Suffolk Counties. Many of these waste streams contain small concentrations of heavy metals and organic chemicals that are considered hazardous. In addition, studies undertaken as part of the Long Island 208 investigation have shown that other sources of hazardous substances also exist in the area. Some spills and incidental discharges at industrial and commercial facilities and along transportation routes also contain heavy metals and organic chemicals.

Significant discharge of such pollutants to the ground has been occurring on Long Island for decades. Because of heavy groundwater withdrawals and the resulting pumping patterns, the migration of pollutants from the surface into the deeper aquifers presently used for public water supply may be accelerating. Monitoring to date has already shown their presence in deeper aquifers, and this has led to restriction of the use of some wells in various parts of the two counties.

There is a definite need for more complete evaluation and monitoring of the movement of heavy metals and organic chemicals throughout the aquifer system underlying the Island so that an assessment can be made of the long-term threat to continued use of groundwater in critical water supply areas. At the present time, monitoring programs are incomplete from the standpoint of serving as a warning mechanism on the vertical and lateral migration of hazardous chemicals. It is not known, for example, whether shallow untapped aquifers contain high concentrations of heavy metals and organic chemicals that may in the future move into the deeper, heavily pumped, aquifers. If this were to occur on a broad scale, the results would be a significant reduction in the availability of potable groundwater in the Region.

The Nassau-Suffolk Regional Planning Board and the two counties should be responsible for the work, which is expected to take one and one-half years. The estimated cost is $750,000.

6.5.1.6 Assimilative Capacity of Subsoils. Measure and determine the saturation capacity, and whether a substantial difference exists between assimilative or absorptive capacity of different soils in various formations, and determine the limits of these natural treatment processes. The ability to predict saturation levels of various subsoils would aid greatly in the planning of recharge facilities and water supply systems. The information gathered could become an integral part of the groundwater quality model developed in the 208 Program. The soil columns findings could be used in conjunction with viral, organic chemicals, heavy metal studies, etc. The Suffolk County Department of Health Services should undertake a two year study. The estimated cost is $75,000.

6.5.1.7 Determination of the Impact of Leakage and Spills from Hazardous Materials Storage and Transport, and Identification of Best Means of Control. Sufficient evidence already exists to indicate that leakage of materials such as gasoline, fuel oil, solvents and chemicals into the groundwater from storage and transport facilities constitutes a major pollution problem that must be controlled. A study is needed to further define the problem and to provide the information necessary to develop legislation for control. Once regulations exist, enforcement will proceed involving extensive testing and inspection of tanks and pipelines with repair, improvement or replacement as needed. This will also lead to the discovery of existing pockets of contamination and subsequent clean-up operations. This study and the resulting regulating activities can be carried out by the Nassau County Department of Health in Nassau and by the Suffolk County Department of Environmental Control in Suffolk, with the addition of adequate personnel and equipment. The study will take two to three years. Estimated cost is $320,000.

6.5.1.8 Measurement of Groundwater Underflow Quantity and Quality and Impacts of Duck Sludge Deposits. Groundwater has been shown to be a major source of nitrogen to systems such as Great South Bay and Flanders Bay, where long residence times allow buildup of the nutrients to signifianct levels. Due to the typically good flushing of the North Shore bays, groundwater sources are fairly insignifiant there, compared with the boundary water quality effects of Long Island Sound. Presently, there are no data on actual quantity or quality of groundwater underflow through the bay bottoms. Values for flow quantities used in model calculations were based indirectly on estimates from the USGS groundwater analog modeling efforts, whereas quality was estimated indirectly through historical well sampling landward along the shoreline.

Millions of cubic yards of duck sludge have accumulated in portions of Moriches and Flanders Bays as a result of decades of duck farm operations. Virtually no data exist, however, to establish whether or not the old sludge represents a bacterial or nutrient source. Waste management alternatives currently being formulated for Flanders Bay assume zero discharge from duck farms by 1981. The question of residual loadings from the old sludge deposits remains, however, and cannot be factored into waste load allocations to the bay. In Moriches Bay, where the deposits are most extensive, it has not been possible to estimate nutrient loadings from the sludge deposits.

Recently, a method utilizing enclosed chambers has been devised for directly measuring groundwater seepage rates through the bay bottom and the quality of that groundwater. It is now felt that, since a method for direct measurement is available, such a study would be feasible and practical in assessing groundwater influence and duck sludge influence on bay water quality. Since this type of study should be handled on a regional basis throughout the South Shore bays and in the Peconic Estuary, it is recommended that the Nassau-Suffolk Regional Planning Board and the two counties be responsible. The cost of one summer's field effort for this study would be apporximately $75,000.

6.5.1.9 Determination of the Effects of Inlet Closure on the Water Quality of Moriches, Shinnecock and Mecox Bays and of Inlet Creation on the Water Quality of Eastern Great South Bay. Historically, Moriches, Shinnecock and Mecox Inlets have had a significant impact on water quality within these bays. At present, Moriches Inlet is reported to be closing up, which means that ocean flushing of contaminants will become greatly retarded in Moriches Bay. Considering that water quality conditions are already stressed in Moriches Bay with an open inlet, and in the interest of preserving the high quality of Shinnecock Bay waters, modeling of the two bay systems to allow selection of alternative solutions (such as maintaining the inlets) is recommended. Similar studies should be conducted for Mecox Bay, to determine the water quality benefits of maintaining a permanent inlet.

This modeling study would follow much the same procedure as for the South Shore bays west of Moriches Bay under the Nassau-Suffolk Regional Planning Board 208 Program.

An additional item of interest to wastewater management in this area is the alternative of creating a new inlet through the Fire Island barrier beach in eastern Great South Bay. Such an inlet, if determined feasible, would relax restrictions on point source waste loads within eastern Great South Bay by increasing the ocean flushing of this area. An integral part of this study would include an environmental assessment of the resulting changes in salinity.

Ideally, all of the above problems should be studied simultaneously, since there is considerable hydraulic interface between eastern Great South Bay, Moriches Bay and Shinnecock Bay. A modeling study to address these problems would involve design of monitoring programs, waste source inventory and load estimates, model set up, calibration, verification and calculation of alternatives. Most of this work is completed for the area west of Moriches Bay and could be adapted directly to the study. Such a program could be carried out by the Nassau-Suffolk Regional Planning Board and the two counties. An estimate of the cost for such a program is $300,000.

6.5.1.10 Fertilizer Research. Fertilizers have been identified as significant contributors to Long Island water quality problems. Two research projects should be initiated in order to resolve questions relating to fertilizer use and water quality.

a. *Fertilizer-Nutrient Balance.* The fate of fertilizer nutrients applied to Long Island's agricultural crops (potato, vegetable, nursery, orchard and sod) is understood to some degree. However, there are many variables that influence the movement and ultimate disposition of the nitrogen and phosphorus during and after the growing season. Crop uptake of nutrients varies with the life cycle of the plant. Precipitation patterns during the growing season influence the extent to which nutrients are washed from the surface and leach through the soil profile. Precipitation after the harvest, especially during periods of high runoff when the ground is frozen, may transport the residual nutrients to surface waters. Soil characteristics such as texture, depth and slope also affect the washing and leaching of fertilizers. The timing and method of fertilizer application (broadcast or sub-surface bonding) with respect to the crop requirements, root system and climatic conditions, influences the paths of nutrient transport. Extensive studies to assess the influence of such characteristics on potato crops have already been completed. Further research is now required for other crops and turf to develop a nutrient balance model identifying the nutrient uptake by type of crop, the nutrient leaching through the soil and the nutrient loss associated with stormwater runoff. Investigations using replicate plots to permit evaluation of variations in fertilizer application should be continued year-round for a period of at least three years.

b. *Fertilizer Formulations.* The control of fertilizer-related pollution of ground and surface waters in urban and suburban areas, especially in western Long Island, is largely dependent upon the success of educational efforts since the regulation of lawn fertilizer application practices is not considered feasible at this time. Identification of a relatively non-polluting fertilizer formulation would be a useful adjunct to an educational program.

Organic fertilizers are known to release nitrogen more slowly than inorganic fertilizers. However, local field testing is required to determine whether, and to what extent, the use of organic based nitrogen fertilizers can reduce water pollution on Long Island.

A research program should be developed in which various formulations of fertilizer would be applied to replicate plots of turf. Leachate and stormwater runoff nitrate concentrations, and crop uptake of nitrates, should be determined in order to evaluate the pathways of nitrogen transport and the availability of nitrogen throughout the growing season. Also, the feasibility of recycling existing sources of nitrogen, such as sludge from domestic sewage treatment, should be rigorously explored.

Cornell University should act as lead agency for the above studies, which could be carried out in cooperation with the U. S. Geological Survey and the Suffolk County Department of Environmental Control. Total estimated cost is $100,000.

6.5.1.11 Groundwater Screening for Aldicarb. Aldicarb has been identified as a potential groundwater contaminant. A separate program to look specifically for Aldicarb in groundwater underlying farm areas should be undertaken. New York State should assume responsibility for this work, which could be carried out by Cornell University-Cooperative Extension Service. Estimated cost is $25,000.

6.5.1.12 Heavy Metals in Sediments. Generally, metals in marine, fresh and groundwater are rapidly adsorbed onto sediments. Major metal pollutant problems have tended to arise from accumulation of metals in the food chain where there is a high metal level concentrated in sediment or water column. Such a situation may occur when sediment metal levels are high and members of the food chain are detritus feeders. Thus, sediment metal levels should be monitored. Such data is lacking for the Long Island bays, and a program should be instituted to obtain it. The work should be undertaken by Nassau

County Department of Health, and the Suffolk County Departments of Health Services and Environmental Control, and is expected to cost $125,000.

6.5.2 Demonstration Projects

6.5.2.1 Marsh-Pond Treatment of Sewage. The marsh-pond approach to sewage treatment should be tested at a full-scale installation where it will receive the normal amount of operational attention. The proposed program at Greenport should be encouraged and supported and a similar program instituted elsewhere if the Greenport program is not implemented. The Nassau County Department of Public Works and the Suffolk County Department of Environmental Control should have the responsibility for a two year study. Estimated costs are $100,000.

6.5.2.2 Marsh-Pond Treatment of Runoff. The Nassau-Suffolk 208 Study has identified a number of point sources and non-point source stormwater runoff as significant contributors of pollutants to both surface and groundwaters. The main problem in treating these pollutants arises from the facts that:

a. small point sources are widely dispersed and may involve effluent volumes too small to justify transportation to and disposal at a large regional or subregional wastewater treatment plant; and,

b. stormwater runoff is characterized by highly variable frequencies, volumes, duration and pollutant loadings.

The solution to these problems would be a system that could be scaled for various effluents and volumes, which would be relatively inexpensive to install, have low maintenance and allow discharge of the polished effluents to either ground or surface waters.

Systems such as the marsh-pond form are presently being evaluated on a small scale, primarily for wastewater renovation. However, it appears that they may also provide satisfactory treatment for stormwater runoff prior to recharge or disposal to surface waters. Therefore, projects utilizing the marsh-pond approach should be set up at two existing recharge basins in order to ascertain the degree to which this treatment can improve the efficiency of the basins. Treatment efficiency should be compared to that of two other existing basins that do not employ marsh-pond treatment. Efficiency, in each case, should be determined on the basis of the quality of the recharge water leaving the basin. Particular emphasis should be placed on the removal of heavy metals and organic chemicals. The Nassau County Departments of Health and Public Works, and the Suffolk County Department of Environmental Control should be responsible for the project. Estimated cost is $200,000.

6.5.2.3 Street Cleaning. Two projects should be established to determine the costs and identify the effects of street sweeping/vacuuming programs. A North Shore and South Shore area should be selected in order to permit observation of the effect of topographic influences. Various street sweeping and street vacuuming programs at different frequencies should be studied. The magnitudes of reduction of total annual loads as well as load reductions for individual storm events should be determined. The Nassau County Departments of Health and Public Works and the Suffolk County Department of Environmental Control should be responsible for the project. Estimated cost is $200,000.

6.5.2.4 Structural Treatment of Stormwater Runoff. Structural treatment, employing settling and the swirl-concentrator type of approach, should be evaluated. In addition, the efficiency of treatment by natural impoundments should be analyzed and compared to that of settling basins constructed specifically for the purpose. The Nassau County Departments of Health and Public Works, and the Suffolk County Departments of Environmental Control and Public Works should be responsible for the project. Estimated cost is $2,500,000.

6.5.2.5 Comprehensive Monitoring as an Aid in Making Wastewater Management Decisions. It is recommended that, prior to general implementation of comprehensive monitoring systems, immediate steps be undertaken, in coordination with ongoing 201 investigations, to develop a monitoring system in an area where a decision is pending on sewering and/or non-point source controls. This should be in an unsewered area that has been developed for at least ten years and has a population density of between five and nine persons per acre. The objective of such a demonstration monitoring system would be to establish the sampling frequency, number and spacing of wells and data reduction techniques that could be used as guidelines for subsequent 201 Studies, and for newly developing areas.

In the initial planning of this prototype, considerable attention would be paid to planning the system according to the statistical objectives of the study, that is, to obtain a good estimate of the average shallow groundwater quality and to define the time and spatial variability of selected constituents, particularly nitrates. Analyses have already been conducted within the 208 Program that could aid in planning those systems. The planning, drilling, sampling and analytical techniques developed during this demonstration study could then be used in future programs.

It is estimated that a study of this type would take about one year to complete. Assuming about twenty-five shallow wells were needed, the cost of the total program, including planning, drilling, sampling, analytical work and data reduction, would probably be about $150,000, and should be conducted by the Nassau County Departments of Health and Public Works, and the Suffolk County Departments of Health Services and Environmental Control.

6.5.2.6 Denitrification of Individual Subsurface Sewage Disposal Facilities. One of the major causes of the increases of nitrate-nitrogen concentrations in groundwater has been attributable to the leaching and subsequent oxidation of ammonium laden wastewaters from the many thousands of cesspools. The Suffolk County Department of Health Services is currently investigating nitrate removal in a subsurface individual sewage disposal system. This program is designed to eliminate nitrates from this source.

The experimental unit that has been installed uses methanol in the denitrification phase. The Department is interested in denitrification methods that would not require the homeowner to replenish the methanol, as is required by the present system.

Since it has been demonstrated by the Suffolk County Department of Health Services that denitrification of nitrified septic tank effluent can be achieved under controlled conditions in the ground below a conventional leaching field, steps should now be taken to set up demonstration installations in various parts of the county. Upon the successful completion of these demonstration projects, these systems could be installed as needed throughout the Region. Suffolk County Department of Health Services should undertake a two year project. Estimated cost is $110,000.

6.5.2.7 Removal of Nitrates from Drinking Water Supplies. A number of our public water supplies are experiencing problems as a result of increasing nitrate-nitrogen concentrations in the groundwater supply. The primary cause of these contaminants in some areas has been attributed to the leaching of nitrate fertilizers applied to farms and, possibly, lawns. The Suffolk County Department of Health Services has undertaken a project to perfect means for removal of nitrate contaminants from groundwater to be used for public water supplies. This would be accomplished by a biological denitrification anaerobic filter using methanols or sugar for bacterial activities. This would be treated at the wellhead, followed by rapid sand filters for removal of solids carried over, then followed by disinfection.

The study has progressed to the point of developing laboratory scale systems to investigate various parameters for design. The correlation in the laboratory findings will allow for the development of a pilot scale operating denitrification plant. The construction of a pilot scale operation for denitrification at the wellhead should be continued and, if successful, should provide solutions in areas affected by high nitrates. The Suffolk County Department of Health Services should undertake this project. Estimated cost is $450,000.

6.5.3 Research

6.5.3.1 Viruses in Aquatic Systems. There are no established standards for viral pollution levels in aquatic systems. Reasons for this include sampling difficulty, the lack of a standard method for enumeration and identification of species, and the lack of epidemiological data concerning waterborne transmission of the many viral groups. The study recently undertaken as part of the 208 Program just touched upon the Enterovirus group as it was found in various aquatic systems. However, no information was gathered on non-Enterovirus species, which may also be found in sewage polluted systems.

The following viral studies are needed in order to establish the magnitude of the problem and to permit formulation of appropriate control programs:

a. *Determination of the Significance of Non-Enterovirus Groups such as Adenovirus, Reovirus, Rotavirus and Norwalk Agents in Long Island Aquatic Systems and Wastewaters.* This study will help to quantify non-enterovirus groups, and to identify their sources, in order to assist in the development of control programs.

b. *Determination of the Epidemiological Significance of Human Viral Carriage by Shellfish Taken From Long Island Waters.* Such a study could help to define the problem, identify specific sources and sectors, and permit the formulation of control programs. It might also help to determine whether public health would be better served by the use of shellfish standards, related to the presence of viral agents or other types of indicators, rather than to coliform bacteria.

c. *Determination of the Movement of Virus Particles through Long Island Sub-Soils.* This would assist in the evaluation of standards for the location of wells, recharge basins, etc. and would confirm or refute the current belief that viruses emanating from sewage treatment plants and recharged would not have impact on groundwaters.

These studies should be the responsibility of the Nassau County Department of Health and the Suffolk County Department of Health Services. The cost is estimated to be $450,000.

6.5.3.2 Air Pollution and Wastewater Management (Intermedia Study). Wastewater management is affected by and affects air quality. The following studies can be expected to improve understanding of these relationships and to permit more informed, cost-effective and environmentally acceptable choices among waste management alternatives.

a. *Effects of Air Pollution on Water Quality.* Air pollutants can contaminate rainwater, and thus add non-point pollutant loads to bays and groundwater. To evaluate this problem, a rainwater sampling program is required. A series of samples of rainwater for various recharge areas on Long Island should be studied. These samples should be analyzed for nutrients, metals and organic chemicals.

b. *Effects of Wastewater Treatment on Air Quality.* Incineration, co-incineration, pyrolysis and land application of sludges all have the potential to introduce air pollutants. Standard loading coefficients exist to evaluate expected load per year per quality of sludge. An air quality dispersion model and loading coefficients for other air pollutant sources are both required as task inputs. The air quality model can then be run for various water quality management and sludge disposal scenarios.

These studies should be undertaken by the Nassau County Department of Health and the Suffolk County Department of Health Services. Total cost is estimated to be $300,000, of which task a. will require $60,000 and task b. $240,000.

6.5.3.3 Evaluation of the Nitrate Standard for Drinking Water. The United States Public Health Services' drinking water standards established in 1962, set a maximum of 45 milligrams per liter nitrate as NO_3 (equivalent ten milligrams per liter as nitrogen). This has been questioned by a great number

of eminent scientists. E. F. Winston in 1970 reported that much data did not support the low standards and recommended additional research. In the last five years several studies have been performed which show that relatively high nitrate concentrations in drinking water do not constitute a health hazard. There has not been a reported fatality due to methemoglobinemia in the past seventeen years. Few, if any, cases of methemoglobinemia have been reported in the United States where the water comes from community water supplies.

The World Health Organization recommends eleven parts per million nitrate-nitrogen with a maximum of 22 parts per million nitrate-nitrogen. Since a number of researchers have questioned the existing standards and since the World Health Organization has taken steps to change these standards and because of their serious implication on our groundwater supply, we recommend that the EPA systematically review this entire question, taking advantage of all the most recent studies, and update their current standards.

Section 7 Implementation

7.0 Introduction

The Act and the regulations drafted by EPA thereto, require a commitment from the 208 agencies to indicate how implementation of the planning recommendations will be carried out. Responsible units of local and state governments must agree to support existing or new agencies to do the work and to have sufficient taxing, budgeting and regulatory authority to finance the various tasks.

This implies that technical, fiscal and political objectives can be achieved and that major constraints will somehow be ameliorated. The Areawide 208 Plan developed for Nassau and Suffolk Counties is implementable. The ease of implementation, though, is partially dependent on knowledge of the constraints that inhibit public action, and thorough preparation to cope with them. This is true for minor projects and even generally popular ones, let alone costly and less favored ones. Constraints often are complex and not easily identified or categorized. Attempts must be made to reduce these limits to implementation as though they were singular. For this purpose it is assumed that all barriers fall into three neat classes: technical, fiscal and political. Unfortunately, an apparent technical limit to some observers may justifiably be considered to be really fiscal in origin by others. Such potential definitional disputes are recognized. We dispense with this dilemma by taking a firm grasp of this disclaimer: *The following paragraphs are illustrative and can be re-defined as to category, but are accurate in that they all tend to hinder implementation of public programs.*

7.1 Constraints

7.1.1 Technical Limits. Technical limits include the availability and quality of the data on which technical alternatives are identified, prioritized and chosen; the state of the art of equipment and methodology; and the existence of suitable agencies to design, construct, operate, monitor, maintain and regulate the structural devices and facilities.

One concern that permeated this program was the adequacy of the input data that was used to verify the models and identify the "real world" of Long Island's hydrogeological/ecological system. Serious researchers can never be complacent when considering the relative completeness of technical data. More should be known about organic chemicals, metals and viruses. More wells should have been installed for test purposes. More should be known about the movement of contaminants through the aquifers. More monitoring should be conducted, and on a continuous basis. More has to be known about health and environmental standards. The list is awesome! The unknowns constitute an important set of recommendations for future work and are mentioned in the previous section. Fortunately, sufficient information and experience were available to enable the preparation of this initial 208 Plan. When implementation is considered, however, it must be in the context of a *continuous* planning effort. As the data and knowledge base improve, modifications of the Plan may become necessary.

Waste treatment processes and equipment currently available (from the standpoint of proven reliability and efficient performance) can meet the recommended needs of the Nassau-Suffolk Program. However, some management alternatives, such as large scale recharge to the aquifer, will not become operationally reliable until ongoing demonstration tests at Cedar Creek are completed. Another example of state of the art deficiency is the obvious need for improved means of producing organic-free potable water.

The administrative aspects of technical implementation are perhaps the least difficult set of problems to resolve. Existing county and State agencies in both counties are now implementing many monitoring, regulatory and operational waste treatment programs. Land use controls, to a lesser extent, are also being carried out. Non-point source control measures have to be significantly strengthened. The main administrative questions relate to new opportunities to improve the quality and efficiency of service for the future.

7.1.2 Fiscal Limits

7.1.2.1 Availability of Funding. Fiscal constraints fall into two general classes. One is the availability of money. The other is the legal requirements that must be met prior to spending public funds.

Federal and State transfers of revenue to local governments are the major source of funds for major public works, *e.g.,* highways, sewers, etc. These grants are often the major catalyst in generating local initiation of projects. Yet these monies also deter action due to the following:

1. There might not be an adequate amount to fund all the requests throughout the country or state. Prorated shares would necessitate a larger local contribution, regardless of the aid formulas. Thus, instead of moving local actions, the deficiencies deter them.

2. The funds are often categorical, *i.e.,* monies are earmarked for specific projects and/or specific construction solutions, *e.g.,* at one time, the Federal Government would fund outfalls, but not recharge. (The law has now been changed to make more items eligible.) Local governments are forced to choose between a technology they may not want, but can be funded; or if a different solution is chosen, pay for it with local revenues. This latter case is crucial to 208 implementation, since most non-point pollution abatement techniques and facilities are not currently eligible for Federal grants, except for agricultural areas.

Another fiscal constraint is the low priority accorded the subsidization of sewer lateral construction, which can amount to 90 percent of a sewering program's costs.

3. The condition of the bonding market also affects the availability of funds. Recent experiences in Suffolk County indicate that due to the unstable fiscal situation in New York City, the bond market was reluctant to invest heavily in municipal works, except at exorbitant interest rates. One alternative to this impasse would require the county to partially guarantee the district bonds with earmarked revenues from the county general sales tax. The County Legislature chose this path to avoid default on the partially constructed Southwest Sewer District. The controversy over the financing of this District has already created a strongly negative county-wide attitude towards any further major structural programs for waste treatment.

7.1.2.2 Legal Limits on Spending. State constitutional limits and other State and local statutes related to public spending often slow implementation. Although conceived of as a means of providing fiscal integrity and protection for the citizenry, these laws can impede and sometimes prevent the creation of necessary public works.

1. Most Federal and State grants require that the local governments provide a matching share. If the project is small enough or popular enough, the local share may be obtained by the issuance of bonds for the purpose. This can often be authorized by local legislative resolution after a public hearing is held on the matter. If the local government cannot come up with their share, the grants are cancelled.

2. Projects that are costly and/or controversial are subject to either permissive or mandatory referendum. Permissive means that the legislative body may act in the prior case, but can be challenged by a segment of the public to submit the action to a public vote. It is rare that elected bodies risk permissive actions. This means that the proposal is put to referendum as though it were manadated. In most instances the vote takes place at the next regulary scheduled election. This process alone can delay action for almost one year.

7.1.3 Political Limits. In the last analysis, political limits determine the "go/no-go" real world climate; they are the most complex and, therefore, the most interesting ones to resolve in moving any public program or policy towards successful implementation. Although related to and affected by technical and fiscal issues, political constraints are more reflective of the democratic system, which must be responsive to the public will. There are virtually no limits, technical or fiscal, if the public support is favorable.

The development of an implementation program and schedule is the concluding phase in the preparation of a planning study. It requires that there be a recommended course of action, or at least the identification of resonable alternatives, *e.g.,* the specfic objectives to be attained including timing; the administrative agencies to conduct the initiation and operation of programs, facilities and regulatory procedures; the fiscal resources to fund the effort; the legal provisions to substantiate and protect the program content; and the fostering of citizen interest to assist in making the action politically supportable.

7.1.4 Summary. Secton 3 presented a detailed recital of the many alternatives that may be used for waste management in the two counties. Section 4 commented on the environmental consequences of each alternative. Sections 5 and 6 concentrated on preferred responses. The CAC recommendations are in Section 5. Section 6 represents the TAC point of view. Fortunately, there is a strong overlap indicating a healthy, independent consensus on major issues.

The remaining task is to pull the administrative, fiscal, legal and policy elements together into a workable and therefore implementable package. The following pages summarize these matters under the headings of Management Agencies, Fiscal Needs, Legal Needs and Public Informational Program.

7.2 Management Agencies

7.2.1. Introduction. At the present time, all agencies required to implement the various portions of the Nassau-Suffolk Comprehensive Areawide Waste Treatment Management Plan are extant. The Nassau County Department of Public Works and the Suffolk County Department of Environmental Control are statutorily established, with full powers and authority for the planning, design, construction, operation and maintenance of public sewage collection and treatment systems. These agencies, in conjunction with the two County Health Departments, currently can implement the monitoring

and regulatory functions relating to all of the public health matters that are addressed in the Plan.

These four agencies, in conjuction with the powers of the New York State Department of Environmental Conservation, cover the entire gamut of point and non-point concerns called for in the Plan. Land use recommendations contained in the Plan are currently administered by the Nassau and Suffolk County Planning Commissions in accordance with State and/or County Charter provisions.

The Federal law and regulations, which set forth the requiremtns of 208 planning (40 CFR 131.11 (n) (3) (i), state that, "to the extent practicable, waste treatment management shall be on a statewide and/or areawide basis . . . ." It must be stressed that this goal should be measured in the context of economy of scale. In Nassau and Suffolk Counties, the planning is conducted on an areawide basis (the two counties are an SMSA), and, therefore, meets the general requirements. The operating and regulatory functions, though are carried out by the respective counties. Since the two counties are sufficiently large (almost 3 million people) and have well established agencies that would not gain effectiveness by further centralization, the NSRPB does not recommend any major changes. The areawide 208 planning function can continue to serve as a bridge for the two counties to ensure coordination and cooperation of mutual water quality management objectives.

There are, however, several management agency options that should be considered, since this study would not be complete if it did not analyze the efficacy of existing structures.

The balance of this section contains a discussion of management agency options for the operation and regulation of point and non-point source controls, water development and areawide planning. This is followed by NSRPB recommendations for designated agencies to carry out the various tasks.

7.2.2 Point and Non-point Source Controls. The control of point and non-point sources of pollution involves regulatory and operational activities. Most county units of government that undertake these responsibilities share the task along functional lines. The County Health District (department) assusmes the regulatory activities. The County Department of Public Works undertakes the design, construction and operation of structural facilities. This is the pattern in Nassau County.

Suffolk County has developed a more complex approach. Initially, a separate Sewer Agency was created to undertake the planning, design, construction and operation of the Southwest Sewer District. It was never attached to the extant Department of Public Works. Subsequently, a Department of Environmental Control was established, which assumed all the functions of the sewer agency and also included some regulatory and monitoring functions. Some of the prior duties of the Department of Health Services in these fields were transferred to the new agency. However, the Health Department could not relinquish those duties that were mandated to it by virtue of N.Y.S. Public Health Law. Thus, Suffolk County has two agencies whose duties in regulation and monitoring potentially overlap. To address this concern, the two agencies have signed a memorandum of understanding, intended to clarify jurisdictional assignments. (See Appendix C.)

The following pages describe the responsiblities, operations, environmental monitoring, proposed additional functions and advantages of the present administrative structure. This is followed by several questions and observations that may require future action.

7.2.2.1 Suffolk County Department of Environmental Control Responsibilities. The following are the representative examples of the functions performed by the individual units of the SCDEC that fulfill Charter responsibilities: Realty Subdivision, Planning, Engineering, Construction, Operations, Environmental Monitoring (Freshwater Resources, Marine Resources, Air Pollution Control, and Water Pollution Control) and Special Services/Energy Programs.

7.2.2.2 Suffolk County Department of Health Services Responsibilities. The County Charter, Public Health Law, New York State Sanitary Code and the Suffolk County Sanitary Code have mandated environmental programs to the Health Services Department. This includes the supervision and control of public water supplies, bathing beaches, public swimming pools, individual water supplies and sewage disposal systems, realty subdivision and ionizing radiation. In addition, the Department is responsible for the enforcement of standards regarding operations of county-owned facilities. Thus it appears that the Health Department and Environmental Control Department share duties relative to realty subdivisions and fresh and marine water monitoring and regulation.

7.2.2.3 Administrative Considerations. The present management structure in Suffolk County appears to have created potential impediments to more effective operations. One is philosophical in nature, the others are jurisdictional.

Generally, agencies are assigned either operational or regulatory functions. This is to avoid, to the degree possible, potential internal conflicts of interest. The State and Federal environmental protection agencies' duties include enforcement, monitoring, standard setting and the administration of grant programs. They generally do not build or operate sewage treatment facilities. In New York State this latter function is the responsiblity of a separate New York State Environmental Facilities Corporation.

The opposite argument is that substantial benefits are derived from maintaining within one agency comprehensive, interdisciplinary capabilities for addressing environmental matters. In addition, dual participation of an agency (*e.g.*, SCDEC) in both the 208 Study and 201 facilities planning assists in assuring that the recommendations of the 208 Plan are implemented on the 201 level.

Jurisdictional issues are considered here solely for the objective of understanding where the practice of shared responsibilities breaks down. The main problem appears to be with enforcement. When responsibilities

for enforcement are shared among several agencies (in this case, NYSDEC, SCDHS and SCDEC) disputes are bound to occur. The shortcomings of current enforcement capabilities provide the basis for implementing a local environmental law as described in Section 7.4.7.

7.2.2.4 Administrative Options. There are several models that may be considered for point and non-point management agency assignments. In Suffolk County, they include:

1. a. Assign *all* monitoring and regulatory functions to the Health Department.

b. Assign *all* operational activities to the Department of Public Works.

This model is close to that used in Nassau County. In all other New York State counties, save upstate Erie County, shared responsibilities do not exist. The monitoring and enforcing of environmental control standards is carried out by county health departments.

2. a. Assign *all* monitoring and regulatory functions to the Health Department.

b. Assign *all* operational activities to the Sewer Agency.

3. a. Assign *all* monitoring and regulatory functions to the Department of Environmental Control as an agent of NYSDEC and NYSDH.

b. Enact a local environmental regulatory law with responsibilties assigned to the Department.

c. Assign all operational activities to DPW or an independent Sewer Agency.

4. Maintain the current administrative status quo.

At this time, Nassau County does not have to re-evaluate its agency structures. The county's sewer program is well established and functioning. The areas of responsibility are clear-cut. Finally, the agencies are conducting their respective duties successfully.

In the case of Suffolk County, the NSRPB has offered some models to consider. The Board fully recognizes that ultimately these are decisions to be pondered by the newly formed Citizens Charter Commission, considered by the County Executive and Legislature, and finally, determined by either permissive or mandatory referendum.

7.2.3 Water Development. The 208 Plan indicates that the quantity of groundwater should be adequate through the planning horizon. However, it is possible that a part of this resource may become polluted and, therefore, effectively limit the available potable supply through time. In such event, it may become necessary to ensure the adequacy of supply through the following actions:

- Limit the withdrawals from individual wells or well fields, or establish district-wide limits.
- Require the inter-district allocation of water supply.
- Require the inter-county allocation of water supply.
- Sequence and coordinate the capital investments necessary to provide an adequate distribution network, inside each county, between counties and outside the Region.
- Establish pricing policies throughout the SMSA to achieve significant water conservation.

Provisions for these activites do not now exist throughout the Region. At the present time, each county copes with the problems of water production, quality control, distribution and sale through a variety of administrative mechanisms. Suffolk County has an Authority with county-wide powers to carry out the above mentioned functions. Although individual wells and private and municipal water companies exist, the Authority has powers of condemnation and purchase. Since the mid-1960's, the Authority has striven to build a coordinated system. Some of the municipal water districts purchase water from the Authority, and then retail it to local customers.

Water production and supply in Nassau County is currently managed by 46 separate independent water companies—43 in municipal and three in private ownership. The balkanization of water management obviates the county's ability to efficiently respond to the reality that water is a county-wide resource and concern and should be managed as such.

This observation is neither new nor startling. In 1963, the Greeley-Hansen, *Summary of Report on Water Supply*, recommended the consolidation of Nassau's water supply. In 1971, an updated report by the same consulting firm modified their positions to stress the need for supplemental water. Since this report was published, the NCDH has revised the projected "deficit" from 126 MGD to 47 MGD in 2000. The "deficit" is the estimate of the difference between projected water supply demands and the calculated safe yield of the resource.

The county has partly responded by the creation of a Water Resources Board charged with a review of the 1971 recommendation as a prime responsibility. Their first report urged: (1) the development and adoption of a master plan, (2) creation of a new department or division to implement, when necessary, any part of the Master Plan that calls for the provision and transmission of supplemental water, (3) acquisition by Nassau of the large water main under Conduit Boulevard and Sunrise Highway and (4) action by NYSDEC to reduce the heavy groundwater pumpage in Queens County. Additional actions should now be taken. There are at least three options that the county government should consider.

An obvious option entails the creation of a county-wide authority or department that would have the sole resonsibility for the production, quality control and distribution of water. This would mean the absorption of the county of the 46 existing companies.

A second possibility would be similar to the first for the production of water, *i.e.*, the location and operation of wells, control over pumping rates, and the sole responsibility for water quality monitoring and control. The 46 existing companies would remain for the purpose of local distribution and sale of water Presumably, the county agency could acquire any of the inde-

pendent companies by purchase as is the case in Suffolk County.

The third alternative would be that water production can be assigned to the Department of Public Works. In this case production of water and construction of a county-wide distribution system would be assigned to the Department, with monitoring and quality control assigned to the Health Department.

Several additional advantages to be considered as a result of centralization include:

1 The ability to foster water conservation through the use of pricing schedules.

2. The establishment of uniform, continuous and sophisticated monitoring surveillance of the groundwater resource.

3. The development of a formal reporting system to ensure that the County Executive and Board of Supervisors receive adequate and timely information regarding the county's water supply situation.

4. The ability to create an administrative mechanism to address intercounty water problems and solutions.

On this last point it must be recognized that Nassau and Suffolk Counties are one region in several senses. There is general understanding that demographically and economically the counties constitute a clearly identifiable Standard Metropolitan Statistical Area (SMSA). Transportation is another obvious regional activity and concern. Certainly, this is also true for water. The aquifer, already designated by the EPA as a "sole source aquifer," does not relate to municipal boundaries. It is a common resource. In fact, if anything defines the unity of Long Island in a physical sense, it would be the groundwater underlying the Region.

Since self-sufficiency of water supply is a good possibility, assuming intelligent management, it is essential that regional policies be formulated and established.

This is an important concern for Nassau County in that it must choose from three possible alternatives of obtaining supplemental water that represent widely divergent approaches. Self-sufficiency may be maintained by (1) recharge of an advanced treated wastewater effluent or (2) by having Suffolk County water made available to Nassau County users.

The third alternative is for Nassau County to consider joining with New York City to implement the U.S. Army Corps of Engineers proposal to skim the floodwaters of the Hudson River. This requires the construction of a new water tunnel and distribution system.

Although this was a wastewater management study, water treatment at the wellhead should not be ignored as a management tool. Public water supply treatment in many areas may, in fact, be required regardless of the structural or non-structural recommendations cited in the Plan. Every effort should be made to prevent further degradation of the resource.

State and/or local legislation that would permit public water supply wells to be located on public lands should be considered. In many cases such locations afford maximum protection for the water supply. These installations can be constructed in a manner that would still preserve the initial integrity and use of the land for which it was originally set aside.

7.2.4 Areawide Planning. Since December 28, 1974 the Nassau-Suffolk Regional Planning Board has been the designated Section 208 areawide planning agency. Between January of 1975 and December 31, 1977, this agency has been responsible for the conduct of the $5.2 million 208 Program. With the completion of the initial plan, questions remain as to continuity of effort for periodic updating and for subsequent work related to any portions of the initial plan subject to conditional approval. Several options exist for the future. They would include:

1. continuance of the Nassau-Suffolk Regional Planning Board as the areawide agency.

2. the designation of Tri-State Regional Planning Commission as the areawide agency, and

3. the assumption of these functions by the New York State Department of Environmental Conservation in accord with the similar responsibilities in other portions of the State of New York.

The first option offers several benefits. The NSRPB and its 208 affiliates—the TAC and CAC—have developed a good working relationship among the responsible agencies and a very active and broad based citizen group. A comprehensive and strongly controversial planning process was conducted relatively on time, and with a remarkable degree of consensus among the participants. Both advisory committees expressed almost unanimous recommendations that the NSRPB continue its 208 planning functions. The administrative mechanisms are in place and functioning, and the decisionmaking process is directly available and open.

The second option is not recommended. The Tri-State Planning Commission has not been involved in 208 planning and would not be able to guarantee smooth continuity.

In view of new EPA/State agreements whereby the relationships between the Federal Government and the State for waste treatment planning purposes are being clarified, one could build a good argument for Option Three to take place. Since the State has the full responsibility for the entire State, it would make sense to coordinate these activities in one agency. Local input could then be achieved through the review process. In short, the Nassau-Suffolk Regional Planning Board would review and comment on the periodic updatings prepared by the State as they affect Nassau and Suffolk Counties.

This would require a significant increase in staff trained in land use planning to handle the land use and other non-structural aspects of 208 work. At the present time, NYSDEC is not responsible for state planning functions. After the demise of the Office of Planning Coordination, modest planning responsibilities were assigned to the Secretary of State. That office is currently specializing in coastal zone management planning.

7.2.5 **Designations.** One responsibility in the formulation of an areawide water quality management plan is the designation of, and acceptance of, implementation responsibility by regulatory, planning and operating agencies to carry out the adopted plan. The following pages contain the NSRPB recommendations. In general, the NSRPB believes that all management agencies required to implement this water quality management plan are currently in place and have adequate legal and administrative jurisdictions. Agency acceptance of functions designated in this water quality management plan constitutes a moot point, because they already have such responsibilities and their authority is demonstrated to derive from existing legislation, *i.e.*, N.Y. State Public Health Law, N.Y State Environmental Conservation Law, Federal Law, General Municipal Law of the State of N.Y., regulations of local Health Districts, County Charters, local laws.

The designations are identified for point source control, non-point control, water development and areawide planning. The NSRPB has taken a conservative approach. Although a range of management alternatives has been discussed in previous pages, as required by law, the major focus must be on the successful implementation of the 208 Plan. Thus, the recommendations made now are workable.

Several of the options mentioned in 7.2.2 and 7.2.4 that call for new agencies or shifts in functions between agencies are certainly premature in view of the statutory and/or Charter amendment procedures that must occur and can be quite time consuming.

The NSRPB recommends the following designations.

7.2.5.1 **Point Source Control, Operations.** The facilities planning, design, construction, operation and maintenance of collection systems, treatment plants and disposal facilities are currently the responsibility of State, county, municipal and private groups. The NYSEFC, NCDPW and SCDEC should be the prime agencies. Municipalities within the two counties that currently operate sewage treatment plants should also be designated. We do not recommend the continued practice of private operation and maintenance of sewage systems.

7.2.5.2 **Point Source Control, Regulatory.** The NYSDEC, ISC, NCDH, SCDEC and SCDHS be designated the regulatory agencies for each county for the promulgation, monitoring and enforcement of standards, laws and regulations concerning the safe operation of sewage treatment plants for health and environmental control.

7.2.5.3 **Residual Waste Disposal, Operations.** The NCDPW and the SCDEC be designated for the management of hazardous wastes and sludge waste for county facilities. The municipalities be designated for the management of solid wastes and sludge waste from municipal facilities.

7.2.5.4 **Residual Waste Disposal, Regulatory.** The NCDH, SCDHS, SCDEC and NYSDEC be designated for the regulation of residual waste disposal.

7.2.5.5 **Non-Point Source Control, Operations.** Municipalities and county agencies now responsible for street sweeping, catch basin maintenance, storage and use of road salts, and the regulation of Best Management Practices, be designated.

7.2.5.6 **Non-Point Source Control, Regulatory.** The NYSDEC, NYSDH, NCDH, NCPC, SCDHS, SCDEC and SCPC be designated to carry out the regulatory duties involved in non-point controls.

7.2.5.7 **Non-Point Source Control, Advisory.** The Suffolk County and Nassau County Soil and Water Conservation Districts, USDA, SCS, NYSDEC, ASCS, Cornell University and CES function in an advisory capacity to the non-point source regulatory and operations agencies in the preparation of regulations and standards, the review of permit applications and inspections of operations relating to industrial discharges, the storage and transportation of chemicals and hazardous materials, storm runoff, erosion control and agricultural chemicals application, as well as continue their function in agricultural non-point source control.

7.2.5.8 **Areawide 208 Planning.** The NSRPB be designated for continuing land use aspects of waste management planning. The NYSDEC be designated for overall 208 planning.

7.2.5.9 **Regulation of Land Use and Zoning.** The municipalities be designated for the initiation, local planning, and regulation of land use and zoning, and that the NCPC and SCPC be designated the agencies responsible for review, override and consistency of local land use actions with the 208 Plan.

7.2.5.10 **Water Production, Operations.** The SCWA be designated for the production and distribution of potable water in Suffolk County. The 46 independent water districts and companies in Nassau County be designated for the local distribution and sale of water. An existing Division within NCDPW could be assigned expanded, county-wide responsibilities for water production policy, including well locations, pumpage rates and design, construction, operation and maintenance of these water production facilities, and for the implementation of any plan adopted by Nassau County for the acquisition, transmission and distribution of water, whether inter- or intra-county. Other administrative options, such as a new department, could also be considered.

7.2.5.11 **Water Production, Regulatory.** The NYSDH, NCDH and SCDHS be responsible for drinking water quality and be assigned all monitoring and related quality control functions for potable water in the two counties.

7.2.5.12 **201 Planning.** The NCDPW and SCDEC be designated as the lead agencies for all 201 Programs.

Figure 7–1 depicts the recommended table of organization for planning operations, monitoring and implementation of the Water Quality Plan

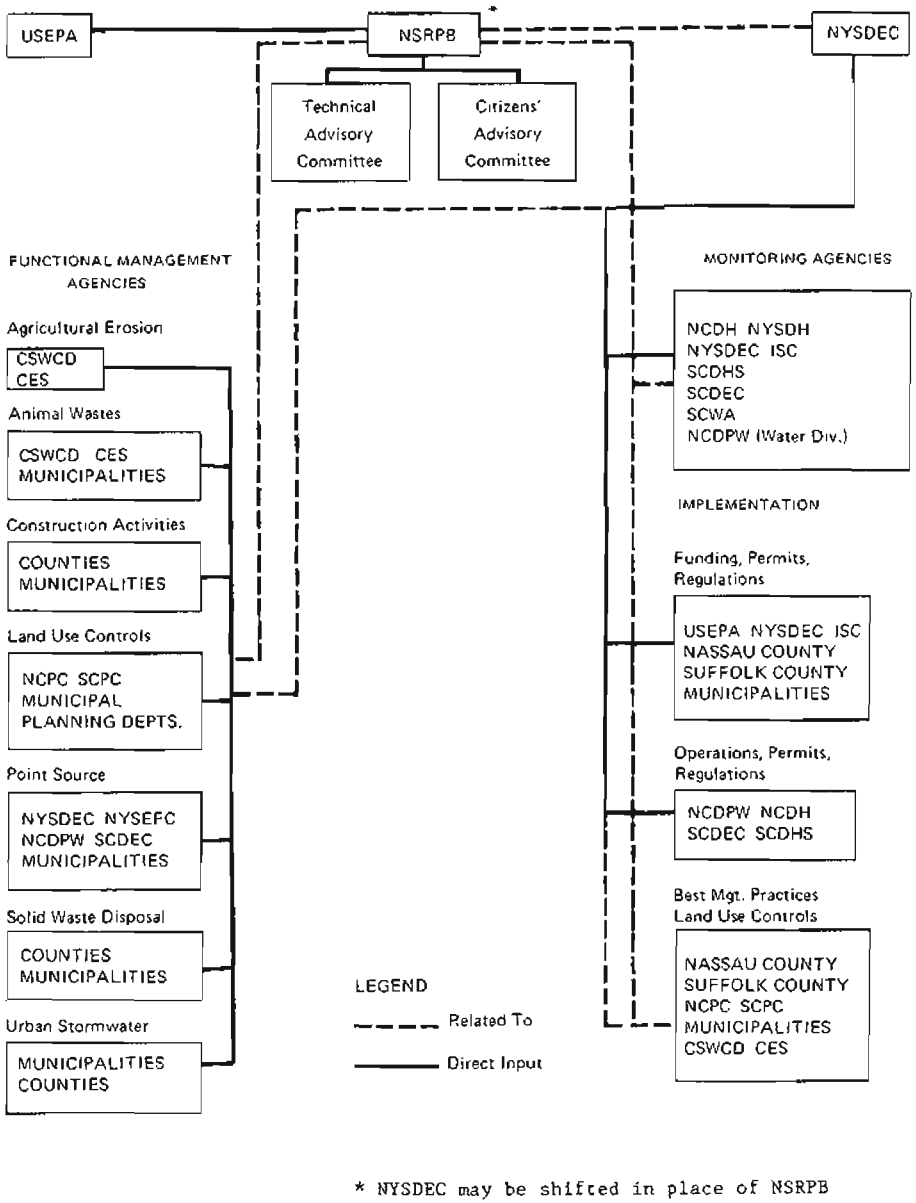


FIGURE 7–1 *Management Organization: Ongoing 208 Planning*

7.3 Fiscal Needs

7.3.1 Introduction. Historically, waste treatment programs centered around engineering solutions. Thus, it is not surprising that the Federal response in terms of intergovernmental relations has been to sponsor major grants for construction. Present sewage construction projects eligible for EPA and state support may receive grants up to 87½ percent of the total project's costs. This is a very necessary and strong support if the communities are to meet the needs for a water pollution-free society. However, in view of the impetus set forth in the Act, which encourages non-point source and planning control measures, it is perhaps timely for Congress to consider adequate funding to achieve these ends as well. For example, the Southwest Sewer District in the Towns of Islip and Babylon, N.Y., is a network of collection systems, treatment facilities and an effluent disposal outfall, that is estimated to eventually cost approximately $1.0 billion, including financing costs. Major segments will receive 87½ percent funding from EPA and the State. Even the 12½ percent balance to be financed by the users places a heavy burden within the district. If this is to be the future pattern, aid will have to be greatly magnified.

In addition to Federal and State funding (87½ percent) for sewage treatment works, which include treatment plant and interceptor construction, permanent provision should be made for the extension of governmental subsidizing for lateral sewer construction, which would greatly reduce the local financial burden. Another obvious alternative would be to limit the density of growth and thereby avoid the need for communal sewage systems. This objective can be partially realized through zoning controls and successful enforcement. In addition, extensive watershed management will be required, including the reservation of significant areas of open space. These types of public programs are virtually dependent on local fiscal resources. Specifically in regard to 201 Programs, Federal and State funding for non-point and non-structural solutions should also be strengthened.

It should be noted that the high cost of providing the facilities of the Southwest Sewer District are directly related to the fact that action was taken after extensive development had occurred, and substantial water quality degradation had been discerned.

A more fiscally sound approach is to install sewerage facilities in accordance with the 208 Plan as development occurs, as one of the preventative measures for protecting water quality Therefore, in areas where land use controls are not implemented, sewering should be conducted in accordance with the 208 guidelines.

The purchase of development rights and/or the fee simple for open-space lands, or for the maintenance of low density communities should be construed as a modified form of construction project. Wherever land development has not already occurred, this option has to yield a greater return on the public investment. Perhaps fiscal policy improvement can occur if waste treatment programs were written in a format similar to that of the Communi-

ty Development Act, namely, assign block grants to communities with the general requirement to reduce water pollution. Let the local governments decide the most efficacious way of doing this. The states and localities would then have a greater incentive to exercise more stringent land controls.

7.3.2 Funding of Comprehensive Structural Programs. The Southwest Sewer District in Suffolk County has undergone severe financing problems in recent years. Litigation, inflation and rising interest rates on bonds have all contributed to sizable increases in the initial cost estimates made over a decade ago. Local shares must currently be raised by benefit taxes charged to residents and commercial/industrial users within the district.

In order to achieve favorable interest rates on construction bonds, the Suffolk County Legislature pledged a portion of the county-wide sales tax revenue as a guarantee of the worthiness of the bonds. County participation should now be evaluated on a more permanent and direct basis. Obviously the theory of cost/benefit taxation, namely, those who benefit should be the ones to pay for the benefit, is logical. The issue though is, who are the beneficiaries? Certainly the users are direct beneficiaries. In addition, the balance of the people in the county are indirect beneficiaries wherever the quality of a segment of the county's ground and surface waters is enhanced. Therefore it is reasonable to propose that a portion of the District costs be assumed as a general county expenditure. In principle, this is analogous to the justification for county acquisition of parks, farmlands and other county facilities as a general obligation, even though the properties are located in specific areas of the county, on the grounds that all residents indirectly benefit even if they never use the facilities. Numerous funding formulas would apply. Perhaps a base charge could be levied against the users to cover the majority of local costs, thus paying respect to the narrow definition of cost/benefit. Any remaining costs in excess of the base could then become a general county charge.

Financing for the various structural and point recommendations made in this plan can and will be met by existing authorized programs. Sewage treatment plant upgradings, extension of outfalls, improvements in solid waste management and the development of local subdivision sewage treatment plants are generally within the fiscal means of Nassau and Suffolk County governments—assisted by Federal and State grants. Tables 7—1A and B identify the summarization of recommended structural programs and estimated costs thereof

An alternative would be to increase the assesed valuation within the district. The district's transportation system, and the availability of public water facilities and public sewer systems, make this increased density possible. The rezoning of these areas in a prudent, comprehensive fashion should act as a catalyst for the redevelopment of property, with the consequent reduction of the individual tax burden.

7.3.3 Funding of Research Programs. Financing for needed research programs is dependent almost entirely on Federal support. Table 7—2 identi-

Table 7—1A

ESTIMATED COSTS FOR STRUCTURAL RECOMMENDATIONS NASSAU COUNTY(1)

	Total Present Worth (2) (7) (Millions of Dollars)
Southwestern Nassau County Planning Area	
—Relocate Bay Park Outfall to ocean	52
—Reroute Long Beach to connect with Bay Park outfall	0.5
—Lawrence	
a. AWT with present discharge location	3.8
b. Diversion to Bay Park and incremental cost of treatment at Bay Park	3.7
Cedar Creek Facilities Planning Area (Sewer Disposal District No. Three)	
—Terminate Freeport and divert to Cedar Creek	14
Northwest and Northeast Study Areas (North Shore Facilities)	
—Divert northshore plants to Cedar Creek (Oyster Bay, NYIT, C.W. Post, GNSD, Village of Great Neck, Port Washington,	54
—Divert North Shore plants to Cedar Creek (Oyster Bay, New York Institute of Technology, C.W. Post, Great Neck Sewer District, Village of Great Neck, Port Washington, Roslyn, including flows generated from high population densities in Plandome, Sands Point, Kings Point and parts of Manhasset). Incremental treatment costs at Cedar Creek included.	
—Northwest sub-regional facility at Port Washington (divert Great Neck Sewer District, Great Neck Village, Roslyn and Port Washington flows generated from high population densities in Plandome, Sands Point, Kings Point and parts of Manhasset)	33
—Northeast sub-regional facility at Glen Cove (divert Oyster Bay and the following unsewered areas, Sewanhaka, East Norwich, Bayville, Locust Valley and Sea Cliff-Roslyn Harbor to Glen Cove after sewering).	33
—Individual treatment plants.	
a. Village of Great Neck: discharge of 1.5 mgd at present location, with AWT (denitrification).	8.7
b. Roslyn: discharge of up to 2 mgd at present location with AWT (denitrification).	7.9
c. Great Neck Sewer District	

Possible Flow (mgd)	Total Present Worth (Millions of Dollars (2) (7) (8) Secondary Treatment	Mid-Bay Outfall	Total
2.7	5.6	11	16.6
3.5	11	11	22
5.5	15	12	27
7.0	18	12	40

Table 7—1A . . Cont'd.

d. Port Washington Sewer District

Possible Flow (mgd)	Total Present Worth (Millions of Dollars) (2) (7) Option 1 Secondary Treatment	Mid-Bay Outfall	Option 2 AWT	Existing Outfall
4.50	13	7.5	22	1.9
6.50	18	8.8	30	2.2
13.5	29	9.5	50	2.4
14.45	30	9.7	52	2.5

e. Glen Cove.

Possible Flow (mgd)	Total Present Worth (Millions of Dollars) (2) (7) Option 1 Secondary Treatment	Mid-Bay Outfall	Option 2 AWT	Existing Outfall
7.5	19	5.4	33	0.042
11.5	25	5.9	44	0.046
18.5	35	6.3	62	0.046

	Total Present Worth (2) (7) (Millions of Dollars)
Oyster Bay STP(10)	
—Discharge with secondary treatment to present outfall location	13
—Diversion to Cedar Creek including incremental treatment cost at Cedar Creek	11
Bayville	
—Diversion to Oyster Bay, including incremental treatment cost at Oyster Bay	7.5
—Build new facility in Bayville area (Sound outfall)	9.7

fies the recommended research programs and, wherever possible, an estimate of cost has been made.

7.3.4 Funding of Non-Point and Non-Structural Programs. The most difficult to estimate are the non-point and/or non-structural recommendations. Many Best Management Practices, *e.g.*, fertilizer applications, catch basin maintenance, control of animal wastes, depend more on public informational efforts, and financing should not constitute an impediment to implementation. Local governmental controls and current programs can achieve great strides with little or modest budgeting increases. Stormwater runoff control, if requiring structural means, can run as high as $1100/acre according to EPA. (See Section L of the Areawide Waste Treatment Manage-

Table 7—18

ESTIMATED COSTS FOR STRUCTURAL RECOMMENDATIONS
SUFFOLK COUNTY(1)

		Total Present Worth Cost(2) (7) (Millions of Dollars)
I	**Huntington/Northport 201**	
	Regional Alternative Sites	
	1. Huntington Sewage Treatment Plant, or	62
	2. Crab Meadow	68
	Sub-Regional Alternative Sites	
	1. Huntington Sewage Treatment Plant and Northport Village Sewage Treatment Plant	57
	Small Treatment Plants	57
II.	**West Central 201 Study Area**	
	1 Northern Area	
	a. Sub-Regional Alternative Sites	See Note (3)
	1. Suffolk State School and	
	2. Facility located in the eastern portion of this area	
	b. Small treatment plants	See Note (3)
	c. Diversion to the Suffolk Co. Sewer District No. 3 Water Pollution Control Plant (Bergen Pt.)	See Note (3)
	2. Southern Area—Diversion to SWSD	120
III.	**SWSD**	See Note (9)
IV	**Kings Park 201 Study Area**	
	A. Regional Alternative Site	
	1 Kings Park Sewage Treatment Plant	59
	B. Sub-Regional Alternative	
	1 Kings Park Sewage Treatment Plant and Suffolk County Center	76
	C. Small Plants	110
V.	**Port Jefferson 201 Study Area**	See Note (3)
VI.	**South Central 201 Study Area**	
	A. Regional	150
	B. Sub-Regional Alternative Sites	200
	1. West of Lake Ronkonkoma	
	2. Oakdale Vicinity	
	3. Sayville	
	4. Parkland III and SCSD No. 7	
	C. Small Plants	260
	Village of Patchogue	See Note (3)

Table 7–18. Cont'd

VII.	**Yaphank 201 Study Area**	
	A. Sub-Regional Alternative Site	
	1 Three Sites (Selden, Suffolk County Property at Horse Block Road, and Mastic Beach east of William Floyd Parkway.)	280
	2. Six Sites (three sites above plus Rocky Point, Artist Lake vicinity, and Center Moriches east of Forge River)	270
	B. Small Plants	330
VIII.	**Riverhead 201 Study Area**	
	A. Regional Site	
	Riverhead Sewage Treatment Plant	27
	B. Sub-Regional Sites	
	1 Riverhead Sewage Treatment Plant and Manorville	31
	2. Small Plants	31
IX.	**Greenport/Southold 201 Study Area**	
	A. Small Treatment Plants	
	1. Greenport	24
	2. Additional Sites	See Note (3)
X.	**Disposal District 14—Shelter Island**	
	Shelter Island	14
XI.	**Disposal District 12**	
	Small Treatment Plants	See Note (5)
XII.	**Disposal District 15**	
	Sag Harbor	See Note (4)
XIII.	**Disposal District 16**	See Note (6)
XIV.	**Disposal District 17**	
	Fishers Island	2.6

(1) Area specific alternatives correspond with those in Chapter 6 of the Summary Plan.

(2) Present worth costs include interceptors, force mains, pump stations, treatment plant, treatment plant outfalls (excluding mid-bay or ocean in Suffolk), and operation and maintenance. The costs are based on a sewering criterion of 2 DU/acre everywhere (1995 population), present worth at 6 3/8% interest amortized over twenty years, CRF = .08986 (ENR = 2580, mid-1977 costs).

(3) To be determined in 201 Study when additional detailed information is available.

(4) Plant already constructed. (Further expansion will be a cost.)

(5) Sites to be selected; costs to be determined in future 201.

(6) Sewage treatment to be implemented as need arises.

(7) Costs include 75% replacement of equipment if any wastewater treatment plant greater than fifteen years old was to be utilized in the twenty year planning period.

(8) It was determined with the use of a water quality model that AWT could not meet water quality criteria, hence, only Mid-bay outfall was evaluated.

(9) Total sewerage facilities capital cost (collection and treatment) $601,000,000 (May 1977).

(10) Includes other areas, such as Sewanhaka, East Norwich, Bayville and Locust Valley.

ment Plan.) This would be for control of erosion and runoff from construction sites and, presumably, would be borne mainly by the private developer. Local communities should also be able to utilize a portion of their Community Development funds for stormwater control projects. Thus the fiscal impact on local governments should not be significant. Watershed management, however, could engender significant costs. Zone III contains approximately 45,000 deep recharge acres. Much of this is zoned for low density use. If this pattern is maintained, then the need for public funds will be minimized and less crucial. However, in the most severe case, if these lands had to be acquired either by fee simple or purchase of development rights, the per acre cost could range from $3,000 to $10,000. Suffolk County's farm program already represents a sizable county allocation ($21 million for Phase I) and should enable the purchase of the development rights for approximately 6,000 acres. To the extent possible, priority should be given to those farms within the watershed conservation zone. Other land use mechanisms are also available, *e.g.*, agricultural districting, planned unit development (PUD), transfer of development rights and clustering. These mainly represent non-cost techniques for preserving open space. The recommended land use research would be directed towards the detailing of geographically specific plans designed to assist local governments and Suffolk County to maximize water quality improvement and watershed conservation through the proper application of planning techniques.

For agricultural non-point source control, part of PL 95–217 was amended (The Culver Amendment) to provide cost-sharing to owners and operators of rural lands who implement conservation practices that relate to the improvement of off-site water quality. $200 million has been appropriated to the Secretary of Agriculture for this purpose for 1979, and $400 million for 1980. Thus it appears that financial support for erosion and sediment controls will be available for agricultural lands.

However, this will not provide funds for the implementation of other non-point source control measures.

It is therefore recommended that PL 95–217 be amended to provide for the funding of all Best Management Practices that will reduce pollution caused by non-point sources. This should also allow for the funding of such

Table 7–2

SUMMARY OF ESTIMATED COSTS OF PROPOSED STUDIES AND DEMONSTRATION PROJECTS

	Estimated Cost
Ongoing 208 Studies	
1. Further Definition of Groundwater Management Zones	$ 400,000
2. Application of the Regional Digital Models to Evaluate Regionwide Effects of Man-Induced Changes in Groundwater Elevation	300,000
3. Detailed Mapping of Land Uses, Natural Resources, and Environmental Constraints for the Deep Flow Aquifer Recharge Area	400,000
4. Extent and Causes of Organic Chemical Contamination	400,000
5. Evaluation and Monitoring of the Movement of Metals and Organic Chemicals in the Aquifer System	750,000
6. Assimilative Capacity of Subsoils	75,000
7 Determination of the Impact of Leakage and Spills from Hazardous Materials Storage and Transport; Identification of the Best Means of Control	320,000
8. Measurement of Groundwater Underflow Quantity and Quality and Impacts of Duck Sludge Deposits	75,000
9. Determination of the Effects of Inlet Closure on the Water Quality of Moriches, Shinnecock and Mecox Bays and of Inlet Creation on the Water Quality of Great South Bay	300,000
10. Fertilizer Research	100,000
11 Groundwater Screening for Aldicarb	25,000
12. Heavy Metals in Sediments	125,000
Total	$ 3,270,000
Demonstration Projects	
1. Marsh-Pond Treatment of Sewage	$ 100,000
2. Marsh-Pond Treatment of Runoff	200,000
3. Street Sweeping	200,000
4. Structural Treatment of Stormwater	2,500,000
5. Comprehensive Monitoring as an Aid in Making Wastewater Management Decisions	150,000
6. Denitrification of Individual Subsurface Sewage Disposal Facilities	110,000
7. Removal of Nitrates from Drinking Water Supplies	450,000
Total	$ 3,710,000
Total Ongoing 208 Studies and Demonstration Projects	$ 6,980,000
Research	
1 Viruses in Aquatic Systems	$ 450,000
2. Air Pollution and Wastewater Management	300,000
3. Evaluation of the Nitrate Standard for Drinking Water	N. A.

programs as catch basin maintenance, street vacuuming and other measures. The funding level should be commensurate with that provided for structural solutions.

The areawide recommendations for insuring the proper functioning of on-lot waste disposal systems also includes local and county government responsibility for the provision of scavenger waste treatment and disposal facilities. This would be especially necessary where the non-structural land use controls recommended in this Plan have been implemented, thus obviating the need for central collection and treatment of sewage. However, it is presently the State's position that costs for such facilities are not eligible for state construction grant funding.

It is therfore recommended that the State revise its position relative to the funding of such facilities and provide grants similar to those presently given for central collection and treatment facilities.

7.3.5 Funding of Comprehensive and Sub-Regional Groundwater Monitoring Programs. An integral part of the Nassau-Suffolk 208 Plan is that general comprehensive groundwater monitoring and area-specific monitoring programs (such as 201 study areas) be initiated immediately, in order to determine the extent of groundwater contamination and the need for implementation of structural and/or non-structural controls.

These monitoring programs are a key link in the decisionmaking process and are not presently provided for by funding in sub-regional or "201" Studies. In order to integrate the areawide 208 Plan with ongoing and future 201 Studies, funding at all levels (Federal, State and local) is essential and recommended.

7.3.6 Funding of Structural Stormwater Control Programs. The Nassau-Suffolk 208 Program has identified a number of structural stormwater control measures that may provide a cost-effective solution to surface and groundwater pollution problems in certain areas. Site-specific studies are necessary to determine the most cost-effective solution in areas where stormwater discharges have a significant impact on surface and groundwater quality.

Section 211(C) of the Clean Water Act of 1977 (PL 95-217) prohibits the funding of treatment work for the control of pollutant discharges from separate storm sewer systems. This restriction could severely limit the investigation and implementation of stormwater control measures.

Therefore, it is recommended that the Clean Water Act of 1977 be amended to remove the restriction on the funding of stormwater pollution control measures.

7.3.7 Funding of Operation and Maintenance Costs. Operation and maintenance costs for the structural recommendations contained in Tables 7–1A and 7–1B are estimated to be approximately $20–25,000,000 per year This will be a substantial portion of the total costs of the recommended projects.

Originally, Section 17-1905 of the Environmental Conservation Law provided for State assistance of up to one-third of the approved annual opera-

tion and maintenance costs. However, this assistance is subject to the limits of annual appropriations of the State Legislature. In recent years, the rate of reimbursement has varied between 33 percent and 10½ percent. However, Section 17-1905 has been amended to reduce the level of maximum assistance to one-fourth and funding is presently at the 25 percent level. On the Federal level, a similar program does not exist.

It is recommended that a Federal Operation and Maintenance Assistance Program be developed, which is similar to the current New York State program and that funding be provided at least at a 25 percent reimbursement rate.

Such a program would insure protection of the multi-million dollar investment of State, Federal and local funds that have been used to construct sewerage facilities in Nassau and Suffolk Counties.

7.3.8 Caveat. This section discusses costs in order to provide a frame of reference as to the relative scope of water management. It is done with a great deal of reluctance. Structural costs, which are the easiest to estimate based on average prices derived from previous projects, can be in error by a factor of two. First of all, accurate estimating must be based on detailed designs and specifications. This is the province of 201 work. Future costs affected by inflation, bond market responses, new materials, techniques and equipment, and the status of the construction industry are some of the latent factors that affect prices. Indeed, the reader must keep in mind that pricing based on general planning can only lead to the dimension of future investment needs—not the real dollar cost. Consider the difficulty of the defense establishment in building a plane, tank or warship within the estimated budget after the device has been designed in excruciating detail. For that matter—how many homeowners or car buyers pay the "sticker" price.

The advantages of even going through a pricing exercise do exist however. First, it focuses attention on the general magnitude of the Program needs. Second, it alerts State and Federal agencies of future capital support budgets they may have to consider if local governments are to get the job done. Third, it is possible to achieve closer harmony with reality where cost estimates are made for projects that should be undertaken immediately, *e.g.*, moving an outfall or initiating monitoring or research. Fourth, it clearly indicates that in most cases prevention is less costly than remedial action. Non-structural and land use solutions do require less public expenditure to achieve water quality protection than structural solutions built after pollution occurs. This does not include secondary impact analysis. Fifth, it also provides relative costs for structural alternative comparisons.

7.4 Legal Needs

7.4.1 Introduction. In general, existing laws and regulations are sufficient to cope with the majority of sewage and solid waste management needs. Point and non-point pollution sources are covered under New York State Health and Environmental Conservation laws and, additionally, by Nassau and Suffolk Charter provisions and/or ordinances. Land management and land use planning controls originate with the General Municipal Laws of the State of New York and are amplified by the two counties' charters. Thus, it is currently possible to operate a successful areawide waste treatment program in Nassau and Suffolk Counties in the framework of existing laws. Nevertheless, recommendations are contained herein to strengthen the management agencies' abilities to control non-point sources of pollution. In most instances, local statutes enacted by the counties and/or municipalities will be sufficient.

The initial portion mentions point source control for sewage treatment systems. This is followed by a discussion of legal needs covering water production, erosion and sedimentation, animal wastes and land use control. The last portion contains a proposed county environmental law designed to achieve strong control over non-point pollution sources.

7.4.2 Point Source Control. The NSRPB believes that the existing body of legislation, and administrative control relating to municipal sewage treatment plants and other point sources of pollution is adequate to ensure compliance with the Water Quality Management Plan.

Provisions of New York Environmental Law, Article 17, Title 8 (The SPDES program) are legally adequate to control all significant point sources and can be extended to control many non-point sources of surface water pollution in the Nassau-Suffolk SMSA. Permits are required for the discharge of any pollutant to insure compliance with 306 FWCPA, 1972 and "Any other applicable water quality standards and applicable effluent standards and limitations."

The provisions of SPDES are legally and administratively adequate to control all significant point pollution sources in the Nassau-Suffolk area. The program must be continued, supported and expanded. Limitations in the effectiveness of the program are due to inadequate enforcement and a conservative interpretation of the legal mandates conferred by PL 92–500 and the New York State Conservation Laws. Therefore, the NSRPB recommends that deviations from compliance schedules be minimized.

All schedules should be subject to a thorough review by NYSDEC, the EPA, the permittee and a representative of the Health Commissioner of the appropriate County Health District. Compliance is a permit condition and must be enforced.

7.4.3 Water Production. Existing provisions of Nassau County law provide for the effective centralization of water supply within the county. The relevant sections of this law are Article XII, §1202, 1207, 1208, 1212. Suffolk County has a management agency (Suffolk County Water Authority) that controls water production throughout most of the county. It has sufficient legal authority to continue the absorption of local companies.

The main legal needs apply to the process of well drilling. Proposed revisions to the New York State Environmental Conservation Law (S.3896: A.5311) relating to water well drilling and groundwater protection will fulfill these needs.

The NSRPB recommends that the revisions be fully supported. The

Board, however, suggests that this draft be modified as follows:

1. Re §15—1603 and 1625. Large-capacity agricultural wells, or an aggregate number of smaller wells having the same general capacity, must not be exempted, either directly or by implication.

2. Re §15—1623. No well, other than a low-capacity private supply well, shall be permanently sealed, demolished or abandoned by any person, prior to determining the potential usefulness of the well in a groundwater monitoring program. This bill should create the possibility of public access to any well so designated.

3. Re §15—1629. The NSRPB agrees with the logic of establishing critical groundwater areas. However, the bill should recognize the fact that the groundwater resource may be endangered by various chemical contaminants which constitute a real or potential threat to the potable water supply that is equal to, and perhaps greater than, any threat caused by drought and/or overpumping.

In addition, a water supply utility should have the resources available to develop the aquifer containing the best quality water or, if necessary, transport and distribute water from neighboring areas.

Where a public water utility does not have the economic resources or legal authority to finance water main extensions, the same rationale employed in fostering the construction of wastewater collection and treatment systems by Federal and State grants should also be employed in grants for financing water supply expansion. The public health benefit is immediate and directly measurable in contrast to the potential long term benefit assigned to most sewering projects. It is, therefore, strongly urged that legislation be recommended and encouraged to provide this vital protection to the general health and welfare.

7.4.4 Non-Point Source Control, Erosion and Sedimentation. The major source of erosion and the resultant sedimentation in Suffolk County is primarily due to construction activities. Numerous state laws and local ordinances concerned with land use and water resources can be used to implement some level of erosion control. The Soil and Water Conservation District Law is the only State law that deals specifically with soil erosion and sediment control.

The law states that by January 1, 1980, the Districts will have provided a plan to each owner and occupier of agricultural land within the District boundaries who have requested a plan. The law is deficient on two counts. It only applies to agricultural lands and contains no enforcement procedures to assure compliance.

The NSRPB recommends that the State law be amended to overcome the current deficiencies, thus assuring positive control for the agricultural areas of Long Island. This would be timely and not impose a burden on owners due to the recent passage of the FWPQA amendments of 1977.

Construction related erosion can be managed by extending the Conservation District approach into non-agricultural areas or by strengthening existing devleopment controls, *e.g.*, subdivision ordinances, grading and filling permits, etc. The NSRPB recommends the latter approach with the added requirement that "site clearance and development plans" be part of the approval process. Such plans would identify, step-by-step, all of the activities to be undertaken on a given site and would also indicate the procedures to be followed to minimize runoff and erosion.

7.4.5 Non-Point Source Control, Fertilizers. The NSRPB recommends that the following three steps be implemented.

1. An educational effort be immediately adopted to discourage any excessive use of fertilizers and to promote adoption of low-maintenance lawns;

2. Research to be undertaken to:

a. Further monitor the use and fate of nitrogen applied to turf;

b. Investigate the feasibility of developing satisfactory low-maintenance lawns; and

3. Update the New York State law to require a label on turf fertilizers identifying them for use in Nassau and Suffolk.

7.4.6 Non-Point Source Control, Animal Wastes

7.4.6.1 Introduction. Dogs and semi-wild White Pekin ducks were found to be unregulated sources of non-point animal waste pollution. Urban runoff containing dog waste and other animal waste is responsible for most of the recent closures of shellfish growing areas. An information program and new laws are recommended to control dog waste disposal. Semi-wild White Pekin ducks and their descendants are also serious sources of pollution in many ponds and lakes. New laws and public awareness concerning the problem are needed to control these wastes.

Market duck waste has been a pollution hazard in the past and is now regulated by Federal and State laws. Under these laws, duck farmers have been required to achieve very limited discharges of wastewater by July 1, 1977, and zero discharge to any receiving surface waters by 1983.

Zoning ordinances in some municipalities are used to control horse waste and, indirectly, the waste related problems. However, there are many small non-point horse waste pollution sources affecting surface waters. These may require control.

The following discussion offers specific recommendations for new or amended legislation and/or local statutes to control animal wastes.

7.4.6.2 Non-Point Source, Animal Waste, Dogs. Dog curb laws may have a negative effect on the environment. East Hills and Rockville Centre have dog curbing laws requiring that owners walking dogs allow their pets to defecate only at or near the street curb. In theory, animal waste will then be swept up by street cleaning operations. In fact, animal waste in or near the road is easily flushed into the storm drainage system by rainstorm runoff. The drainage system empties into bays and estuaries, recharge basins, etc.

The NSRPB recommends that the following be implemented:

1. That affected municipal governments be encouraged to repeal dog curbing ordinances.

2. That all municipalities on Long Island, either by statute and public

informational efforts, prohibit owners from permitting dogs to defecate on roads, sidewalks, parking lots, play areas, parks or other places where people congregate, unless there is prompt cleanup and removal of feces; and prohibit the free roaming of dogs, with or without license and collar.

7.4.6.3 Non-Point Source, Animal Wastes, Ducks. Duck farm animal waste is regulated by Federal and State laws. Under those laws, duck farms are required to achieve zero discharge of wastewater to any receiving surface waters by 1983. A majority of the present Long Island duck farmers now plan to meet this requirement.

Semi-wild ducks are not specifically controlled or protected by law. The State law, authorizing towns and municipalities to establish dog catchers as peace officers with certain police powers, is not clear as to whether such persons can enter properties to capture and remove semi-wild ducks. Property owners can, under this law, have the town or municipality receive and impound the ducks removed by an owner from his property.

This study has found no law or section of a law that can be construed to suppt the contention that semi-wild ducks are a public nuisance. However, Article 26, Section 354 and Article 25B, Section 35 of the Agriculture and Markets Law do address aspects of the problem. The first, which attempts to discourage the sale of baby ducks for pets, states that, "No person shall sell, offer for sale, barter or give away living baby chicks, ducklings or other fowl under two (2) months of age in any quantity less than six (6)." In attempting to solve the problem of domestic ducks polluting local ponds, these laws may have complicated the issue by encouraging larger purchases. The second, which applies to dogs and other animals as well as ducks, states that, "The owner. . . of an animal, who abandons such animal. . .is guilty of misdemeanor, punishable by imprisonment of not more than one year or by a fine of not more than $500 or both."

The NSRPB recommends that Nassau and Suffolk Counties and/or the municipalities enact local laws authorizing and directing dog wardens, park employees and law enforcement officers to remove White Pekin ducks and their offspring and hybrids from publicly controlled reaches of inland bodies of water

It is further recommended that local laws be enacted at the county level prohibiting the sale of White Pekin ducks as pets anywhere in the two counties.

7.4.6.4 Non-point Source, Animal Wastes, Horses. The present primary document for statewide control of horse waste is the New York State Public Health Law, which cites animal wastes as sewage when they are waterborne, whether carried by storm runoff or base flow seepage, and as a public nuisance when the waste is offensive to neighboring property owners. Upon complaint, a health department representative may investigate, cause a hearing to be held relative to the nuisance, and require the abatement of the problem.

Zoning ordinances are often used to control the keeping of horses and, indirectly, the related problems. In the more densely populated areas in western Nassau County, such ordinances frequently prohibit the stabling of horses or limit such activities to a few selected locations.

The NSRPB recommends that all municipalities with horse populations adopt local ordinances that provide a limit on the number of horses per acre on residential land, and specify the management of disposal of horse wastes. The following clauses should be included in order to insure adequate waste management:

1. Not less than one half acre of open, unpaved land shall be provided for a single horse or other equine livestock; not less than one fourth acre of open, unpaved land shall be provided for each additional horse.
2. Each premise having less than one half acre of open, unpaved land per horse shall have and meet the provisions of an approved animal waste management plan (agency to be specified), or be in violation.
3. Animal waste, including manure and soiled bedding, shall be kept in weatherproof containers at least 50 feet from adjoining property lines.
4. Paved or otherwise unvegetated or bare soil areas used for horse yards, paddocks, pastures or similar purposes shall be graded or controlled so that no storm runoff wastes from one year frequency rainstorms falling on such areas, shall flow from the horse owner's property to other public or private lands.

7.4.6.5 Conservation Plan for Animal Wastes. Under present State law agricultural producers must develop a plan to reduce sediment and related animal waste pollution by January 1, 1980. This plan is to be developed with the assistance of the Nassau and Suffolk County Soil and Water Conservation Districts. The NSRPB recommends that the present law be amended to require non-agricultural animal owners, who have high concentrations of animals per acre, to develop a plan, with Soil Conservation District assistance, for the control of animal waste. Table 7–3 indicates the maximum number of animals that should be allowed per acre of open land without a conservation plan.

Table 7–3
MAXIMUM ANIMALS PER ACRE OF OPEN LAND
WITHOUT A CONSERVATION PLAN

Equine Livestock	2	Hogs	14
Beef Cattle	3	Ducks	400
Dairy Cows	2	Sheep	24
Turkeys	160	Dogs	20
Chickens	500		

or any combination of animals exceeding 2,000 pounds of body weight.

7.4.7 Ensure the Proper Functioning of On-Lot Waste Disposal Systems.

a. *Provide for Routine Maintenance of On-Site Disposal Systems.* Provision should be made for routine pumping and maintenance of on-site systems in order to extend the service life of the leaching facility and to ensure its continued efficacy. Local or county government should be responsible for the provision of scavenger waste treatment and disposal facilities.

County sponsored public education to encourage voluntary implementation is recommended. The promulgation of legislation mandating routine pumping and maintenance is not proposed at this time.

b. *Prohibit the Use of Certain Chemical Cleaners in On-Lot Systems.* If organic solvents and other chemical agents contain ingredients which might reasonably be expected to impair groundwater quality, their use for cleaning or extending the service life of on-lot sewage disposal systems should be prohibited or controlled. A program to identify such products is presently being conducted by Nassau County Health Department and Suffolk County Departments of Health Services and Environmental Control, and should be continued and emphasized. This should be coupled with specific county legislation banning the local sale of these products within Nassau and Suffolk Counties.

7.4.8 Strengthen and Enforce Regulations Pertaining to Industrial Wastes, Product Storage and Transportation, and Residuals.

a. *Expand Regulations and Enforcement Regarding the Disposal of Industrial Wastes.* Where industrial wastes are discharged to municipal sewer systems, strict enforcement of sewer use ordinances should be insured. Suffolk County is revising its sewer use ordinance to conform to applicable State and Federal guidelines. This revision will be implemented by October, 1978. Nassau County has already adopted such an ordinance. These county ordinances should be the model for all other municipalities or sewer districts within each respective county and as such should be adopted by each of these entities. Each municipality or sewer district should be responsible for the enforcement of the ordinances and should maintain an adequate staff for such enforcement.

Present regulations covering the discharge of industrial wastes to the ground should be expanded to include greater coverage of specific contaminants and to prescribe allowable discharge levels. This applies primarily to organic chemicals and heavy metals.

b. *Regulate the Storage and Transportation of Chemical Products.* Permits and other controls should be required for the storage and transportation of chemical products that pose a threat to either the groundwater or surface water. The regulations should cover prescribed practices, safety requirements, inspection of equipment and contingency plans for interim storage and clean-up. The county agencies should be responsible for enforcing the permit regulations and control measures; the individual operator should be responsible for maintaining records and monitoring. In addition to industrial chemicals, these products include chemical wastes and sludges, de-icing salts and petroleum products. Salt storage facilities should be designed to prevent leachate contamination of groundwater.

Particular emphasis should be placed on the regulation of gasoline storage facilities at automobile service stations and, to a lesser degree, home heating oil storage tanks. Criteria should be developed and enforced to ensure the integrity of all storage facilities. The 208 Study has recognized these two types of facilities as major potential pollutant sources but has not been able to define the precise magnitude of the problem.

c. *Provide for the Treatment of Hazardous Wastes.* The industries in the Nassau-Suffolk region and the wastewater treatment processes they employ generate two kinds of hazardous wastes: small volumes of strong, toxic industrial wastes, and industrial waste treatment sludges.

In view of the environmental sensitivity of the study area, continued disposal of these types of hazardous wastes outside of the area should be encouraged. However, if this disposal option is not available in the future, treatment facilities or landfills for the disposal of hazardous wastes will have to be provided in the bi-county area. The 208 recommendation is for a regional hazardous waste treatment facility for both counties. If a single facility cannot be implemented, individual county facilities are then recommended.

Treatment facilities should, wherever possible, be located at a sewage treatment plant with an ocean outfall. The effluent from the hazardous waste treatment facility should be disposed via the outfall, not to the plant influent. The outfall disposal will provide a temporary discharge in the event of a hazardous waste facility upset.

If a hazardous waste treatment facility cannot be located at a sewage treatment plant with an ocean outfall, it can be located somewhere in the area served by the plant, and can discharge *treated* effluent to the sewer system. Effluent monitoring must then be intensive so that, in the event of a plant or process upset, a slug of toxic waste can be prevented from reaching the downstream treatment plant.

If a hazardous waste treatment plant is not connected to a treatment plant ocean outfall, and is located in the deep-flow aquifer recharge area, special provisions must be made to contain any waste spillage. The wastes must not be allowed to percolate into the ground. Consequently, impermeable retention lagoons must be provided, large enough to take the entire plant inventory, in the event of a radical plant failure.

The hazardous waste treatment facilities should provide treatment for both organic and inorganic wastes where feasible. Radioactive wastes should not be handled at the facilities.

7.4.9 Stormwater Runoff Control. Pollution of surface waters from runoff water can be reduced by controlling the amount of pollutants in the streets, the flow of water transporting the pollutants, natural treatment of the runoff, and mechanical treatment and disinfection of collected stormwater.

It is recommended that a uniform procedure be adopted for estimating the total and peak rates of runoff by all the municipal and county planning agencies. This requires amendments to at least some of the existing subdivision regulations.

It is also recommended that the Conservation Farm Planning Law be amended to provide for enforcing of agricultural stormwater runoff where offsite damage occurs.

In order to implement these recommendations, the NSRPB should establish an ad hoc committee of municipal and county planners, engineers and water resource specialists to prepare a handbook of guidelines and standards for Best Management Practices (BMP) for the control of storm-water erosion and non-point sources of pollution.

7.4.10 Land Management/Land Use Authority. Various sections of the FWPCA (101, 201, 303 and 314) make reference to land use management requirements, the preservation of land resources, and generally indicate that land use regulations should be utilized to control point and non-point sources of pollution.

Section 208 provides that the areawide treatment management plan include "the establishment of a regulatory program to regulate the location, modification and construction of any facilities within such area which may result in any discharge in such area, . .". This appears to require indirect authority for the 208 Plan to regulate location of all pollutant discharges by seeking appropriate changes in land use plans from the agencies possessing land use control jurisdiction in the 208 area.

A more explicit authority for the 208 Plan to consider land use in the 208 area is provided in Section 208 (b) (2) which states that the plan will set forth procedures and methods, including use requirements, to control to the extent feasible non-point sources of pollution. The term "land use requirements" in Section 208 (b) (2) should be interpreted to include those land use controls (legally permitted uses) and those land management regulations (regulations of activities conducted on land) that contribute to the attainment of water quality standards.

The nature of the "land use authority" that is required by FWPCA is discussed in EPA, Draft Guidelines for Areawide Treatment Management, (May, 1974), Chapter 4. These guidelines provide that:

"primary reliance will be placed on utilizing existing land use plans and controls. In some cases it may be necessary to update these in order to incorporate changes responsive to water quality objectives. In such cases, the 208 planning agency *must work closely with the local governments possessing legal authority* for land use planning and controls. It is also possible that some jurisdiction within the 208 area will not have land use plans and/or controls. In this case, the 208 agency should work with the appropriate jurisdiction to gather enough information about the area so that current and future development patterns and policies can be identified and, if necessary, updated to incorporate water quality objectives."

Acting pursuant to the provisions of the General Municipal Law and County Charter provisions, Nassau and Suffolk have authorized their respective County Planning Commissions to review certain actions. Municipalities are required to submit to the county planning commission: new zoning regulations, amendments to zoning regulations; changes in zoning district classifications, variances from zoning ordinances; special use permits, special exceptions or other special authorizations.

Municipalities are required to refer the zoning actions to the county planning commission when the action will affect real property lying within a distance of 500 feet of municipal boundary lines; existing or proposed county or state parkways, thruways, expressways or highways; existing or proposed rights-of-way of any stream or drainage channel owned by the county or for which the county has established channel lines; and existing or proposed state and county-owned land on which public buildings or institutions are located.

7.4.10.1 Nassau County. The Nassau County Planning Commission reviews four basic types of zoning actions: (1) amendments to zoning ordinances; (2) variances; (3) zone changes; and (4) special use permits and special exceptions. The Commission evaluates the effects of zoning applications in relation to adjacent properties, arterial highways, public parks and other recreation areas, public institutions, the environment and the projected needs of the community. In this way, the Commission attempts to encourage comprehensive and coordinated planning between all communities in the county

Depending on circumstances, the Commission adopts resolutions recommending either disapproval or modification of the application. The Commission may also recommend that the matter be determined locally, *i.e.*, when it has no objections, which constitutes a majority of the actions. When the Commission recommends disapproval of the application, the local board may overrule with a majority-plus-one vote, accompanied by a statement as to the reasons of its action within seven days, either overruling or modifying the application.

7.4.10.2 Subdivision Plat Approval. § 1610, as amended, of the Nassau County Charter, gives the Planning Commission conclusive authority to approve subdivision plats, establish standards for public improvements such as road, utilities and storm drainage, and to supervise the installation of required improvements in the unincorporated areas of the county, and reviews subdivisions that are located either within a distance of three hundred feet of city and village boundaries, or in unincorporated areas.

7.4.10.3 Suffolk County, Zoning Review. Article XIII of the Suffolk County Charter provides for review by the Suffolk County Planning Commission of zoning actions, special permits, variances and land subdivision plats that are within one mile of a nuclear power plant or airport; or within 500 feet of the boundaries of: villages, towns; county, State or Federal parks; rights-of-way for county or State roads; rights-of-way of county-owned streams or drainage channels; boundaries of other county, State or Federal land; or the Atlantic Ocean, Long Island Sound, any bay in the county or estuary of those waters.

Planning Commission response may be (1) no recommendation (a matter for local determination); (2) disapproval (or with modification recommended) for stated reasons; or (3) approval for stated reasons. The municipality may override by vote of a majority-plus-one, with a statement of reasons therefore.

§1330 of the Suffolk County Charter provides that any adopted zoning ordinance or amendment thereto (excluding variances and special permits) occurring within 500 feet of a town or village boundary must be submitted for review to the Planning Commission. The Commission has forty-five days in which to act on these referred zoning actions. If an objection is registered within twenty days of receipt, the Commission must schedule a public hearing and render a decision which can only be negated through court action.

If an objection is registered with the Commission by a state agency concerned with environmental protection a public hearing will be scheduled and decision rendered by the Commission within forty-five days. A proposed municipal zoning action disapproved by the Commission may not be adopted by the town or village that referred it, and if an action is approved by the Commission with change, it may not be adopted by the referring body except as amended in accordance with the Commission's report.

7.4.10.4 Subdivision Plat Referral. The Suffolk County Charter also provides for Planning Commission review of proposed subdivisions. Section 1333, Article XIII, of the Suffolk County Charter provides for the referral of certain proposed plats by the authorized municipal agency to the Suffolk County Planning Commission.

Plats must be referred to the Suffolk County Planning Commission if located wholely or partly within one mile of a nuclear plant or airport, or within a distance of five hundred (500) feet from: any municipal boundary, existing or proposed county, State or Federal parks, roadways, other public lands and the coastal edge including county designated streams.

The Commission response may be (1) local determination; (2) disapproval; (3) conditional approval; or (4) approval as submitted

These rules and regulations of the SCPD establish subdivision plat review criteria that are relevant to water quality management. For example, subdivisions are required to provide stormwater collection systems so designed that no water running across or falling on the tract shall reach a county road or roads. Further, stormwater cannot be directly disposed of into any creek, stream, brook, bay, harbor or any other body of water. In the case of waterfront lots in shoreline areas: no buildings can be placed at the top of slope or at the edge of bluff. Additional setbacks are required to compensate for the effects of erosion on the shoreline. No stormwater drainage or concentrated runoff is permitted to flow down the face of the bluff or shoreline slope. All grading and clearing on shorefront lots is restricted to insure stability of the face of slope or bluff against erosion.

Sections 1321 and 1322 of the Suffolk County Charter further provide that the Planning Commission may recommend a comprehensive zoning plan to any town or village in Suffolk County and may make such other recommendations involving the performance of the planning function by towns or villages as the Commission deems appropriate. The Planning Commission may, on request of any town or village in Suffolk County, furnish the town or village with requested planning services.

7.4.10.5 Recommendations. Thus, it is evident that most municipal zoning requests and subdivision designs are already subject to review, advice and/or regulation by the county planning commissions.

Subdivision review is consistent with the requirements of 208 planning and is completely handled by Nassau County and local municipalities. In Suffolk, the preponderance of cases is reviewed by the county.

It is recommended that Section 1333, Article XIII of the Suffolk County Charter be amended to provide that all proposed subdivision plats be referred to the Planning Commission to insure that non-point source runoffs will not occur as a result of subdivision construction activities.

It is also recommended that similar amendments be made to Section 1330, Article XIII of the Suffolk County Charter and Article 12–b, Subsection 239 n of the General Municipal Laws. Obviously, any zone changes that produce use density increases, will have a direct impact on water quality management. Intensification of use may require an increase or the creation of additional collection and treatment facilities. Since the two counties have the lead responsibility for implementation of the 208 Plan, it is imperative that the counties are aware of, and participate in, the total zoning process. It is recommended that NCPC be authorized to implement 239 n.

Realistically, this should be within the current budgetary and staffing capabilities of the two county planning departments, since those agencies now handle well over 90 percent of such actions.

7.4.11 County Environmental Law. This discussion on "Legal Needs" contains a number of recommendations for new or amended legislation and ordinances to augment the existing authorities. However, the passage of laws does not automatically guarantee compliance and implementation. Federal and State environmental laws have often been permissively enforced. Persuasion rather than penalty has been the rule. In Suffolk County there has been discussion of providing a strong comprehensive county environmental law—analogous to the State law, except that it provides for strong local legislative control. It must be stressed that this is a draft and subject to revision.

7.5 Public Informational Program

7.5.1 Introduction. Implementation of planning programs depends on the translation of "good planning" into "good politics." The public must perceive that there is a real crisis confronting them that must be resolved, and this collective perception must be made known to the elected decisionmakers. All too often, public officials are confronted by the "naysayers." Rarely is affirmative general support brought to their attention. Yet this is the key. It is the essence of all successful policies and programs.

The scientific and technical findings of this 208 Program has convinced the participants that a real crisis exists in the two counties about waste

treatment management. The quality of the Island's potable and swimming waters, the opportunities for rational growth, the potential for sound economic development, the protection and enhancement of the living resources—in sum the future quality of life on this Island—depends on sound areawide waste treatment management.

We must now expand efforts to share the results of research efforts, findings and recommendations with the broadest array of citizens possible. This will include the dissemination of reading materials, public hearings and a broad-based speaking program.

7.5.2 Publications. The TAC has published a special report on animal wastes, six interim reports, and this Plan Summary. In the aggregate these reports constitute a summary of the more than 150 reports, studies and data memoranda produced during the conduct of the Study. (See Appendix B for a summarization of the data and printed material.)

All public libraries in the two counties will be furnished with the set of TAC reports. The complete set of basic documents and data printouts will continue to be available at the NSRPB office for viewing during regular working hours.

The news media—radio, television and papers—have given fair coverage of the Study during the past two years. Steps have been taken to assure broad coverage of this Plan Summary in the media to aid in the widest distribution possible.

7.5.3 Public Hearings. Formal presentations will be made to the two county legislative bodies this spring. Additional hearings will be held in various locations to afford town and village governments a direct opportunity to question the technicians. These public hearings will be presented by the NSRPB staff, members of the TAC and the appropriate consultants.

7.5.4 Speaking Program. It is obvious that a region of 1200 square miles and almost three million people will require more than a limited number of public hearings if the general public is also to receive a live explanation of the 208 Plan. The staff will endeavor to also respond to business, civic and environmental groups. We expect to be ably assisted in this opportunity by members of the CAC. They independently established a speakers bureau and prepared their own printed materials and a very ably executed slide presentation.

During 1978, the NSRPB anticipates that the public informational program, which has been in effect since 1976, will reach every interested group in the two counties. Funding for the staff presentations will be a NSRPB responsibility. If continuing 208 funds will not be available for the CAC informational efforts, the NSRPB will cover these costs as well.

Although the campaign to secure implementation will be quite arduous, it is certainly worth the commitment of time, money and energy. The 208 Plan is a sound one, technically and fiscally, often imaginative, and absolutely vital if Long Island's most basic natural resources, its superb potable and marine waters, are to be preserved and enhanced.

7.6 Implementation Schedule

7.6.1 Nassau County Municipal Point Source Abatement Dates

a. *Bay Park—Designated 201 Facilities Planning Area*

(Including the Bay Park, Inwood, Cedarhurst, Lawrence, West Long Beach and the Long Beach Sewage Treatment Plants)

PHASE 1. Expand to 75 million gallons per day with Bay Outfall

Step 1	Approved	2nd quarter 1978
Step 2	Completed and Approved	2nd quarter 1980
Step 3	Completed	1982/83

PHASE 2. Ocean Outfall

Step 1	Approved	1st quarter 1979
Step 2	Completed and Approved	1st quarter 1981
Step 3	Completed	1983/84

Note: a. Lawrence Sewage Treatment Plant—Further investigation recommended as regards diversion or AWT
b. Long Beach Sewage Treatment Plant—Possibility of a 201 Study to be conducted by City and County
c. Unsewered areas (such as Point Lookout) will be considered in this schedule

b. *Cedar Creek—Designated 201 Facilities Planning Area*

(Including the Cedar Creek, Farmingdale, Meadowbrook, Grumman and Freeport Sewage Treatment Plants)

Step 1	Initiated	3rd quarter 1978
Step 1	Completed (including pilot studies)	3rd quarter 1981
Step 2	Completed and Approved	3rd quarter 1983
Step 3	Completed	1986/87

Note: Plants already scheduled to divert flow:

Farmingdale Sanitarium	Cease discharge 1981
Meadowbrook	Cease discharge 1978
Grumman	Cease discharge 1981
Freeport	Cease discharge 1979

c. *Port Washington Peninsula—Designated 201 Facilities Planning Area*

(Including the Port Washington and Village of Roslyn Sewage Treatment Plants)

Step 1	Initiated	4th quarter 1977
Step 1	Completed and Approved	4th quarter 1979/80
Step 2	Completed and Approved	4th quarter 1982/83
Step 3	Completed	4th quarter 1984/85

Note: All unsewered areas will be considered in the above timetable.

d. *Oyster Bay and Surrounding Areas—Designated 201 Facilities Planning Area*
(Including the Oyster Bay and Sewanhaka Yacht Club Sewage Treatment Plants)

Step 1 Initiated	2nd quarter 1978
Step 1 Completed and Approved	4th quarter 1980
Step 2 Completed and Approved	4th quarter 1983
Step 3 Completed	4th quarter 1985/6

Note: All unsewered areas such as Bayville will be considered in the above timetable.

e. *Great Neck Peninsula—Undesignated 201 Facilities Planning Area*
(Including the Belgrave, Village of Great Neck and Great Neck Sewer District Sewage Treatment Plants)

Step 1 Designation	3rd quarter 1978/9
Step 1 Completed and Approved	1st quarter 1981/2
Step 2 Completed and Approved	1st quarter 1984/5
Step 3 Completed	1986/7

f. *Glen Cove—Designated 201 Facilities Planning Area*

Step 1 and Step 2 Completed	1978
Step 3 Completed	1981/2
AWT (N Removal) or mid-bay outfall	1985/6

Secondary treatment with a nitrification stage is presently being constructed. Due to studies undertaken during the 208 Study it may be necessary to conduct further studies in this area.

g. *Plants not Included in a 201 Designated Area*

New York Institute of Technology AWT or Diversion	1985/6
C. W Post AWT or Diversion	1985/6

7.6.2 **Suffolk County Municipal Point Source Abatement Dates**

a. *Southwest Sewer District*

• commence operations	10/78
• complete construction	1980
• design flow	1986

1 Central Islip State Hospital Sewage Treatment Plant
2. Republic Aviation Sewage Treatment Plant
3. Farmingdale Agricultural and Technical Sewage Treatment Plant
4. Islip Scavenger Waste Sewage Treatment Plant
5. Babylon Scavenger Waste Sewage Treatment Plant

b. *Port Jefferson*

201 Step 1 Complete	4th quarter	1978
201 Step 2 Complete	4th quarter	1980
201 Step 3 Complete		1984

1. Port Jefferson Village Sewage Treatment Plant
2. Strathmore—Stony Brook Sewage Treatment Plant

c. *Yaphank* (assumes county approval in 1978)

201 Designation	1st quarter	1979
201 Step 1 Completed	4th quarter	1980
201 Step 2 Completed	4th quarter	1982
201 Step 3 Completed		1985/1986

1. Selden Sanitary Sewage Treatment Plant
2. Brookhaven Scavenger Waste Sewage Treatment Plant

Permit Compliance 1978

d. *S. Central* (assumes county approval in 1978)

201 Designation	1st quarter	1979
201 Step 1 Completed	4th quarter	1980
201 Step 2 Completed	4th quarter	1982
201 Step 3 Completed		1985/1986

1. Patchogue Village Sewage Treatment Plant

Permit Compliance March 1983

e. *Kings Park* (assumes county approval in 1978)

201 Designation	1st quarter	1979
201 Step 1 Completed	4th quarter	1980
201 Step 2 Completed	4th quarter	1982
201 Step 3 Completed		1985/1986

1. Kings Park Sewage Treatment Plant

f. *West Central* (assumes county approval in 1978)

201 Designation	1st quarter	1979
201 Step 1 Completed	4th quarter	1980
201 Step 2 Completed	4th quarter	1982
201 Step 3 Completed		1985/1986

1. Suffolk State School Sewage Treatment Plant
2. Strathmore—Huntington Sewage Treatment Plant
3. Pilgrim State Hospital Sewage Treatment Plant

g. *Riverhead*

201 Step 1 Completed	2nd quarter	1978
201 Step 2 Completed	2nd quarter	1980
201 Step 3 Completed		1984

1 Riverhead Sewage Treatment Plant

h. *Huntington*

201 Step 1 Completed	4th quarter	1979
201 Step 2 Completed	4th quarter	1981
201 Step 3 Completed		1985

1. Huntington Sewage Treatment Plant
2. Northport Sewage Treatment Plant

i. *Greenport*

201 Step 1 Completed	4th quarter	1979
201 Step 2 Completed	4th quarter	1981
201 Step 3 Completed		1985

1. Village of Greenport Sewage Treatment Plant

7.6.3 Nassau County Industrial Discharges

- Powers Chemco: 6/78 to meet NPDES permit.
- Fairchild Camera: currently meeting SPDES permit; will connect to sewer by 12/84.
- Grumman currently meeting SPDES permit; will connect to sewer by 9/81.
- Liberty Industrial: currently meeting SPDES permit; will relocate to Suffolk County by 6/78.
- Metallurgical Processing Corporation: 6/78 to meet SPDES permit, will connect to sewer by 12/84.
- TOD Manufacturing: currently meeting SPDES permit, will connect to sewer by 12/81.
- Li Tungsten: currently meeting NPDES permit.
- Cerro Wire: 12/78 to meet SPDES permit; will connect to sewer by 12/84.
- General Instruments: currently meeting SPDES permit; will connect to sewer by 12/81.

7.6.4 Suffolk County Industrial Discharges

- Circuitron
- Fairchild Republic
- Fairfield Noble
- Deltown Foods
- Suffolk Processing Corporation

The above firms are within the Southwest Sewer District and, are anticipated to be discharging to municipal sewers by 1980.

- Hazeltine Corporation: has converted to a completely closed system.
- Liberty Industrial: will relocate to Suffolk with a closed system.
- Bellport Islip Cleaners
- Bluepoint Laundry
- Strebels Laundry
- Arrow Laundry

Compliance schedule will be modified on NYSDEC approval of engineering report. The above firms currently operate in violation. Full compliance expected by January 1980.

- Entenmann's Bakery: compliance by 6/78.
- Stimson: no abatement date established.
- Q. C. Circuits: compliance by 1/79.
- Oak Tree Farm: schedule modified, compliance by 3/78.

7.6.5 Nassau-Suffolk Industrial Non-Point Discharges. The following programs and schedule dates apply to industrial source control programs in both counties. The majority of the industrial sources have been identified and are being inspected and sampled on a regular basis.

Salt Stockpiles. Identification, inspection and sampling are presently underway and SPDES applications are scheduled for completion by 1/79.

Industrial Storage Practices. Identification, inspection and sampling are presently scheduled to be undertaken by 6/78 and SPDES permit applications are scheduled for completion by 6/79.

Petroleum Storage Practices. Identification, inspection and sampling are presently scheduled to be undertaken by 1/79 and SPDES permit applications are scheduled for completion by 1/81.

7.6.6 Solid Waste Management Facilities

a. *Landfills.* Article 27, title 5 of the New York State Environmental Conservation Law authorizes NYSDEC to regulate the design, construction and operation of all solid waste management facilities to protect the public health and the environment of the State. 6 NYCRR360 was adopted in September 1973 and established a permit system to insure compliance with design and operations standards and provides, in part, as follows:

- that all new solid waste management facilities must comply with the provisions of 360 as a permit/operating condition.
- that existing facilities that do not comply with 360 must furnish an improvement schedule as a permit condition.

The NSRPB Water Quality Management Program incorporates all compliance dates and schedules developed pursuant to Part 360 by reference.

Specific recommendations for solid waste management facilities are contained in Chapter Six of the Plan Summary and Section K of the Water Quality Management Program.

b. *Incinerators*

The Black-Clawson facility is expected to begin shakedown operations by July 1978. At a later date, when the facility is fully operational, the following facilities will cease operations:

- N.C.S.D. No. 1
- Valley Stream
- Garden City
- Long Beach

Target dates for other incinerators are as follows:

• Glen Cove Co-Disposal Facility	operation:	1980
• Patchogue	cease operation:	1980
• Huntington	cease operation:	June 1981*
• Islip	cease operation:	June 1981*

- Babylon — cease operation: 1981*
- Multi-Town Solid Waste Management Facility — operation: 1981

*These facilities will cease operation when the Multi-Town Facility is operational.

c. *Scavenger Waste Plants*

- Shelter Island/Southold
- Riverhead/East Hampton
- Southampton

The present planning for the scavenger waste plants for Shelter Island/Southold and Riverhead/East Hampton for compliance with permit conditions was intended to be keyed to the completion of the proposed Southampton facility. The completion date for the Southampton facility is now projected as approximately September 1979.

- Islip/Babylon: cease operation 1980/81; will become part of Southwest Sewer District facility at Bergen Point.

7.6.7 Stormwater Control. The NSRPB does not believe that it is possible to establish definite abatement dates relating to stormwater control. The Nassau-Suffolk Water Quality Management Program, however, can establish a generalized phased approach to stormwater control that will entail a number of sequenced activities. This sequence assumes that USEPA will approve the NSRPB Water Quality Management Program by mid-1978, and that Congressional funding of USEPA will permit the required demonstration.

- Develop a detailed plan of study relating to various stormwater control options in the Nassau-Suffolk SMSA, including, but not necessarily limited to, improved street cleaning, diversion, detention, and treatment. Study dates are outlined below:
  - —Study outline completed—June 1978.
  - —Demonstration projects approval—June 1979.
  - —Demonstration, alternative assessment monitoring program, nonstructural approaches—end 1983.
  - —Implementation of selected approaches—1984, depending on nature or extent of construction requirements.

Appendix A Modeling

See Interim Report No. 2

Appendix B Bibliographic Data Summary

B.1 Introduction

In a project as complex as the 208 Program it is extremely difficult to produce a description of all of the efforts which have gone into the acquisition and analysis of the data gathered during the course of the study. This report will outline the major study tasks and the type of data acquired for each. It will also outline those areas where major data collection was performed and a list of all documents produced with cross references to the type of information available in each Interim 208 Study reports will receive extensive distribution to government, educational and research organizations. It would be almost impossible to publish and make available for general distribution all of the original, historical and newly obtained data which was used in preparing final reports. The latter documents are on file at the Nassau-Suffolk Regional Planning Board and are available to those interested in more detailed information on a particular phase of the project.

In some cases, such as groundwater quality, treatment plant operation and bacteriological quality of surface waters, a substantial amount of historical data existed. Information on nutrient levels in certain bays, organics and viruses in surface and groundwater and non-point sources was lacking in many cases. Even where historical data were available, extensive analyses of these data were required to determine the accuracy due to changing analytical techniques and long-term natural fluctuations in parameters such as runoff, nutrients and flushing characteristics.

It is obvious that in such a complex, interdisciplinary study a great deal of information is required to adequately characterize the system under investigation. As in any ecosystem, each functional part is inter-related. In few places is this shown as clearly as on Long Island. Water is not only a major connecting link, but the limiting factor in development and the types of activities which can take place on the Island. Any alteration in the hydrologic regime will have direct or indirect effects on other parts of the system

The investigations had as their major emphasis the collection and analysis of data required to determine the quality and quantity of surface and groundwaters. Groundwater studies required the use of analog and digital models to predict the effects of pumping rates and patterns and the effects of groundwater contamination by pollutant sources such as landfills (see Appendix A). In order to be reliable, these models required the input of large amounts of current information on groundwater elevations, subsurface geology and present and predicted pumpage patterns. Characterization of groundwater quality required design of sampling programs to study the concentration and distribution of viruses, trace metals, trace organic compounds, pesticides, fertilizers and other chemical constituents related to water quality. In many areas, new test wells were drilled to obtain this information.

Since the surface waters of Long Island are intimately connected with changes in groundwater, field programs were designed to obtain data on the hydrography, chemistry, microbiology and point and non-point sources of pollution in the bays and surrounding marine surface waters. A major data collection effort was required to inventory and characterize all possible point sources in the Nassau-Suffolk area. These included municipal and private wastewater treatment plants, landfills, scavenger plants, industrial sources and incinerators. Data were also compiled on present and projected wastewater flows in order to assess possible structural alternatives in the wastewater management program.

It was initially agreed that to whatever extent possible, the operating and regulating agencies of each county would carry out the field sampling and laboratory analyses. The rationale for this is quite clear:

a. These agencies work with this information on a day-to-day basis and thus exhibit a level of expertise relative to local conditions which an outside consultant could not be expected to have;
b. The operating agencies were already equipped in many cases to undertake various aspects of the field programs; and,
c. Funds provided by the grant would allow the agencies to develop a greater degree of efficiency through purchase of new equipment. This equipment and the experience gained would provide a basis for continued updating of the Program when the initial planning phase was completed.

B.2 Data Collection Program

For each phase of the Program, collection and analyses of existing data were required before field surveys and sampling programs could be formulated. In some cases this meant an extremely long period of searching the files of government, educational and research agencies. In others, voluminous data held by organizations had to be verified as to their relevancy to the Program. Table B–1 lists the agency involved, main topic of investigation and the present repository of the original data. The location of the original data is listed rather than reports comprising reduced data since those interested in pursuing further research on a particular subject generally desire the former type of data over reports containing final analyses of basic research reports.

Table B–2 summarizes the type of data available for each geographical area. The explanation of the Table gives examples of data types included under each topic.

Data pertaining to the mainland areas, such as general hydrogeology or trace organics in test well samples, are listed as Nassau or Suffolk County "General." No effort has been made to indicate the amount of data for a particular parameter available for a specific location. For example, although hydrogeological data is shown for almost all bays, the only data available in many areas are estimates of subsurface underflow to the bay which are based on indirect evidence from other studies. Conversely there is a great deal of historical and newly acquired data available on the groundwater and subsurface geology of the mainland of the Island.

Table B–3 is a compilation of the types of data collected by each agency or consultant (see Table B–2 for explanation of heading) Again, there has been no attempt to indicate the amount of data held by a particular agency since the data collection effort involved parameters which were of interest to or routinely collected by several agencies. For example, although the Suffolk County Water Authority is especially interested in groundwater quality, it also routinely collects precipitation data. Because of this, a certain degree of interpretation is required in using these Tables. For example, suppose we were interested in coliform data for Hempstead Harbor. Table B–2 indicates that such data is available while Table B–3 lists five agencies possessing microbiological data. Since Hempstead Harbor is in Nassau County, the primary contact would be the Nassau County Health Department followed by the general consultants, such as Tetra Tech, Inc.

Table B–4 lists all reports and publications prepared or assembled to date according to subject. Individual reports are listed serially in Section B.3, the Bibliographic Summary. Each report, as received, was assigned an accession number, the data types entered in Table 4 and the reference added to the end of the Bibliography. Using this system, a reader interested in all reports dealing with a particular topic, such as non-point source pollution, merely has to write down the accession numbers of all reports listed under "Pollutant Sources." One may at the same time make a "first-cut" by eliminating all those except the reports indicated as having "Pollutant Sources" as their major emphasis.

Since planning is a continuous process, it is expected that new information will be generated. Table B–4 and Section B.3 are arranged to allow for additional listings.

Explanation of Tables 2, 3 and 4

Following is a list of major data types included in Tables B–2, B–3 and B–4 with examples of sub-categories within each major heading.

- Reference number (Accession number of each reference as listed in Appendix A)
- Type (Primary [P] or Secondary [S] reference)
- Administrative (proposals, request for proposal, project control plans, contracts, etc.)
- Biology (wildlife, shellfish, productivity, etc.)
- Chemistry (COD, trace metals, inorganics, organics)
- Data Acquisitions (historical data, field sampling, methodology)
- Demography (population, land use, etc.)
- Ecology (natural resources, environmental impacts, etc.)
- Economics (cost/benefit, etc.)
- Geology (surface and subsurface, sediments)
- Hydrogeology (groundwater quality and quantity)
- Legal (present and proposed regulations)
- Meterology (air quality, wind, precipitation)
- Microbiology (bacteria, viruses, algal species, BOD)
- Modeling (analog and numerical)
- Nutrient Chemistry (nitrogen and phosphorus)
- Physical Oceanography (temperature, salinity, tides, flushing, currents, etc.)
- Toxicology (pesticides, herbicides, organics, etc.)
- Residuals (sludge, solid, hazardous, etc.)
- Point Sources (treatment plants, industrial discharges, duck farms, etc.)
- Non-Point Sources (stormwater runoff, septic tanks)
- Trace organics (in groundwater, rainfall)

Table B-1
LIST OF PARTICIPATING AGENCIES/CONSULTANTS
AND MAJOR AREAS OF STUDY

Agency/Consultant	Main Area of Interest
Nassau-Suffolk Regional Planning Board (NSRPB) H. Lee Dennison Executive Office Building Veterans Memorial Highway Hauppauge, New York 11787 (Dr. Lee E. Koppelman, Executive Director)	Administration Demography Land Use Planning Legal Aspects
United States Geological Survey (USGS) Water Resources Division 5 Aerial Way Syosset, New York 11791 (Grant Kimmel)	Analog Modeling Geology Hydrogeology
Suffolk County Soil and Water Conservation District (SCSWCD) U. S. Department of Agriculture (USDA) Soil Conservation Service 127 East Main Street Riverhead, New York 11901 (Anthony Esser)	Agricultural Runoff Animal Wastes Erosion
New York State Department of Environmental Conservation (NYSDEC) Region I, Building 40 State University of New York Stony Brook, New York 11794 (Philip Barbato)	Administration Advisory Review Lab Analyses
Suffolk County Department of Environmental Control (SCDEC) 65 Jetson Lane Hauppauge, New York 11787 (Vito Minei)	Laboratory Analyses Meteorology Non-Point Sources Sampling Surface and Groundwater Sampling
Suffolk County Department of Health Services Bureau of Environmental Health (SCDHS) H Lee Dennison Executive Office Building Veterans Memorial Highway Hauppauge, New York 11787 (Dr. Aldo Andreoli)	Groundwater Quality Trace Organics Sampling Trace Metal Sampling Viruses
Suffolk County Water Authority (SCWA) Water Quality Laboratory Sunrise Highway Oakdale, New York 11769 (August Guerrera)	Groundwater Quality Laboratory Analyses
Nassau County Department of Health (NCDH) Bureau of Water Pollution Control 240 Old Country Road Mineola, New York 11501 (Theodore Burger)	Groundwater Sampling Marina/Boating Effects Point and Non-Point Source Sampling Surface Water Sampling
Nassau County Planning Department (NCPD) Division of Environment and Conservation One Old Country Road Carle Place, New York 11514 (George Andrek)	Intra-Agency Coordination Land Use Planning
Nassau County Department of Public Works (NCDPW) Division of Sanitation and Water Supply Nassau County Executive Building One West Street Mineola, New York 11501 (James Oliva)	Point Sources Structural Alternatives
Town of Islip Department of Environmental Control (IDEC) 577 Main Street Islip, New York 11750 (Barry Andres)	Non-Point Source Sampling Surface Water Sampling Virus Sampling
Cornell University Division of Agricultural Engineering (CES) Ithaca, New York (Dr. Keith Porter)	Fertilizers Hydrogeology Nitrogen Modeling Pesticides
Princeton University Department of Civil Engineering Princeton, New Jersey 08540 (Dr. George Pinder) (Dr. Robert Cleary)	Groundwater Modeling Hydrogeology Landfill Leachates

Table B-1 Cont'd.

Agency/Consultant	Main Area of Interest
State University of New York Stony Brook, New York (SUNY) (Dr. Edward Beltrami) (Dr. T. Owen Carroll)	Project Control Plan Critical Pathways Program Schedule
Brookhaven National Laboratory (BNL) Division of Applied Sciences Upton, New York 11972 (Dr James Vaughn)	Viruses
Energy Resources Company, Inc. (ERCO) 185 Alewife Brook Parkway Cambridge, Massachusetts 02138 (Ronald Beck)	Cost/Benefit Analyses Environmental Impacts
Geraghty and Miller, Inc. (G&M) Consulting Hydrogeologists 44 Sintsink Drive East Port Washington, New York 11050 (David Miller)	Groundwater Quality and Quantity Hydrogeology
Tetra Tech, Inc. (TT) 496 Smithtown By-Pass Smithtown, New York 11787 (Gary Bigham)	Analyses of Structural Alternatives Surface Water Modeling Water Quality Assessments
R. F. Weston (RFW) 1044 Northern Boulevard Roslyn, New York 11576 (John DeFilippi)	Cost of Structural Alternatives Point and Non-Point Sampling Program Structural Alternatives Wastewater Management Options
Woodward-Clyde Consultants (W/C) 2909 West 7th Avenue Denver, Colorado 80204 (Daniel Rabinowitz)	Hydrogeology Well Drilling Program

Table B–2

DATA AVAILABILITY vs. GEOGRAPHICAL AREA

Data Type	Western Long Island Sound	Nearshore Atlantic	Manhasset Bay	Hempstead Harbor	Oyster Bay	Huntington Bay	Port Jefferson	Peconic-Flanders System	Moriches Shinnecock System	Mecox Bay	Great South Bay	South Shore Bays (Nassau)	Nassau County (General)	Suffolk County (General)
Alternative Analysis			✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Administration													✓	✓
Biology	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓		
Chemistry	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Data Acquisition	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Demography													✓	✓
Ecology			✓	✓	✓	✓	✓	✓			✓	✓		
Economics													✓	✓
Geology			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Hydrogeology			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Legal													✓	✓
Meteorology		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Microbiology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Modeling			✓	✓	✓	✓	✓	✓			✓	✓		
Nutrient Chemistry	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Physical Oceanography	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Toxicology													✓	✓
Residuals													✓	✓
Point Sources	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Non-Point Sources			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Trace Organics													✓	✓
Non-Modeled Areas	✓	✓							✓	✓				
Modeled Areas			✓	✓	✓	✓	✓	✓		✓	✓	✓	•✓	•✓

• — Indicates groundwater models
✓ — Indicates data available

Table B—3

DATA AVAILABILITY vs. AGENCY AND CONSULTANT

Data Type	NSRPB	USGS	SCSWCD	NYDEC	SCDEC	SCDHS	SCWA	NCDH	NCPD	NCDPW	IDEC	CES	Princeton University	SUNY	BNL	ERCD	G&M	TT	RFW	W/C
Alternative Analysis	✓									✓								✓	✓	
Administration				✓					✓	✓				✓						
Biology			✓	✓	✓			✓								✓		✓		
Chemistry			✓	✓	✓	✓	✓	✓				✓	✓				✓	✓		
Data Acquisition	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓
Demography	✓	✓							✓											
Ecology																✓				
Economics	✓				✓					✓						✓			✓	
Geology		✓	✓				✓					✓	✓				✓			✓
Hydrogeology		✓					✓					✓	✓				✓		✓	✓
Legal	✓			✓					✓			✓								
Meteorology					✓		✓						✓		✓					
Microbiology					✓	✓		✓			✓				✓			✓		
Modeling												✓	✓	✓				✓		
Nutrient Chemistry					✓			✓				✓						✓		
Physical Oceanography					✓													✓		
Toxicology												✓								
Residuals					✓	✓													✓	
Point Sources				✓	✓			✓		✓			✓				✓	✓	✓	
Non-Point Sources			✓		✓	✓		✓		✓		✓					✓	✓	✓	
Trace Organics						✓	✓	✓								✓				

✓— Indicates data available

Table B—4

CROSS-REFERENCE OF DATA TYPES CONTAINED IN INDIVIDUAL REPORTS COMPILED IN NSRPB 208 STUDY

Ref. No.	Type	Alternative Analysis	Administration	Biology	Chemistry	Data Acquisition	Demography	Ecology	Economics	Geology	Hydrogeology	Legal	Meteorology	Microbiology	Modeling	Nutrient Chemistry	Physical Oceanography	Pollutant Sources	Toxicology	Residuals
1	P		(x)																	
2	P		x												(x)					
3	S			x										(x)						
4	S			x										(x)						
5	P			x										(x)						
6	P				x						x		—						(x)	
7	S				x		—				(x)			—		—		—		
8	P				—		—			—	x				(x)					
9	P						x												(x)	
10	P				—		—												(x)	
11	P				(x)		x									—				
12	S	(x)				—	—	—							—			—		
13	S	(x)				—	—	—							—			—		
14	P				—		—			—	x				(x)					
15	P				—		—			—	x				(x)					
16	P				(x)	—					x							—		
17	P		(x)																	
18	S	—	—			x		(x)												
19	S											x					(x)			
20	S	x	—			—		(x)												
21	S	—	—					(x)												
22	S		—			—														
23	S	—	—			—		(x)												
24	S	—	—					(x)												
25	P				(x)	—					x							x		
26	P				x	(x)														
27	P				x	(x)					x									
28	P				x	(x)					x									
29	P	x		x	x			(x)	—					x	—	x	x	x		—
30	P	x		x	x			(x)	—					x	—	x	x	x		—
31	P	(x)						x	x									x		x
32	P					x	x			x	(x)	—						—		—
33	P					—	x				(x)									
34	P		(x)								x									
35	P									x	(x)									
36	P		(x)								x							x		x
37	P						—				(x)							x		x
38	P						—				(x)							x		x
39	S		x																	(x)
40	S		—								(x)							x		
41	S		—									(x)								
42	S		(x)																	
43	S				x	(x)					x									
44	P		—				(x)													
45	P		(x)																	
46	P		—												(x)					
47	S									—	x	(x)								
48	P					x				x	(x)				x					
49	P					x				x	(x)				x					
50	P					x				x	(x)				x					
51	P									(x)										
52	P			x		x						x						x		(x)

(x) — major emphasis, but may include other minor topics or data
x — data with discussion
— — data presented but discussion minimal or lacking

Table B—4 (cont'd.)

CROSS-REFERENCE OF DATA TYPES CONTAINED IN INDIVIDUAL REPORTS COMPILED IN NSRPB 208 STUDY

Ref. No.	Type	Alternative Analysis	Administration	Biology	Chemistry	Data Acquisition	Demography	Ecology	Economics	Geology	Hydrogeology	Legal	Meteorology	Microbiology	Modeling	Nutrient Chemistry	Physical Oceanography	Pollutant Sources	Toxicology	Residuals
53	S											(x)		x						
54	S																	(x)		x
55	S										x							(x)		x
56	S	(x)									x							—		—
57	S				x	(x)														
58	P	x			x	x							—	x	(x)	x	x	x		
59	P	x			x	x							—	x	(x)	x	x	x		
60	P	x			x	(x)								x		x	x	x		
61	P		(x)												x					
62	P	x			x	(x)								x		x	x	x		
63	P				x	(x)								—	—	—	—	—		
64	P	x			x	x							—	x	(x)	x	x	x		
65	P			(x)																
66	P	x			x	x							—	x	(x)	x	x	x		
67	P		(x)							x					x					
68	P				x	(x)								x		x	x	x		
69	P				x	(x)								x		x	x	x		
70	P				x	(x)								x		x	x	x		
71	P		x		—	—							—	—	(x)	—	—	—		
72	P	x			x	x							—	x	(x)	x	x	x		
73	P	x			x	x								x	(x)	x	x	x		
74	P				x	(x)								x		x	x	x		
75	P					x							—		(x)					
76	S											(x)					x			
77	P				x	(x)								x		x	x	x		
78	P				x	(x)								x		x	x	x		
79	P			x		x								x			(x)			
80	P	(x)			x									x		x	x	x		
81	P				x	(x)								x		x	x	x		
82	P				x	(x)							—	x	(x)	x	x	x		
83	P				x	(x)								x		x	x	x		
84	P		—		—	x								—	(x)	—	—	—		
85	P	x			x	x							—	x	(x)	x	x	x		
86	P	x			x	x							—	x	(x)	x	x	x		
87	P	x			x	x							—	x	(x)	x	x	x		
88	P		—			x									(x)					
89	P	(x)			x	x								x	(x)	x	x	x		
90	P				x	(x)								x		x	x	x		
91	P		—		—	—								—	(x)	—	—	—		
92	P	x								x	x				(x)					
93	P	x								x	(x)							x		
94	P	x								x	(x)									
95	P	x								x	(x)				(x)					
96	P				x	x	x											x		x
97	P	(x)			x	x	x											x		x
98	P	(x)			x	x	x											x		x
99	P	(x)			x	x	x											x		x
100	P		(x)																	
101	P						(x)				x					x		(x)		
102	P				x	x	x				—		x	x		x		(x)		
103	P				x	x	—				—			x		x		(x)		
104	P				x	x	—				—			x		x		(x)		

(x) — major emphasis, but may include other minor topics or data
x — data with discussion
— — data presented but discussion minimal or lacking

Table B–4 (cont'd.)

CROSS-REFERENCE OF DATA TYPES CONTAINED IN INDIVIDUAL REPORTS COMPILED IN NSRPB 208 STUDY

Ref. No.	Type	Alternative Analysis	Administration	Biology	Chemistry	Data Acquisition	Demography	Ecology	Economics	Geology	Hydrogeology	Legal	Meteorology	Microbiology	Modeling	Nutrient Chemistry	Physical Oceanography	Pollutant Sources	Toxicology	Residuals
105	P													x		x		(x)		
106	S													x		x		(x)		
107	P													x		x		(x)		
108	S	(x)												–		–		–		
109	P													x		x		(x)		
110	P	x																x		(x)
111	P		(x)								–									
112	S		(x)								–									
113	P										x									
114	P		(x)								–									
115	P	(x)							x									x		x
116	P	(x)							x									(x)		
117	P	(x)				–			x		–							x		x
118	P										–	(x)								
119	S									–	x				(x)	x				
120	S	(x)									x							x		–
121	P											–		x				(x)		
122	S									x	x					x		(x)		
123	P										–					(x)		x		
124	P	(x)							(x)									x		
125	P										x					x		(x)		
126	P									x	(x)									
127	P									x	(x)									
128	P	–												x	–	x	x	x		
129	P													x	–	x	x	x		
130	P																	x		
131	P				x	x							x	x		–		(x)		
132	P					x											(x)			
133	P			x	x	x										–	–	x		
134	P			(x)	x	x										–	x			
135	P					x				x	(x)		x							
136	P					x					x									
137	P				x	x							x	x		x		x		
138	P				–							x		–				(x)		
139	P			x								–		x						
140	S											x								
141	S											x								
142	S											x						–		
143	P			x				x				x								
144	P				x	x								x		x	–			
145	P				x	x								x		x		x		
146	P				x	x								x		x		x		
147	P		x				x					x								
148	P			x	x									x	–	x	–	–		
149	P				–		x					–						x		
150	P				x									x				x		
151	P				–							x		–				–		
152	P				–									–	–	–		x		
153	P				–									–		–		x		
154	P	x	–						–									x	–	
155	P	x							–									x	–	
156	P	x			–				–					–		–		x		

(x) — major emphasis, but may include other minor topics or data
x — data with discussion
– — data presented but discussion minimal or lacking

BIBLIOGRAPHIC SUMMARY

Primary and Secondary Data Sources Generated During Nassau-Suffolk 208 Study. *Primary sources are those developed or used as main data inputs for the 208 Study. Secondary sources are reports or data relevant to 208 as background information, but not specifically used in calculations or included in data analysis.*

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Note: In the text, all Subparts are referred to as Sections, e.g., Section a is Subpart a.

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Appendix C

MEMORANDA OF UNDERSTANDING BETWEEN
THE SUFFOLK COUNTY DEPARTMENTS OF HEALTH SERVICES
AND ENVIRONMENTAL CONTROL

I. Memorandum of February 10, 1972

This memorandum is an agreement between the Departments of Health and Environmental Control regarding the transfer of the Department of Health functions to the Department of Environmental Control based on the charter law which established the Department of Environmental Control and understandings previously agreed upon. It is understood that further changes may be considered from time to time to clarify the respective roles of the two departments.

The Department of Environmental Control and the Department of Health hereby agree that effective February 1, 1972, the Department of Environmental Control is responsible for environmental management, protection and control; the Department of Health is responsible for personal and public health services and protection and control. It is agreed that the two departments will cooperate with each other in the exchange of information and by coordination of services in which both departments share a mutual concern.

The attached exhibit contains the specific allocation of responsibilities as between the two departments and it is agreed that each department will provide its full cooperation in giving service to the public in accordance with this memorandum and the attached exhibit.

Dated: February 10, 1972
Signed: George E. Leone, M.D., Commissioner of Health
John M. Flynn, P.E., Commissioner of Environmental Control

EXHIBIT I
DIVISION OF RESPONSIBILITIES
SUFFOLK COUNTY DEPARTMENT OF ENVIRONMENTAL CONTROL
AND SUFFOLK COUNTY DEPARTMENT OF HEALTH

*Primary Contact—DEC except starred items which are Health

Air Pollution	D.E.C.	Health
All monitoring and other activities	X	
Open burning	X	
Incinerator inspections (for operations)	X	
Plan review (incinerators)	X	
Primary contact	X	
Solid Waste		
Planning	X	X
Research	X	
Liaison with towns		
(re: comprehensive planning)	X	
(re: solid waste district)	X	
(re: operations landfill)		X
Monitoring volumes	X	
Contracts with Environmental Facilities Corporation		
(comprehensive planning)	X	
(sites)		X

EXHIBIT I . . . Cont'd.

Enforcement—land			X
Surface or groundwater	X		
Truck permits			X
Inspection—landfill			X
Storage—garbage			X
Site permits			X
Primary contact			X
Water Pollution Control			
Planning	X		
Design	X		
Plan, review and approval			
*under 30,000 gallons per day (cesspools)			X
plant and collection system (sewers)	X		
Inspection—construction			
*cesspools			X
plant and collection system	X		
Operation	X		
Maintenance	X		
Development of standards	X	jointly	X
Training and approval of operators	X	jointly	X
Sewer permits			
Communal collection and treatment	X		
*Cesspool			X
Enforcement			
*Surface water pollution (cesspools)			X
Surface water pollution (other sources)	X		
*Groundwater pollution (cesspools)			X
Groundwater pollution (other sources)	X		
Industrial wastes (includes launderettes & duck farms)	X		
Sewage treatment plants			
Other than county	X		
*County-owned (monitoring effluent only)			X
Scavenger waste treatment facilities	X		
*Trucks—permit			X
Realty Subdivisions			
Standards development	X	jointly	X
*Approval	X	jointly	X
Water Resources			
Lab—chemical	X		
Lab—chemical and bacteriological			X
*Individual wells			
*Plan, review and approval			X
*Inspection and construction			X
*Final approval			X
*Sample district system			X
*Customer complaints			X
*Development of standards			X
*Training and approval of operators			X
*State Sanitary Code			
*Enforcement regarding water supply			X
*Section 444 of Conservation Law (State Health Department)			X
*Bathing beach standards and sampling			X
*Detergent ban enforcement			X
Comprehensive planning	X		X
*Review new water supply projects for approval to DEC	X		X
*Plan review and construction inspection supply projects			X
Groundwater monitoring wells	X		
*Groundwater supply wells			X
*Stream and lakes bathing			X
Stream and lake monitoring	X		
Other			
Insect and pest monitoring and control	X		X
Thermal discharges	X		
Oil spills	X		
Boat toilets	X		
Radioactive wastes	X		X
*Monitoring			X
Monitor marine waters	X		
*Monitoring bathing waters			X

MEMORANDUM OF UNDERSTANDING BETWEEN SUFFOLK COUNTY DEPARTMENTS OF HEALTH SERVICES AND ENVIRONMENTAL CONTROL

2. Memorandum of March 9, 1977

This memorandum supersedes the Memorandum of Understanding between the Suffolk County Departments of Health Services and Environmental Control dated February 10, 1972; however, any areas not covered by this agreement shall be governed by the prior Memorandum of Understanding.

The intent of this memorandum is to delineate the responsibilities of each department in order to minimize overlap of jurisdiction and duplication of effort.

It is agreed that the two departments will cooperate with each other in the exchange of information and data and by coordinating programs in which both departments have a mutual concern.

The specific allocations of responsibilities between the two departments follow:

Air Pollution

It shall be the responsibility of the Department of Environmental Control to monitor and control all forms of ambient air pollution and to carry out all the necessary functions as the local agent for the New York State Department of Environmental Conservation. The Department of Health Services' activities in air pollution control shall be limited to inspecting, monitoring and enforcing standards for air pollution in connection with county-owned facilities operated by the Department of Environmental Control.

Solid Wastes

The Department of Health Services shall continue its activities in the control of solid waste storage and transportation and the monitoring of landfill operations as a local agent for the State Department of Environmental Conservation. The Department of Environmental Control, also a local agent for the State Department of Environmental Conservation, shall be responsible for comprehensive planning for solid wastes and for water and air pollution related to solid waste treatment and disposal facilities.

Water Pollution Control

The Department of Environmental Control shall be responsible for controlling sewage and industrial waste collection, treatment and disposal, with the exception of individual subsurface sewage disposal facilities which shall continue to be under the jurisdiction of the Department of Health Services. The Department of Health Services will continue to make the determination as to when sewage treatment facilities will be required for new privately-owned facilities under 30,000 gallons per day flow. It is understood that in some environmentally fragile areas, this flow limitation may be modified. The definition of what constitutes a fragile area will be formulated jointly by both departments. When a sewage treatment plant is required, the Department of Environmental Control will, from that point on, handle all aspects of the project.

The Department of Health Services will continue to inspect, monitor and enforce standards in connection with sewerage facilities owned by the county and operated by the Department of Environmental Control as the local agent for the State Department of Environmental Conservation, while in all other instances the Department of Environmental Control will act as the local agent for the State Department of Environmental Conservation.

The Department of Health Services will continue to carry out an inspection program for scavenger waste vehicles and enforcement of the local detergent ban legislation, while all other aspects of controlling water pollution at the county level will be the responsibilty of the Department of Environmental Control

Realty Subdivisions

The Department of Health Services will continue to be responsible for all aspects of water supply for realty subdivisions and for determining when communal sewage collection and treatment are required, except as specified in Section 277–5 of the Town Law. The determination of the type of communal sewage collection and treatment facility shall be the responsibility of the Department of Environmental Control (Sewer Agency).

Water Resources

Each department will continue to operate its own laboratory facilities.

The quality and adequacy of drinking water supplies, both publicly and privately owned, shall be the responsibility of the Department of Health Services. The Department of Environmental Control shall have responsibility for ground and surface waters. This agreement is not intended to limit either department in exercising its respective responsibilities for protection of water resources.

The Department of Health Services shall be responsible for monitoring all waters in the county, both fresh and marine, in connection with enforcement of bathing water standards.

The Department of Environmental Control shall be responsible for monitoring of all fresh and marine waters in the county, in connection with standards other than enforcement of bathing water standards.

Other

The Department of Health Services shall continue to be responsible for control of the reservoirs and vectors responsible for disease transmission.

The Department of Health Services shall continue to be responsible for monitoring and control of radioactive materials and ionizing radiation in the county Both the Department of Health Services and the Department of Environmental Control have responsibility for monitoring and control of radioactive materials released into the environment.

The Department of Environmental Control shall be responsible for the control of thermal discharges, oil spills and boat sewage discharges at the county level.

This agreement shall be amended from time to time to reflect any pro-

posed control of new areas of environmental concern not covered in this document.

It is agreed that each department will cooperate fully in carrying out the terms and spirit of this agreement.

Dated: March 9, 1977
Signed: David Harris, M.D., M.P.H.
Acting Commissioner of Health Services
John M. Flynn, P.E.
Commissioner of Environmental Control

Map Section

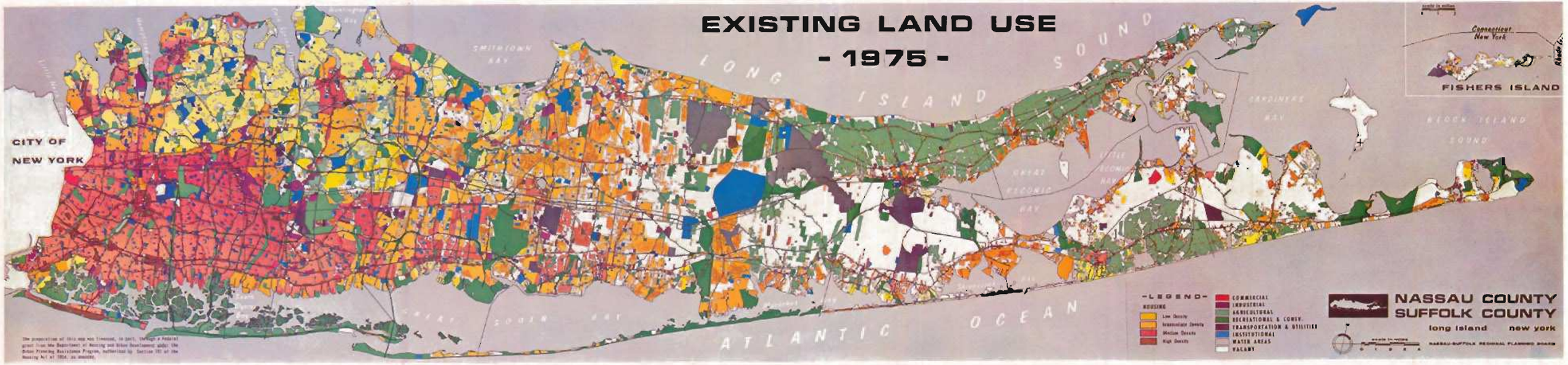
EXISTING LAND USE
- 1975 -
CITY OF NEW YORK
SMITHTOWN BAY
LONG ISLAND SOUND
GREAT SOUTH BAY
ATLANTIC OCEAN
GREAT PECONIC BAY
LITTLE PECONIC BAY
GARDINERS BAY
BLOCK ISLAND SOUND
FISHERS ISLAND
Connecticut
New York
-LEGEND-
HOUSING
Low Density
Intermediate Density
Medium Density
High Density
COMMERCIAL
INDUSTRIAL
AGRICULTURAL
RECREATIONAL & CONSV.
TRANSPORTATION & UTILITIES
INSTITUTIONAL
WATER AREAS
VACANT
NASSAU COUNTY
SUFFOLK COUNTY
long island new york
NASSAU-SUFFOLK REGIONAL PLANNING BOARD

Figure 2-1

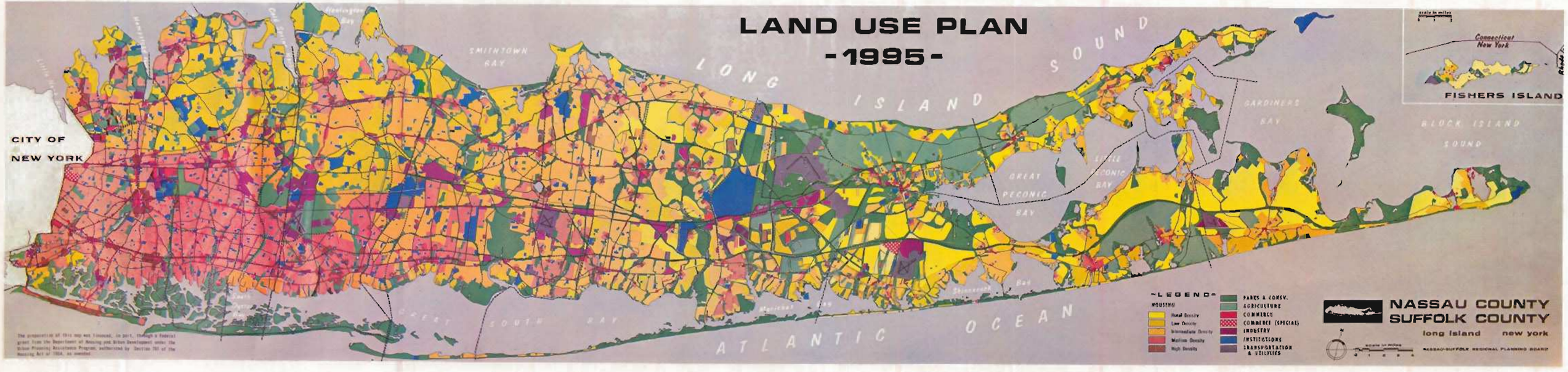
LAND USE PLAN
-1995-
CITY OF
NEW YORK
SMITHTOWN
BAY
LONG
ISLAND
SOUND
GREAT
PECONIC
BAY
GARDINERS
BAY
BLOCK ISLAND
SOUND
FISHERS ISLAND
Connecticut
New York
GREAT SOUTH BAY
ATLANTIC OCEAN
-LEGEND-
HOUSING
Rural Density
Low Density
Intermediate Density
Medium Density
High Density
PARKS & CONSV.
AGRICULTURE
COMMERCE
COMMERCE (SPECIAL)
INDUSTRY
INSTITUTIONS
TRANSPORTATION
& UTILITIES
NASSAU COUNTY
SUFFOLK COUNTY
long island new york
NASSAU-SUFFOLK REGIONAL PLANNING BOARD

Figure 2-2