A METHODOLOGY TO ACHIEVE THE INTEGRATION OF COASTAL ZONE SCIENCE AND REGIONAL PLANNING

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Introduction

The Nassau-Suffolk Regional Planning Board was established in 1965 to develop a comprehensive plan which could address the problems stemming from the area's rapid and virtually uncontrolled development. This planning agency, assisted by a "701" grant from the United States Department of Housing and Urban Development (HUD), completed the Comprehensive Development Plan in 1970. It emphasizes the following broad planning goals:

1. The control of the pace of development.
2. The provision of adequate employment opportunities.
3. The development of a balanced transportation system.
4. The preservation of the existing housing stock with sufficient new construction.
5. The preservation of open space and the protection of the area's natural environment.

These goals forced the explicit recognition of the importance of the marine environment in the region's development. In 1965, the Board created an Oceanographic Committee to study the implications of development on the region's marine environment. A Committee report, "The Status and Potential of the Marine Environment," published in December 1966, included an assessment of the present value and economic potential of Long Island's marine resources. The Committee concluded that it would be necessary to halt the increasing adverse pressures on these resources. The Committee also identified those activities which have significant impact on the marine environment, and emphasized the inadequacy of existing knowledge and management programs to deal with these problems.

Acting on the recommendation of the Committee, the Regional Planning Board created a Regional Marine Resources Council to develop a research program to obtain knowledge relating to the marine environment, and to design a method to incorporate the research findings in a management-oriented program. The Council membership is divided among voting and advisory members who represent academic, commercial, governmental, and environmental interests in the two counties. Generally, advisory members are drawn from those Federal, State and local agencies which have a direct interest in the management of the marine environment.

In 1967, this Council initiated a program to identify the knowledge that would be required to develop a management system for Long Island's marine resources. A consultant, the Travelers Research Corporation, was engaged to provide the initial research and systems analysis. This firm developed a research program consisting of a series of functional and inter-related steps along with an initial framework for classifying environmental problems. They identified 17 marine-related problems in the Long Island area and four of these, water supply and wastewater disposal, dredging and spoil disposal, coastal protection, and wetlands, were selected for subsequent analysis.[1] Studies were undertaken with the support of the Sea Grant Program covering the specific issues of these marine environmental conditions.

[1] A total of fourteen research reports were prepared by Travelers Research and its successor, The Center for the Environment and Man, Inc. (Hartford, Conn.). A list of publications prepared under Regional Planning Board and Marine Resources Council auspices is found in an annotated bibliography appended to this document.

Based on this research, the Regional Marine Resources Council adopted a series of marine environmental guidelines and recommended them to the Planning Board in the Spring of 1973. These guidelines in the areas of water supply and wastewater disposal, dredging, coastal protection, and wetlands were adopted by the Planning Board and are presently available to interested persons.

As a supplement to its research activities, the Council initiated several technical seminars led by various agencies. These included: shellfish management (N.Y.S. Department of Environmental Conservation); wastewater treatment and disposal (Environmental Protection Agency, U.S. Geological Survey, Army Corps of Engineers); wetlands management (U.S. Department of Commerce, National Oceanic and Atmospheric Administration); dredging, dredge spoil disposal, beach erosion, and coast stabilization (Army Corps of Engineers); oil spill prevention and cleanup (U.S. Coast Guard); and the use of energy conservation measures and alternative energy sources (Regional Marine Resources Council). Current projects include an investigation of the probable effects of potential oil and gas production on the outer continental shelf off Long Island, and the development of management guidelines for Long Island's hard clam resources.

One result of these research efforts was the realization that a link was missing between the production of scientific information and knowledge, and the planning and management process. The bi-county area has a completed and partially adopted comprehensive plan. There are implicit and explicit policy recommendations in the Plan that affect the marine environment. Yet much of this work was based on the knowledge existing at the time of Plan development. Perhaps the new data would suggest modifications to the Plan. A further concern is that some relevant existing natural science information may not have been input into the Plan due to the difficulty of translation. Most natural scientists, either by training or personal philosophy, appear loath to present their findings in non-technical jargon or to discuss the normative and policy implications of their work. This places the burden on the planners of determining the relevance and applicability of the scientists' contributions.

This project, *The Analysis and Development of Guidelines for the Integration of Comprehensive Planning and Coastal Management,*[2] is an attempt to integrate the techniques and aims of traditional land use planning and environmental management by considering them in terms of a single activity complex. The effort incorporates and builds upon the Planning Board's experience in the development and implementation of a large scale comprehensive land use plan and upon the scientific data relating to the marine environment that has been collected by the Marine Resources Council. The essential tasks of this project, then, are to combine these diverse elements of land use planning and environmental knowledge to yield the following policy oriented objectives:

1. To determine the probable environmental impact of the Comprehensive Development Plan on the marine resources of Long Island and to determine the influence of the marine environment on the land uses and functional components of the Plan.
2. To identify and recommend modifications to the Plan which can minimize its adverse effects on marine resources.
3. To recommend an institutional framework for implementing the modified Plan based on an assessment of political and economic feasibility.

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[2]This research proposal was submitted to the Office of the Assistant Secretary for Policy Development and Research and was approved for contract on July 1, 1973.

4. To evaluate the transferability of the project's methodology and findings.
5. To prepare a set of guidelines for the integration of comprehensive planning and coastal zone management which can assist decision-makers in other areas.

The project is composed of nine tasks. This paper — Task 1 — represents the first step, namely, the design of a methodology for the entire effort.

Task 2 is the primary inventory segment of the project. Land uses and activities contained in the plan that are related to, or are part of, the marine environment will be identified. The impacts of these uses on the natural system will then be identified and quantified. An examination and inventory of existing environmental, legal, and public health standards as they relate to the land use impacts will be made. This task will also attempt to identify the limits or carrying capacities of the natural environment to support various land uses and activities. This work is an extension of the earlier work developed by Travelers Research Corporation in building a cause-environmental condition-effect framework.

Task 3, which will commence simultaneously with Task 2, is concerned with the design and selection of a suitable programming model capable of ordering, classifying, and combining the large amount of data that will be generated in Task 2 for evaluation.

Task 4 is concerned with the development and examination of various alternatives that can minimize the probable marine environmental damage caused by the environmental impacts implied in the Nassau-Suffolk Comprehensive Development Plan. These three tasks involve the natural science input in the overall project.

The successful completion of this project depends greatly on the analytical framework developed for Tasks 2, 3, and 4. This framework is viewed in terms of a resource allocation problem with environmental constraints.

The approach developed by Travelers Research Corporation was to construct a series of "cause-environmental condition-effect" networks. The approach provides us with a "positive" model — analogous, in a sense, to an input-output model. They present a set of functional relationships designed to reflect enough of reality to enable an analyst to make some predictions regarding the probable effects of a change occurring within the system itself. They are not decision tools. It is necessary, therefore, to extend this approach and develop a "normative" model which explicitly introduces goals into the formulation of the problem itself. The overriding requirement is to develop an analytical scheme which presents the decision-maker with various feasible alternatives relating to the efficient allocation of resources to further a set of predetermined social objectives. This problem can be most generally stated in terms of a mathematical programming model in which some objective is to be maximized (or minimized) subject to the existence of one or a number of constraints. In this analysis the objective function relates to the goals of the Plan and the characteristics of the resource base.

The programming framework provides a decision tool that explicitly introduces goals in both the objective function and in the constraints as well. The decision-maker must choose among various and often competing alternatives, and it is the ability to deal with problems of choice that characterizes a programming framework as a decision tool.

We intend to utilize both approaches. Due to the level of the existing knowledge base, some examinations lend themselves more readily to one or the other method. For example, the "cause-environmental condition-effect" approach makes it possible to construct detailed networks representing the probable effects of specific activities, such as

dredging. In contrast, the study conducted by the Sanitary Engineering Research Laboratory and School of Public Health, University of California, Berkeley, sought to develop a model which could provide an optimal plan of waste treatment and waste discharge in the San Francisco Bay region relative to a prescribed water quality standard. This study was designed in terms of a mathematical programming model applied to the problem of optimizing the cost of achieving water quality objectives. Hopefully, the data gained in the cause-condition-effect networks will provide valuable inputs into the programming model.

The remainder of the project subjects the natural science-land use alternatives to an examination in order to achieve economic, political, and environmental feasibility. All of the findings – the failures and the successes – will be discussed and translated into management and planning guidelines for general use in other coastal areas.

Task 5 subjects various alternatives to the Plan's land uses and activities to an economic and political evaluation.

Task 6 seeks to identify the administrative and institutional structure needed to carry out the Plan as it might be modified.

Task 7 represents an attempt to select a mix of feasible Plan alternatives which can satisfy the following criteria: 1) the minimization of probable or implied marine environmental damage, 2) technical and political feasibility, and 3) reasonable cost-effectiveness. This task identifies those changes which will be made in the Plan and their relevant trade-offs.

Task 8 entails a detailed assessment of the project's diverse methodologies in terms of their applicability and transferability to similar types of problems elsewhere in the country.

Task 9 provides a detailed documentation of the entire project and provides a general set of guidelines and procedures for the integration of comprehensive planning and environmental management.

The last two tasks constitute a large measure of the *raison d'etre* for the study. It is true that our provincial interests lead us to seek solutions to the problems of the Nassau-Suffolk region. Yet this area is a segment of the coastal zone of the United States. Within a 50 mile belt of land adjacent to the oceans, the Gulf of Mexico, and the Great Lakes, reside 53 percent of the nation's population. In 1972, the Senate Committee on Commerce commented that some population projections estimate that by the year 2000, about 80 percent of our population may live in the coastal zone. One of the heaviest concentrations of people in the United States is the New York metropolitan region, where almost 18 million people live and work. By 1985, the population of this region is likely to increase by some 6 million.

In recent years, national attention has been directed to problems of coastal zone management. The Coastal Zone Management Act of 1972 is an initial effort in this direction and pending Federal land use legislation will bring additional attention to coastal zone and related land use management problems.

Other Federal programs have also drawn attention to many specific coastal zone problems. Several of these are HUD's Urban Planning Assistance and Flood Insurance programs, NOAA's Sea Grant and Marine Eco-System Analysis programs, EPA's programs designed to combat the problems of air and water pollution, Interior's regulations of the development of outer continental shelf resources, the Coast Guard efforts to contain and

minimize damage from oil spills, and the Corps of Engineers' work on navigation improvement, beach erosion control and wetland protection. Various states have also increased their management efforts in the coastal zone with Massachusetts and New York, as examples, enacting various laws to protect their wetland areas.

Those coastal areas of the United States undergoing rapid urbanization present a planning problem complicated by the interactions of three planning areas. These include urban areas and their surrounding metropolitan communities, rural areas and their interactions with metropolitan areas, and their marine environment which affects and is affected by both.

The rapid development of Nassau and Suffolk counties presents the planner with this very problem. He must deal with an almost totally urban area in western Nassau, a rapidly developing area in the middle of the Island, and rural agricultural sections in eastern Suffolk. The development activities taking place in these areas imply various effects on the region's extensive coastal environment. With the possible exception of certain heavy industry complexes, the planning-environmental problems encountered in Nassau-Suffolk are likely to typify those occurring throughout most of the Nation's coastal zone, namely those conflicts stemming from increased demand pressure on the limited supply of coastal resources.

Therefore, the data, methodology, standards, and guidelines developed in this undertaking should have relevance to other segments of the coastal zone. Even our failures should be of value by enabling other agencies to avoid re-inventing "square wheels."

We consider this paper the first product of the study. Initially one month was scheduled for its completion. Instead, it took 10 months. The first delay was in putting together the environmental science team that is essential to Tasks 2, 3, and 4. Additional time was expended in the review process between our staff and the expert advisors from the various federal agencies. And last but not least, the substance itself required a great deal more thought than originally anticipated. However, when compared with the initial work program design, we feel the time was well spent. The error was not in lost time, but in not appreciating the proper amount of time necessary to do an adequate job. Hopefully, this paper will save other agencies the start-up time of their own projects.

In order to acquaint readers not familiar with the Nassau-Suffolk Region of the essential background for this work, we have divided the book into 3 independent parts. Parts 1 and 2 contain summary discussions of the marine setting of Long Island and the salient elements of the Comprehensive Regional Development Plan. Part 3 contains sequential discussions of the tasks and a description of the objectives, methodology, skills required, levels of effort, anticipated findings, and products for each. Many of the tasks and their component work elements run concurrently. The relationships between tasks in terms of timing and substance are summarized graphically by flow charts.

Within each task, milestones, levels of effort, and skills required to complete the tasks have been identified. As tasks and individual work elements are completed or milestones reached, presentations will be made both to the Regional Marine Resources Council and to the Regional Planning Board. Completed tasks, work elements and other milestone efforts, as well as frequent progress reports, will be submitted to the Government Technical Representative for review and comment.

It is customary at this point in the introduction to thank all and sundry for their valuable contributions and to ascribe all errors and shortcomings to the authors. Instead, I prefer to acknowledge the professional motivation and dedication of my colleagues in bringing the study this far. This certainly includes Dr. Arthur Zeizel – my counterpart on the project representing H.U.D. – whose criticisms, questions and advices greatly sharpened our collective focus. The physical appearance of the book is due to the talent and patience of our compositor, Ms. Newilda LaGrandier of Globe Composition Service.

August 8, 1974 Lee E. Koppelman

Part ONE

THE MARINE SETTING

HISTORICAL

The economic and social history of Long Island from the pre-colonial times of the Pouspatucks, Nissaquakes, Shinnecocks, and other Indian tribes to the present, indicates a heavy dependency on the marine environment.

Long Island waters offered the Indian a rather continuous and ample protein diet to be had literally 'for the picking'. Archeological research indicates that most of the tribes located their encampments near the water.[1]

Many of the first white settlers, arriving from New England in the mid-seventeenth century, had to rely heavily on seafood until the ground was broken, sown, and harvested. This hardy breed of people were not strangers to the sea. They brought with them a heritage and knowledge of shipbuilding, fishing, and sailing. It was quite natural that marine activities flourished. Fishing fleets sailed from Greenport and other eastern ports to the Grand Banks, whalers from Sag Harbor sailed the world, and for 300 years, baymen and lobstermen have collected a rich return from the harvesting of clams, oysters, scallops, crabs, and lobsters.

Freight haulage to New York City and New England markets was an established practice by the early nineteenth century. Cordwood cut in central Suffolk County was loaded aboard schooners in Smithtown and shipped on a regular basis.[2] Industrial and agricultural technology began to have an impact on marine activities by the mid-nineteenth century. Rail service supplanted water-borne haulage, and improved agricultural production lessened the demand on sea products. The discovery of petroleum and natural gas, and the later use of electricity for illumination, reduced interest in whaling. The 1849 gold strike in California also played a significant role in the demise of Long Island's deep-water fishing industry. It was far more profitable to carry miners around the Cape to California than to search for whales or fish. In addition, many sailors deserted their ships to join in the search for gold.

With the exception of certain limited aspects of Commerical fishing, there has been a steady decline in the marine economy from the 1850's to the present. A similar relative decline characterizes the national industry as well.[3] In 1964, for example, the United States fish catch ranked fifth with 5.1 per cent of the world's total.[4]

Perhaps the pioneering efforts related to pushing the frontiers westward, the emphasis on industrial development, abundant high quality food, the political concept of isolation, and other factors, have all been responsible for the lack of emphasis on the marine environment. However, there is now a resurgent interest in this field.[5]

The nation's space program has indicated areas of parallel interest with submerged space problems. Off-shore petroleum has enticed private investment in exploration and the need to improve technologies and techniques has resulted in both pure and applied research programs.

Interest in ocean or marine activities was generated on Long Island as a result of growing national interest, and by concern for the local employment base. During 1962-1963, the Republic Aircraft corporation discharged approximately 10,000 workers. This represented 1.6 per cent of the combined Nassau-Suffolk resident labor force.[6] Subsequently, the unemployment rate in Suffolk County rose from 4.5 per cent to over 7 per cent. There has been a realization that the stabilization of the defense-oriented economic base of Long Island was endangered by fluctuations in defense spending. Several studies have called for the diversification of industrial activity to provide additional jobs and to cushion the effects of defense-related dislocations. The existing marine industries have also tried to enlist governmental action to protect the marine environment. The rapid urbanization of Long Island and its associated environmental and economic effects, e.g., dredging, wetland loss, pollution, and higher land values for shorefront facilities, has contributed to the decline of the area's marine industry. Citizen conservation groups were formed to lobby for intelligent planning of the Island's resources. The Nassau-Suffolk Regional Planning Board created a subcommittee on oceanography to respond to these needs.

GOVERNMENT AND ADMINISTRATION

On April 26, 1965 the Board determined to include a major section related to the marine environment in the development of the bi-county comprehensive plan. The Board hoped to achieve an understanding of the opportunities and problems arising from the effects of increased population on the marine environment and to relate this knowledge to an action program.

On June 30, 1965, a committee was selected with representation from industry, finance, education, research, and regional planning. At the first formal meeting of the committee, held on September 15, 1965, it was agreed that the following broad objectives would be established:

1. The Oceanographic Committee of the Nassau-Suffolk Regional Planning Board will examine the contributions which marine resources can make to the economic and cultural development of Long Island. In doing this, the Oceanographic Committee will attempt to identify and concentrate on those aspects of Long Island's geography which give it a competitive advantage.
2. The Oceanographic Committee will attempt to outline and set priorities for programs of industrial and public support, for various levels of education, and policies that will increase the Island's advantages and promote its industry.

The Committee held a total of 41 meetings. More than 50 witnesses appeared, and 12 papers were submitted by interested individuals or organizations.

At the start of the Committee's activities it appeared that there were two separate areas of interest. These were:

1. Opportunities on Long Island to participate in the growing national oceanographic and ocean engineering programs.
2. Oceanographic problems growing out of the effects of population expansion on Long Island's marine environment.

As the work progressed, it became evident that the two areas of interest were inseparable. It also became apparent that the study and action required to preserve a favorable marine environment provided an opportunity for Long Island to become a center of oceanographic activity and a major participant in the growing national oceanographic and ocean engineering program.

From a planning point-of-view there are three factors of overriding importance to the growth and development of Long Island.

1. The long narrow shape of Long Island.
2. The proximity of Nassau and Suffolk Counties to the Greater New York City area.
3. The complex marine environment of Long Island with its extreme sensitivity to the effects of population expansion.

Long Island's shape and proximity to New York City are unalterable, but the complex marine environment is all too alterable. Population expansion on the Island has caused serious deterioration of a marine environment which has been a major contributing factor to its attractiveness and growth.

PHYSICAL CHARACTERISTICS

Location

The stream, lake, river, ocean, bay, and sound shorelines of Nassau and Suffolk Counties have a total frontage exceeding 1,000 miles. Long Island Sound on the north, and the Atlantic Ocean on the south and east, afford a unique setting 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. These Bays are connected with the ocean through Jones, Fire Island, Moriches, and Shinnecock Inlets. This portion of the Long Island peninsula is over 100 miles long with its maximum width, 20 miles, near the Nassau-Suffolk boundary. The major land area extends eastward from the Queens-Nassau border for approximately 60 miles to Riverhead. At Riverhead the land mass breaks into two peninsulas, or forks. The north fork is about 20 miles long and terminates at Orient Point. The southern fork is about 45 miles long and terminates at Montauk Point. The total land area of the two counties is approximately 1,200 square miles.

Topography

The topography is uniform with a gentle to moderate slope from the north to the south shore. A high ridge of glacial origin runs approximately east and west from the north westerly corner of Nassau County. It runs in a southeasterly direction through Suffolk and 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 south shore

bays.[9] Four main river watershed valleys 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 which runs through the Towns of Riverhead, Brookhaven and Southampton.[10]

Geological Description

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. This rock floor lies close to the surface in northwest Nassau, and slopes downward in a southeasterly direction to a depth of some 2,100 feet below sea level in the vicinity of Fire Island. The subsoil is generally sandy of yellow color except on the ocean side of the south shore dunes which are light gray sea sand. The topsoil is well suited for agricultural uses. 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 hardwoods and evergreens.

Water Supply

The water supply is obtained entirely from groundwater. Natural replenishment of this supply is derived solely from precipitation which averages 42 inches per year. Due to losses from evaporation, stream flow, and other factors, only part of this precipitation ever reaches the water bearing strata, and it has been estimated that approximately 50 per cent of the precipitation is lost. On the basis of past experience and engineering projections, the groundwater reservoir appears to be adequate to serve a population of approximately 3 million.

WETLANDS

Description

The marine environment of Nassau and Suffolk Counties includes all the bays and barrier islands, the Long Island Sound, the inner tidal zones, the estuarine creeks, and the salt marshes. There are two broad types of wetlands — fresh water and marine or brackish wetlands. The area's fresh water wetlands are found along the Carmans, Peconic, and Connetquot Rivers, and a portion of the Nissequogue River.

The marine wetlands, including the estuaries, creeks, and other drains which allow fresh water runoff from the mainland to flow into the various bays and harbors, have a salinity which ranges from virtual fresh water to waters approaching the salinity of the ocean itself.

The brackish environment is unique. These shallow waters — less than eight or 10 feet — are prime shellfish producing areas. Fresh water runoff dilutes ocean salt water to a brackish state that is vital for the propagation of shellfish. The nature of the bottom varies from silt to mud to sand and gravel and is an important factor in marine productivity.

Marine Environment

The diverse salinities and temperatures of estuarine marshes and the off-shore waters, contain a variety of shell-and finfish. The inland fresh waters, particularly in Suffolk County, contain large numbers of trout and bass.

Some marine biologists consider the lower or tidal zone — characterized by *Spartina alterniflora* — as having a higher value than the high marsh zone — characterized by *Spartina patens. Spartina patens* is found in that zone of marsh quite common on the shores of bays which are only flooded by lunar and storm tides. Other marine ecologists claim that the differentiation is not necessary since both areas are productive.[12] Much the same argument has gone on relative to bottom type, but with the exception of a bottom composed of duck sludge, the various bottom types all seem to be productive.

The entire marine eco-system complex is vital for shellfish, finfish, waterfowl, many invertebrates, and the entire biological chain which depends on the quality of this environment. This environment serves as a source of food and recreation, including fishing, crabbing, and clamming, and provides a substantial portion of Long Island's economic base.

The success of this environment, in an ecological sense, depends on the protection of the entire food chain where each group of animals or plants plays a very important role. According to research on the Georgia marshes,[13] the *Spartina alterniflora* marsh is the most productive vegetation in the world. Vegetable matter is decomposed in the water and then detrited with all the carbohydrates, proteins, fats, and vitamins, providing food for microscopic life. It is reasonable to

believe that the marine complex of shallow bays, small estuaries, and salt marshes, found on Long Island is one of the primary contributing factors to the rich wildlife found along the Atlantic seaboard, and that the wetlands are vital to the entire range of shellfish, finfish, and waterfowl that inhabit these areas.

Construction Restraints on the Natural Environment

Wetlands are destroyed by landfill operations, dredging, and home construction. The most desirable residential areas in both counties have been, and still are, along the peripheral shore areas. The highest residential land values occur on those building sites adjacent to, or contiguous with, water frontage. The tremendous demand for buildable land in Nassau and Suffolk Counties has placed a significant burden on our ability to protect this natural resource. A lake or any kind of waterfront land is a valuable asset for the developer and for people who live nearby. Water frontage creates low maintenance open space, provides many kinds of recreation facilities, and is so popular that it increases surrounding land values up to five or ten times. Almost any kind of water helps a developer to sell in a competitive market. As a result, many areas of Nassau and Suffolk Counties, particularly along the south shore, have been under heavy development pressure. Most of the wetlands lost over the past twenty years was due to the filling in of marsh and subsequent bulkheading for residential construction.

Filling in marshes to make saleable real estate must be recognized as a significant threat. Between 1954 and 1959, over 13 per cent of Long Island's wetlands were destroyed by land-fill projects.[14] Over the years, it is estimated that approximately 25 per cent of the wetlands have been destroyed. It is obvious that if this practice continues the marine environment must suffer.

Value of Wetlands

Wetlands are among the most productive of all lands[15] and estimates have been made of the shellfish yield per acre in various tidal flats and bays in Suffolk County.[16] Approximately 50 per cent of the tidal flats of Mount Sinai Harbor, for example, had a clam yield of 36 bushels per acre to a high of 400 bushels per acre in isolated spots.[17] These flats are a perpetual source of food revenue and their true valuation should include the capitalized value of the land. At a net return of five per cent per annum, the minimum capitalized value of such land can be in excess of 5,000 dollars per acre, with areas of highest yield having a capitalized value of 60,000 dollars per acre.

Wetlands also mitigate storm surges and tides, and have prevented or reduced property losses from storm conditions. They are, in effect, natural breakwaters with the resiliency of the millions of stalks of cord grass serving to lessen the shock of pounding waves.

DREDGING

Dredging consists of the removal of material from the bottom and the placement of this material as fill. Dredging is generally used to further the following objectives:

1. Create and maintain navigable channels and inlets for commercial and recreational use.
2. Create and improve saleable property, marinas, and recreational areas.
3. Improve flushing action in bays and estuarine creeks.
4. Commercial mining of sand and gravel.

Dredging, however, also implies certain significant environmental impacts and administrative problems:

1. It destroys the feeding and breeding grounds of fish, shellfish, and wildlife. Deliberate modifications of the coastline, such as channel dredging for marinas, shoreline modification for beach stabilization, and filling in marsh areas for developmental purposes, pose serious environmental problems because they often occur in estuaries which are important natural resources in the marine ecosystem.
2. The use of dredging for political, speculative real estate development, or makework projects.
3. The lack of adequate control, legislation, and planning.

Many of these problems arise from a lack of knowledge regarding the consequences of dredging. The areas needing clarification include:

1. The influence of dredging on fish and shellfish ecology.
2. The value of bottom "rehabilitation" through dredging.
3. The effect of dredging on salt water intrusion.
4. Pollution control versus salinity control.
5. The effect of dredging inlets and inlet stabilization.
6. The use of groins for erosion control and beach stabilization.
7. The disposition and effect of dredging spoil.
8. Sand and gravel mining.

From the testimony heard and the research undertaken by the Oceanographic Committee, it would appear that one of the worst examples of the devastation of public resources is the indiscriminate dredging of sand and gravel from Long Island harbors.[18] It is claimed that this dredging has resulted in the partial destruction of the ecology of various harbors including the habitat and food chain of certain shellfish and finfish.

In spite of the effects of dredging on the marine ecosystem, it is a necessary activity. Harbors become silted and require circulation channels, and channels for navigation and mooring are necessary. There is also a need for waterfront power plants and fuel storage tank sites. The U.S. Corps of Engineers agreed that dredging is necessary. Their criteria, however, was navigation improvement. In this regard, the President's Advisory Study on the Environment recommended that decisions by the U.S. Army Corps of Engineers regarding the issuance of dredging permits and the evaluations of the Corps' own operations, be made on the anticipated effects on all resources, not simply on the effects on navigation.

With good planning, proper control, and intelligent use of dredging, it will be possible to serve the needs of the people of Long Island while minimizing its adverse effects on the marine environment. Particular attention must be paid to sand and gravel operations in bays and harbors. Construction requires these aggregates for the manufacture of concrete, and there is no question that this is a necessary industry. Nearshore sand and gravel mining may be the most economical means of obtaining this material.

Much of the dredging problem is the result of improperly supervised activities. Private contract dredging in Mt. Sinai Harbor started in 1955, and more than 3 million cubic yards of sand and gravel have been taken from the harbor's bottom. The wetlands to the south of Cedar Beach were obliterated by dredging to a depth of 40 feet. Although dredges were to fill to a grade of 12 feet below water level, there are still deep holes in the harbor. Boundaries to this dredging were exceeded to the east and, in the south, no boundaries or check points were even established. Approximately 60 per cent, or 140 acres of the former wetlands were lost to this dredging operation.[20]

A review of the dredging that took place in Huntington Harbor leads to contrasting opinions. Dredgers claim that the bottom was rehabilitated and should be a greater producing area for shellfish.[21] The shellfish producers claim that 90 per cent of the area dredged was of the best quality and that at least a portion of it will not be conducive to shellfish growth for a long time.[22]

In another instance, dredges were contracted to remove a sand bar off Center Island Beach in Oyster Bay to a depth of about 18 feet Mean Low Water. Actual depths dredged were up to 33 feet at MLW.

Dredging operations have left their effects on Northport Harbor, Reeves Bay, Flanders Bay, Oyster Bay, Bellport, and Moriches Bay. It is estimated that more than 25 million cubic yards of bay bottom have been removed from the Great South Bay alone, and many acres of shellfish producing land have been destroyed.[23]

The U.S. Fish and Wild Life Services report on an application to dredge in Garret Lead in Hempstead Bay dated August 11, 1965 reads:

> Our investigations indicate that earlier dredging materially altered the bay bottom of Garret Lead and destroyed the marsh lands to the north and to the west. Depth soundings taken in the Lead on June 23, 1965, revealed an average depth of 15 feet and maximum depth of 24 feet mean sea level in these once shallow and productive waters.... Complete dredging and filling projects remove valuable productive town owned bay bottom for private purposes. Fish and wild life habitat were seriously

and irrevocably damaged despite our recommendations that these applications for permit be denied. We find that we cannot object to issuance of this permit because there are no longer any significant fish and wild life resources in the projected area.

These marshes once supported both commercial and recreational shellfishing. They were an asset worth millions of commercial and recreational dollars for the town and were totally self-perpetuating, needing no cultivation, seeding, fertilizing, or planting.

Communities on Long Island are now aware of these problems. Hopefully they will achieve a balance between the services that their industry and population require as well as the need to preserve the marine environment.

As an example of their increasing awareness, a study was undertaken in the Town of Southold, financed by the Suffolk County Board of Supervisors, to study the consequences of dredging.[24] A before and after ecological examination was made to determine the actual effect of a limited dredging operation.

The Town of Babylon acted to preserve its coastal wetlands by instituting a dredging ordinance.[25] It controls and regulates the removal of land from town owned property by any form of dredging operation. In determining the merits of each operation the town solicits the opinion of the New York State Conservation Department.

This ordinance further provides that applications be accompanied by a statement citing the amount of material to be removed, a description of the area in question, and its geographical location based on United States Coast and Geodetic Survey's coordinates of the area, the depth to which such removal is proposed, a sounding of the area in question, and a survey of the area where material is to be deposited. This statement is to be certified by a New York licensed professional engineer or surveyor. The application indicates the officers of the firm and any history of prior dredging operations in Nassau and Suffolk Counties. Permits are granted for removal of material if such material is not required for town purposes and the public interest is not affected. Permits are also granted if the removal of material will benefit the town as a necessary improvement of any waterway. The ordinance fixes a time limit on the beginning and completion of the removal operation and further specifies the times when such operation may be conducted or halted. The New York State Conservation Department, or other authority, acts as a consultant to determine the value of dredge materials, and the licensee pays the town for the material he removes. Unless the permit states otherwise, a dredging operation can not substantially change the course of any channel or the natural movement or flow of any waters. When the work is completed, the licensee must certify that it has been completed in accordance with the ordinance and submit a survey indicating the depth of the area from which material was removed and the slopes connecting the dredged area with the adjoining lands. The licensee must also trim and dress the bottom and leave specifically required side slopes on the boundaries of any dredging areas adjacent to the shore lines. This ordinance contains liability statements and provides for fines and imprisonment for violation.

On April 15, 1965 the New York State Water Resources Commission decided that it was the State's responsibility to evaluate and take a stand on all notices of the United States Corps of Engineers relative to dredging. Within the first six months, 110 public notices were examined, and, of this number, six were recommended for denial. In many other cases, modifications were suggested and approval was subsequently granted.[26] This seems to indicate that many of the conflicts between dredging and environmental values can be resolved through adequate discussion.

THE EELGRASS PROBLEM

One of the major problems faced by sport fishermen and boaters in recent years has been a rapid increase in floating eelgrass in Great South Bay and Moriches Bay. Eelgrass grows in shallow water usually up to six feet in depth where there are no substantial currents. It can reach a length of over six feet, and when loosened from its roots, floating clumps of eelgrass can clog engine intakes and foul nets and lines. As it piles up on shore, rotting eelgrass produces an offensive odor and is often a public nuisance.[27]

It has sometimes been claimed that an increase in the eelgrass nuisance is due to nutrient stimulation caused by municipal and agricultural pollutants. However, a study by Dr. R.M. Wilson of Adelphi-Suffolk College at Oakdale indicated

that this is not the case.[28] Eelgrass was very common in the Great South Bay before 1932, and was found all along the Atlantic coast and on the European and African sides as well. Due to some unknown reason, probably a fungus-withering disease, the eelgrass began to die off, and during the 1930's almost completely disappeared over its entire range. During the 1940's and 1950's, it began to make a sporadic return in most areas but did not return to Great South Bay until the 1960's. The reason for the return of the eelgrass is as mysterious as its disappearance and since it has established itself in both polluted and clean waters, the incidence of pollution in Great South Bay does not seem to be the cause of eelgrass growth.

During the 1920's eelgrass was harvested and sold at from $20 to $60 per ton. It found use as home insulation, as sound insulation, as a substitute for hay, and as a fertilizer. At one time it was used in Canada and France in making paper, and was used in Germany to make gun-cotton. The disappearance of eelgrass resulted in the decline of several communities that depended on it for their livelihood, but the reappearance of the eelgrass has not seen a revival in its use.

> The discovery of an economic use for eelgrass will lead to the final solution of the so-called eelgrass problem. The economic use, which would pay for the cost of collecting, processing, and delivering the grass to the consumer, will pay for its removal from troublesome areas. Of the many possible ways eelgrass could be utilized, perhaps its uses as a fertilizer, insulation, or packing material are the most preferable and probable for further economic development.[29]

The eelgrass itself can serve to improve the marine environment since it provides a natural habitat for many species of fish and shellfish, including weakfish, eels, scallops, and schools of juvenile fish seeking protection from predators. The protective aspect of the eelgrass, along with its decomposition role in the food chain, may indicate that the recurrence of eelgrass will increase the quality and quantity of fish in the ocean and bays. According to Dr. Wilson, there is much more floating eelgrass along the bottoms than along the surface, and the surface floatation may be the result of boats and dredges which stir up the bottom and cause the eelgrass to rise to the surface. Where the normal depth of Great South Bay averages about six feet, in many areas dredging has produced sinkholes of 20 feet or more. These holes have accumulated deposits of dead eelgrass and the decay of this eelgrass underwater, without oxygen, leads to the production of hydrogen sulphide gas. This often occurs along shorefronts where bottom material has been used as landfill. Hence, part of the eelgrass problem may stem from poor dredging practices.

There seems to be no cure for the eelgrass nuisance unless private entrepreneurs begin to harvest it as a commercially useful product. Since one underwater acre can produce about 8½ dry tons of eelgrass, and the growth of eelgrass has been spreading steadily over the last three years, this may be the ultimate solution.

POLLUTION

> The near shore environment is of critical importance. This environment is being modified rapidly by human activities in ways that are unknown in detail but broadly are undesirable.
>
> Pollution, which renders beaches unsafe for swimmers, destroys valuable fisheries and generally degrades the coastline, is the chief modification.[30]

One of the major causes of the loss in value of the marine environment is from pollution caused by an active residential, industrial, and agricultural community along this shore.

Sewage

The waters surrounding our shores are a priceless asset which furnishes county residents and visitors the opportunity to participate in the recreational pleasures of boating, bathing, and fishing. Most of these waters, at the present time, are clean and attractive. Moreover, the inland areas contain many attractive lakes and streams which provide recreation for those who prefer fresh water sport.

Coincident with the population increase along the shorelines, evidences of pollution have begun to appear. The Suffolk County Department of Health has observed a slow but steady deterioration in the quality of these waters.[31] Pollution

is inevitable in shoreline areas with many individual waste disposal systems. The overflow from cesspools, seepage of polluted ground water, and illegal direct discharges of sewage find their way into the surrounding water. The Suffolk County Department of Health has even found it necessary to refuse bathing permits to several beaches on both the north and south shores and on some inland lakes. A joint survey by the United States Geologic Survey and the Suffolk County Water Authority indicated the presence of ABS (a synthetic detergent) in the groundwater and in many of the streams tested.[32] This is a positive indication that sewage is finding its way into the drinking water supply and our recreational waters.

Large quantities of shellfish are taken from Great South Bay and Long Island Sound by both commercial fishermen and local residents. Great South Bay was the original "home" of the famous "Blue Point" oyster and growing and marketing shellfish is still potentially one of the most profitable natural resource industries in Suffolk County. At present, however, the New York State Conservation Department prohibits the taking of shellfish from numerous creeks and canals that empty into the Bay and for a distance off shore of approximately one-half mile.

In order to maintain these waters in a quality state where they can be used without concern for the public health it is necessary to provide for adequate collection, treatment, and disposal of sewage. With the continued use of individual disposal systems, and their subsequent failure, pollution may progress to a point where these waters may constitute a public health hazard.

Public sewers in populated areas would protect those bay waters presently open for shellfishing. Failure to provide public sewers can result in shore front pollution extending further and further into the bays. Similar conditions apply to Long Island Sound on the north shore but more positive dilution by tidal action makes the problem less acute.

In recognition of this problem, the Suffolk County Board of Supervisors created the Suffolk County Sewer Authority to establish a coordinated sewerage system for the county's five western towns.[33]

Industrial and Agricultural Pollution

A second aspect of pollution apart from its sanitary concerns may be termed nutrient pollution. This results in the over-fertilization of the bays and harbors from various types of upland effluents including lawn and farm fertilizers, cesspool seepage, and duck farm wastes.

> A serious pollution problem which caused the failure of a once prosperous shellfish industry and lessened the recreational use and esthetic value of Great South, Moriches and Shinnecock Bays prompted the towns of Islip and Brookhaven to commission the Woods Hole Oceanographic Institute to conduct an analytical survey to find the causative agents and necessary remedial measures.[34]

Their findings indicate that these materials entering the bay waters continually add additional phosphorus and nitrate that enriches the waters to the point where the ecological balance is upset. Nutrient pollution, particularly in the Great South Bay, has fostered the growth of a microscopic green algae that may be so dense (5 million to a cubic centimeter of water) that the shellfish find it virtually impossible to survive. In the Moriches and Great South Bays, much of this nutrient pollution can be attributed to duck farms located in the estuaries. The relatively poor flushing action of Moriches Bay has caused the spread of this nutrient into the Great South Bay. Woods Hole Oceanographic Institute examination of many of the duck ponds in fresh water areas indicated algae saturation.[35] It is possible that some of this problem could be alleviated by clearing Moriches Inlet with a consequent increased flushing action. The best solution, however, may be to implement the laws requiring complete treatment of duck farm waste before discharge.

Pesticides

Another type of pollution is caused by the use of pesticides. This is a serious problem because treatment is difficult and its movement and environmental effects are quite complex. It is known that a large amount of chlorinated hydrocarbons, namely DDT, and similar pesticides, have been used for pest control on the uplands and mosquito control in the salt marshes tributary streams, and catch basins. Through seepage and ground water flow these chemicals find

their way into the marine environment. These pesticides are concentrated in the food chain which results in appreciable amounts being found in fish, sea birds, and other carnivores. Unfortunately, not much is known about the resultant effects on higher forms of marine life, but it seems that the fertility of some species may be seriously affected along with the possibility of adult fish kills.

The problem of reducing pesticide impacts is often attacked through the use of pesticides with different chemical compositions which break down into relatively harmless components. Beyond encouraging research and development of these chemicals, it is difficult to do much in this area.[36] However, since significant pesticide contamination resulted from the operation of the Mosquito Control Commission in Suffolk County, it is reasonable to assume that a great deal of improvement could be achieved through the use of these new chemical pesticides. In Nassau County most mosquito control is done by irrigation and water control to eliminate breeding areas, and by the encouragement of biological forms that feed on mosquitoes. Most of the salt marsh mosquitoes have been eliminated in Nassau, but Suffolk still has problems with this pest. Some of the Island's mosquito problems arise from the influx of mosquitoes from Queens and New Jersey.

In other areas of the country, along the New Jersey coast, for example, upland marshes have been flooded and biological controls introduced in an attempt to rely on natural systems to control the mosquito nuisance.

Flushing of Moriches Inlet

The inlet through the barrier beach off Moriches was closed around 1886. A new Moriches Inlet was created by tidal action in May of 1931. This new inlet increased salinities in the bay with the salinity at Smith Point increasing from 12.7 parts per thousand before the opening to 30.3 parts afterwards. Over the years, the inlet tended to move westerly and to gradually close. Despite dredging and improvements in 1946 and 1947, the channel closed completely in 1951. Before the opening of the inlet, the salinities of Moriches, Shinnecock, and Eastern Great South Bays were too low for shellfish production although the low salinities were favorable to the production of seed oysters.

After the opening of Moriches Inlet, the production of seed oysters was impossible because the increased salinities were favorable to the growth of oyster drills, a predator which destroyed the seed every year. There was however, an increase in hard clams which are not bothered by the drills, and oysters which were transplanted from other waters.

During the 1940's, it became apparent that the presence of a small algae, termed "small forms," was destroying the once prosperous oyster industry in Great South Bay. Blooms of these "small forms", with concentrations of 3 million per cubic centimeter, were preventing oysters from feeding properly. The Woods Hole Oceanographic Institute identified the algae as *Nannochloris,* a microscopic unicellular type of plankton that gave the water a greenish color when it bloomed in force.[37] The *Nannochloris* blooms were found to favor waters of low salinity (less than 25 parts per thousand) and high nutrient content like that found in Moriches Bay. The high levels of nitrates and phosphates was clearly the result of duck farm wastes entering the bay from the many duck farms located on its streams and estuaries.

The Woods Hole report suggested three courses of action to improve the situation of Great South Bay.[38]

1. Reopen and stabilize Moriches Inlet, and provide other inlets to the Bay.

2. Eliminate the pollution of the Bays by preventing duck farm wastes from entering the water.

3. Close off Moriches Bay from Great South Bay by the use of a tidal lock at Smith Point.

In September, 1953, Moriches Inlet was reopened and the shellfish industry immediately revived. Salinities rose, and the counts of "small forms" in Great South Bay declined to near zero. The reopened Inlet reduced the exchange of water between Moriches Bay and Great South Bay and curtailed the amount of pollutants traveling from Moriches to Great South Bay. The new inlet improved flushing action and decreased phosphorus pollutants in both Bays.

After 1953, Moriches Inlet slowly began to fill from shoaling. The bays became increasingly dependent on the level of rainfall runoff from streams to provide adequate flushing. The dredging of Fire Island Inlet, along with the shoaling of Moriches Inlet, has pulled polluted water from Moriches Bay into Great South Bay. This resulted in algae blooms from Moriches Bay to Fire Island Inlet. These algae were identified as *Nannochloris* as well as types of diatom and flagellate phytoplankton. The growth of these algae forms has severly affected the growth of oysters, clams, and other fish. The solution to the problem may lie in maintenance dredging of Moriches Inlet. Dredging the inlet, however, will not be sufficient unless a program of stabilization is also undertaken. Without revetments and breakwaters to curb the continual shoaling action, dredging may not provide a permanent solution to the algae bloom problem.

EDUCATION AND RESEARCH

Committee deliberations were held with representatives from various interests: conservation, sports fishing, commercial fisheries management, charter boat operators, shellfish industry, public health, dredging, education, industrial research, land management, and planning.

It is clear that the field covered by the term "oceanography" is heavily dependent upon education and research. Oceanography, in the context of the Committee's work, was defined as the science of the physical, chemical, biological, geological, and temporal interrelationships of the marine environment. Mathematics binds these ecological elements together, and engineering techniques translate the academic into workable or applied practices. The study of oceanography, therefore, calls for a background in a combination of disciplines. The educational institutions on Long Island are concerned with both the pure science and the applied science aspects of oceanographic studies.

Several of the area's universities and colleges offer courses in marine science, ocean engineering, and related studies.[39]

Adelphi University at Garden City and Adelphi Suffolk College at Oakdale – In addition to basic studies, occasional courses are offered in the general field of oceanography. Adelphi Extension at Oakdale is situated near marine locations and is housed in the same building with the State Conservation Department's laboratories.

C.W. Post College at Westbury – Offers regularly scheduled courses in marine biology in The Graduate Department of Marine Science. The school also offers undergraduate and graduate programs in related sciences.

Hofstra University at Hempstead – The Masters program includes oceanography and courses in hydrobiology, oceanography (as oceanic biology), and general ecology.

New York Institute of Technology (Old Westbury Campus) – There are two and four year programs in the general sciences, e.g., life sciences, bio-medical engineering and aerospace technology.

Southampton College of Long Island University – The division of natural science offers courses in sedimentation, geology, marine ecology, and marine botany as well as the general sciences. The school maintains a marine laboratory at Old Fort Pond. Southampton College is the only school on Long Island that offers a four-year undergraduate program in marine science.

State University Agricultural and Technical College at Farmingdale – Training in practical engineering is offered. These courses relate to the practical aspects of oceanographic operations.

State University of New York at Stony Brook – This institution offers great potential for the development of science of oceanography on Long Island. Its long range plans include the development of educational facilities for studies of the marine environment.

Suffolk Community College at Selden – This school offers an associate degree in marine technology. The college, in conjunction with Fordham, Hofstra, and Southampton College has carried out various studies at Goose Creek, in the town of Southampton.

United States Merchant Marine at Kings Point – This is a Federal school for training deck and engineering officers. The four-year program leads to a Bachelor of Science degree.

Webb Institute of Naval Architecture – This school offers a four-year curriculum in hull design and general naval architecture.

Marine Laboratories

In other areas of the nation, direct educational functions are complemented by various state and federal laboratories. The Cold Spring Harbor Biological Laboratory was originally devoted to marine research. That work has been phased out and it is now conducting investigations in quantitative biological studies. The State Department of Conservation laboratory at Oakdale is the only public facility of its kind in Nassau and Suffolk Counties.

The Ryther Report

An excellent report entitled *Oceanography in New York* was prepared by Dr. John H. Ryther of the Woods Hole Oceanographic Institute in January, 1966.[40] The first four sections of the report deal with the various phases of oceanography and its classification as a science and discuss the development of programs and the organization, scope, and function of various types of oceanographic laboratories.

The fifth section contains an outline of activities and programs in the State of New York. A sixth section contains the following recommendations which apply to Long Island:

1. The curtailment of any venture requiring large oceanographic vessels. Every effort should be made to avoid duplication of programs.
2. The consolidation of marine geology and geophysics at Lamont Observatory with peripheral study by others of the inshore areas.
3. Emphasis on areas of physical oceanography and marine meterology at New York University.
4. Oceanographic engineering is indicated as a primary interest of the Oceanographic Committee of the Nassau-Suffolk Regional Planning Board.
5. General marine biology presently comprises the major area of interest. Dr. Ryther notes the following:
   a. The need for marine study facilities and marine science study sessions as an introduction to the field.
   b. The need for a major marine laboratory facility with specific provisions for teaching and research.
   c. Marine microbiology and ecology are indicated as neglected fields.
   d. The pressing problems of Long Island's concern are pollution of its coastal waters and a decline in shellfish cultivation.
   e. Recreational demands are emphasized.
   f. Specific mention is made of the possibilities of the Nassau County Museum of Natural History as a center for a cooperative effort in marine studies.

Nassau County Museum of Natural History

Public education programs can help to convince the public of the need to protect and enhance our marine environment. Education in the public appreciation sense, as well as in the academic, is a foundation on which oceanographic skills will develop. The potentials in the various fields relating to the marine environment are largely limited by the capacity developed to staff the laboratories, man the equipment, and convince the general public. Nassau County has proposed a program to develop an Estuarine Environment Center at Cow Meadow in Freeport.[41] This installation would include laboratory and lecture facilities which would be made available to local universities on a 'rental' basis. Visits to this facility by elementary and secondary school classes and youth organizations could foster an interest in, and an awareness of, the marine environment. Hopefully, some students will be motivated to study marine sciences and the general public will become better informed of the relationships of Long Island's unique marine environment to the daily life of its people.

Sea Grant Colleges

In 1862, the Congress enacted the Morrill Act which provided grants of Federal land for the establishment of Land-Grant Colleges for the study of agricultural and mechanical arts. The concept was one of setting aside Federal lands in each of the states in the amount of 30,000 acres for each senator and representative in Congress. Several of the eastern states, with already established universities but no Federal lands within their borders, which have been omitted from the program. Congress provided that, in these cases, funds be provided in lieu of land.

Recognition of the need for education relative to the marine environment, resulted in a reappraisal by Congress of the desirability of expanding the Morrill concept to include sea-grant colleges. Dr. Athlestan F. Spilhaus, Dean of the University of Minnesota's Institute of Technology, is credited with advancing the concept:

> I have suggested the establishment of 'sea-grant colleges' in existing universities that wish to develop oceanic work. The sea-grant college would focus attention on marine science, and it would develop strengths in the applications of marine science in colleges of acquaculture and oceanic engineering. These would be modernized parallels of the great developments in agriculture and the mechanics arts which were occasioned by the Land Grant Act of about a hundred years ago. Basic funds, undesignated except that they be used by sea-grant colleges, could be obtained in much the way that agricultural support has been obtained in the past. Establishment of the land-grant colleges was one of the best investments this nation ever made. The same kind of imagination and foresight should be applied to exploitation of the sea.[42]

As an outgrowth of conference held in 1963, Dr. Spilhaus and nine others formed a committee to develop a sea-grant proposal. They later wrote:

> A sea-grant college would specialize in the application of science and technology to the sea, as in underwater prospecting, mining, food resources development, marine pharmacology and medicine, pollution control, shipping and navigation, forecasting weather and climate, and recreation uses. It would relate such application to the underlying natural sciences, which underlie social sciences as they are affected by, and in turn affect, the occupation and exploitation of the sea.[43]

The 89th Congress passed this legislation and provided for Federal grants to selected institutions engaged in studies of oceanography and related marine sciences to encourage further advances in the field. Twenty million dollars was authorized for the first two years. It is apparent that this legislation offered a tremendous opportunity for the universities and colleges of Long Island to advance their capabilities and knowledge in the marine fields.

Summary

Long Island has a unique marine environment. The varieties and degrees of its flora, fauna, population density, and pollution form one ecological system. Each of the marine related assets and debits serves as a constraint on the economy to the degree that its furtherance or elimination is limited by available knowledge. The educational efforts on Long Island should be geared to solving the physical, chemical, biological, and economic problems pertinent to Long Island waters. The success of marine sciences and ocean engineering on Long Island depends on the quality of applied and pure research related to unique Long Island problems and the training of an adequate manpower pool ranging from technicians to PhD's.

The Problem

Long Island's most challenging problem is to carry out a research program that will generate the knowledge necessary to manage its own marine environment in the face of an expanding population. There are many places around the world similar to Long Island that will be forced to understand the interaction between their population growth and their marine environment.

An extensive research program will be required to understand the various contaminants from human, household, industrial, pesticidal, herbicidal, and agricultural wastes; how these contaminants reach the marine environment; their effects on the biology and chemistry of the environment; and their dispersal by off-shore waters. The type of research needed would have to be a comprehensive study that would lead to an understanding of the complex interaction of many different factors upon one another. Some of these important factors are:

1. The life cycle of fish and shellfish.
2. The role of wetlands and the measurement of their productivity.
3. Investigations of the role that coastal lowlands (estuaries and marshes) play in the life

histories of many important fishes and shellfish, and how they are affected by pollution and other man-made alterations.

4. The productivity and role of bottom lands in fish and shellfish production.
5. The complex role of algae, bacteria, and other plankton forms in providing food and in decomposing wastes and bottom sediments.
6. The biology and chemistry of the aquatic environment, the relative contribution of various sources of nutrient elements, and means to control the aquatic plants that flourish in enriched waters.
7. Physical oceanography of storm surges, tidal actions and flushing times of bays and estuaries, and the effects of dredging on flushing time, salinity, and fauna.
8. The impacts of pollutants such as phosphates, nitrates, insecticides, herbicides, detergents, and other industrial and household wastes on the marine environment.
9. The development of more objective techniques to measure the tolerance levels of different organisms to pollutants and to identify and assess the changes in abundance and distribution of organisms making up biological communities under pollution stress.

A better knowledge of these complex biological, chemical, and physical interactions is required before effective planning for the conservation and full utilization of Long Island's marine environment can take place.

Local marine research to date has been sporadic and uncoordinated. Long Island's problems are not concerned with deep-sea oceanographic projects, but with problems associated with inshore marine sciences. Furthermore, comprehensive studies of the marine environment must be carried out on a continual basis so that data can be collected over a series of years. Almost all of the data collection necessary to an understanding of the effects of population growth on Long Island's marine environment must be done on the Island itself and in its adjacent waters.

AN ANALYTICAL PROCEDURE

The level of success in the implementation of a comprehensive research program will depend, in part, on the administrative and organizational procedures that are adopted. Several approaches are possible, and the following schedule is an example based on the assumption that initiation, coordination, and control will be centralized. Other sequences can be developed for alternate forms of administrative management.

Definition of Scope

A review and examination of the local marine environment, including existing and potential problems and areas of conflict must be made. This review must yield an insight into the specific research efforts required to gain a total, or near-total, understanding of the local system. It is also necessary to differentiate between practical and esoteric research because the aim must be to focus on the research that is needed to solve real problems.

A team composed of marine biologists, physical oceanographers, limnologists, marine ecologists, and other scientists will be required staff.

Translation

Once the scope of the study is established, it is necessary to organize the discrete parts into a program. This requires a translation from descriptive language — e.g., study the effect of dredging Moriches Inlet as a method of controlling pollution in Moriches Bay — into research language — e.g., systematically monitor flushing actions, impacts on salinity, sand drift, levels of nutrient aggregation and so on, relative to dredging Moriches Inlet and its consequences on Moriches Bay.

Priorities

The funds and personnel needed to carry out a research program of this nature are limited. Therefore, it is prudent to establish a time schedule or priority roster for the overall program. This first step would be the selection of a pilot program.

The design of the pilot program is a very complicated process, involving numerous priority decisions relating to technical and economic factors.

Technical priority refers to the logical sequence that must be followed to insure scientific rigor and coordination of many steps into a complete entity. Economic priority refers to addressing those problems that may yield an immediate

return, or that require solving to avoid irretrievable losses. For example, research on sand drift may be valuable in coping with erosion control, beach buildup, channel stabilization, and ecological changes in bottoms. The information gained from such study could result in new control techniques that would save millions of dollars. On the other hand, a specific research project on wetland ecology could yield similar returns in improved fish and shellfish production. Both cases involve important areas of concern. A priority choice, however, would probably result in the selection of the wetland study, since there is a continuing attrition of these irreplaceable resources.

Proposal Form

The pilot program, written in research language, must be put into proposal form. This includes the scope of services, performance standards, timing, monitoring procedures, legal requirements, and reporting formats.

Solicit Proposals

All qualified research groups-educational, institutional, industrial, or private-should be invited to submit proposals in accordance with established procedures.

Secure Funds and Award Contracts

On the basis of submitted proposals, funds should be sought from Federal, state, and local governments, foundations, and other private sources to finance the pilot program. In the Committee's opinion, well thought out programs stood in excellent chance for funding. This support is documented in the report of the President's Scientific Advisory Committee, *Effective Use of the Sea.*[44]

Contracts should be awarded solely on the basis of costs and competence. If local schools and research facilities combine their strengths and concentrate on Long Island problems, they should receive as much support as their capabilities will permit.

FACILITIES

The ability to carry out a wide ranging research project is, in part, dependent on the availability of research facilities, i.e., proper sites, laboratories, and supporting equipment. With the exception of shellfish and pollution studies, locally based research and development is not directly concerned with the marine environment of the Island, but with the development of undersea commercial and military products.

Facilities devoted to the problems of the local marine environment are needed. If excellence is developed in this direction it can be expected that industrial spinoffs – research and development, hardware production and maintenance of related hardware – could follow.

Local Effort

Industry has a significant role to play by investing its research talents and money in bolstering the growth of Long Island based ocean engineering, technology, hardware production and marine food fields. The major initiative must, in fact, come from the local community, public and private.[45] It must be recognized that Federal and state support is sought by most communities and those that develop a capacity and know-how should be in a more favorable competitive position.

Several encouraging signs indicate that this cooperation is taking place. The Nassau County Museum of Natural History and the Nassau Department of Conservation and Waterways have cooperated in the creation of new research facilities,[46] and Suffolk has made park lands available for research sites.[47]

State Participation

The State Education Department has designated Stony Brook University as the marine science center for the New York State University system.[48] The school's Institute of Marine Sciences provides a nucleus for research development on Long Island. Flax Pond was acquired by the State and is used for marine research and the New York State Department of Conservation has invested over 1.6 million dollars in marine research facilities at Flax Pond.[49]

Other state programs serve a valuable support role including the funding of land acquisition programs[50] and the various grant provisions of Section 5A of the Conservation Law relating to water and pollution studies.[51]

Federal Participation

Research projects relating to the area's marine environment have been undertaken by the U.S. Coast and Geodetic Survey and the U.S. Corps of Engineers on tides, bottom topography, channel development, harbor dredging, erosion control and various aspects of water pollution.[52]

MARINE-RELATED ECONOMY

This analysis and supporting data was prepared by the Oceanographic Committee in 1965. Although the economic data is obsolete, the analysis of the importance of marine-related activities in the economy of Nassau-Suffolk remains valid to this day.

The marine environment is important to the economic health of Long Island and the value of its marine related industries is conservatively estimated at approximately 180 million dollars. This does not take into account educational dollars, the full value of tourism — largely dependent on the marine attributes of Long Island — or industrial activities in ocean engineering.

A substantial improvement in the marine environment could mean an increase in commercial and sport fishing, tourism and recreation, shellfish production, and boating of an additional 200-250 million dollars annually. The full development of Long Island's marine potential could yield a total value several times this amount. Conversely, a substantial deterioration of this environment could lead to a corresponding decline of this segment of the economy.

Commercial Fishing

The U.S. Bureau of Commercial Fisheries reports that the annual value of the commercial fishery on eastern Long Island is worth a total of 3 million dollars dockside, of which the food fishery is valued at 1 million dollars. The balance represents industrial fish.

The food fishery concentrates on flounder, bluefish, fluke, mackerel, cod, whiting, stripped bass, swordfish, and others. The industrial fishery concentrates on fish not generally used for direct consumption such as menhaden, hake, and butterfish. Menhaden and scup form the major portion of Long Island's fishing business and in recent years there has been a decline in menhaden catches with a resulting concentration on other types of industrial fish.

The output of the industrial fishery is used to make fishmeal and fish oil. The ground fish produces a fishmeal of about 60-74 per cent protein content and the use of fishmeal in the poultry industry has resulted in the production of chickens at lower cost and in a shorter time. Fishmeal is also used as a food for cattle, hogs, and other animals, as well as trout.

An improved type of fishmeal called fish protein concentrate (FPC) can also be produced from these industrial fish. This product is odorless and tasteless and can be stored without spoilage. A plant for producing FPC was established in Greenport, but its odor was considered a public nuisance.[53] If adequate standards are instituted to curtail this nuisance, the FPC industry on Long Island may have good potential. It would be a boon to the fishing industry, resulting in twelve-month employment, and could lead to the development of ancillary food packaging and processing on Long Island.

Fish oil has many product uses, but products made from whole unviscerated fish, such as fishmeal, FPC, and fish oil, cannot be used in products for human consumption in the United States. The Food & Drug Administration is reconsidering its position on FPC, since it has great potential for feeding people.[54] Fish oil is used in Canada to make margarine and cooking oils, but it cannot be used in the United States.

The state of the fish industry is tied to the health of the wetlands. The wetlands are a producer of plankton which forms part of the food chain of larger fish. Small fish feed on these minute food stuffs and, in turn, are food for larger fish. Moreover, wetlands serve as a spawning and nursery area for the larger fish. Menhaden, for example, spawn in the ocean or Long Island Sound. When the young fish are about one inch long they move to the seclusion of the wetlands, where they find their food supply as well as protection from larger fish. After spending about eight months in these shallow estuarine nursery areas, they return to the ocean transformed from slender, transparent larvae into deep-bodied juveniles resembling adult menhaden. Although all fish caught by Long Island fishermen do not necessarily breed in Long Island wetlands, many of them mature here, and the preservation of these wetlands, along with those all along the east coast, is essential for the preservation of the industry. Without these tidal

wetlands, the life cycle of the menhaden, flounder, fluke, and other fish could be broken.

Wetland productivity is threatened by construction, domestic and industrial pollution, pesticides, and municipal sewerage. Furthermore, many dredging operations inflict their own peculiar type of damage on wetlands, and those which have not been destroyed completely often show significant reductions in productivity.

Long Island has a natural advantage in its proximity to the Atlantic fishing grounds, and the village of Greenport is actually as close to them as New Bedford, Massachusetts. Although Greenport is a good, deep water port with adequate docks, improvement of the dock facilities could attract additional industry to the area.

The problems faced by the fishing industry are of broader scope than can be solved by this Committee. Russian trawlers operate within 25 miles of our coast and are government developed, owned, and operated. The U.S. has neither the boats or labor force to compete with the Russians.[55] Our fishery industry is also hampered by a lack of international controls over many fisheries, obsolete crew requirements on large boats, inadequate training programs, and the lack of government subsidies or financing enjoyed by other countries.

Shellfish

Senator Claiborne Pell described the following view from a hypothetical manned space station called "Seascan" in the year 1966.[56]

> Seascan is approaching the most active seacoast in the world. In the bays and estuaries of the Southern New England shore are acres of farms in which varieties of seaweed, lobsters, oysters, clams, mussels, and transplanted North Sea sole are cultivated. On Long Island, not far from Orient Point, is the great nuclear complex in which sea water is desalinated and fresh water piped to the mainland, minerals are extracted from the bitterns, and millions of kilowatts of power are produced. The bays near the nuclear plant are also sea farms, using the waste heat to cultivate odd warm-water creatures from which biological medicines are extracted. The entire east coast is marked with sea farms, and their products are famous...[57]

The shellfish industry has a long history of operation on Long Island and names like the Blue Point oyster are known throughout the country. The passage of time, however, has marked Long Island's decline. Fifty years ago, Long Island produced 3,300,000 bushels of oysters a year. As recently as 15 years ago, though production had fallen to 1,250,000 bushels a year, the Island still ranked as the nation's leading oyster producer, and accounted for 13 per cent of the country's total production. At its peak, the oyster industry employed 3,000 people and produced a crop valued today at 50 million dollars.[58] In 1964, however, production had fallen to 28,500 bushels valued at 315,000 dollars and represented only 1 per cent of the nation's total output. Employment had fallen from 3,000 to a few hundred.

The hard clam industry has fared somewhat better, with production increasing in the last several years. In 1965, the industry produced 5.9 million pounds of clams valued at 5.1 million dollars. The value of the total 1964 shellfish crop was 8.8 million dollars, which includes .7 million dollars in bay scallops. The decline in the oyster industry has been partially offset by an increased concentration on hard clams. Hard clams are harvested by baymen working with tongs, or by shellfish farmers who seed leased areas and harvest the crop with hydraulic harvesters. Clams are graded into three categories – Little Necks, Cherrystones, and Chowders. The small clams bring as much as 14 dollars per bushel while the larger bring about 3 dollars per bushel, depending on the market. New York State is the country's leader in the production of hard clams due to Long Island's output.

The decline of Long Island's oyster industry, and the problems of the shellfish industry in general, can be traced to several causes – some man-made and some natural. With respect to oysters, the shellfish farming operation involves a seeding stage (natural or by hatcheries) and a cultivating stage. In the natural setting, mature male and female oysters in spawning beds emit sperm and eggs into the water. A mature oyster can lay about 100 million eggs a season. Fertilization takes place in the water currents, and the resulting larvae swim freely for approximately 10 days to three weeks. Eventually, they fasten or "set" on the shells, rocks, and other suitable material on the bottom of an open water floor

of a seed bed, usually found in a bay or harbor. Long Island has several areas which are brackish enough (low salinity) to permit natural oyster setting, however, the highest percentage of the best natural set has been grown in Connecticut waters. Due to a variety of factors, Connecticut seed production has fallen to less than 1 per cent of what it was 50 years ago.

During the cultivating stage, the farmer must shift the baby oysters, or "spat", from the seeding beds to the growing beds, and then to shaping beds and finally to fattening beds. During this period the farmer must take steps to eliminate natural predators — starfish, drills, and conches. After a period of from five to eight years, the shellfish can be harvested and sold.

Four elements are necessary for successful shellfish farming:

1. Adequate sources of shellfish seed.
2. Clean waters and an adequate food supply.
3. Adequate control of underwater and shore front property.
4. Control of natural predators.

1. *Sources of Seed* — There is evidence that natural set as a source of seed will face extinction unless steps are taken to remedy the situation. One of the main reasons for the decline was the storm of November, 1950, which virtually wiped out the natural seed and spawning beds in Long Island Sound. A bi-state (Connecticut-New York) cooperative study and development program to restore these natural seed areas is desirable.

   An alternative approach is the controlled production of seed by the special pond culture or hatchery techniques used in Europe and Japan. These techniques have been used to a limited extent in this area and there are several ponds on Long Island which could be adapted to these techniques. Japanese shellfish culture techniques were tried in a pond on Fisher's Island and produced over $100,000 of seed oysters in one year. Hatcheries have been developed in greenhouses where seed can be produced in a controlled environment.

2. *Clean Waters and Food Supply* — Shellfish can only grow if there is an adequate food supply in waters free from toxins. Bacterial and nutrient pollution can ruin a crop.

   The growing population on Long Island has produced sewerage wastes which have polluted many of the potential shellfish farming areas. Of the 550,000 acres of active shellfish producing land in and around Long Island's shores, 145,400 acres (26 per cent) are permanently closed to harvesting due to pollution. Moreover, contamination wastes, such as duck farm effluents, often cause a nutrient imbalance and a resulting bloom of algae. Studies by the Woods Hole Oceanographic Institute shortly after the end of World War II, showed that the over-fertilization of the waters of the Great South Bay by duck farm wastes, combined with a peculiar water circulation pattern, caused a bloom of small plankton algae called *Nannochloris* of over 5 million per cubic centimeter of water.[60] This algae utilizes available nutrients, results in shellfish starvation, and was the chief deterrent of shellfish production in the Bay. At that time, a partial solution to the problem was provided by dredging of Moriches Inlet to improve the circulation pattern and prevent the wastes from flowing westward into Great South Bay. When Moriches Inlet is large enough to flush Moriches Bay, this problem becomes less acute.

3. *Underwater and Shore Front Property* — Long Island is blessed with over 900,000 underwater acres suitable for shellfish farming. Only 40,000 acres is presently leasable and only a small percentage is actively farmed. Since one acre of shellfish ground can produce 500 bushels of marketable shellfish, this unused land represents a vast untapped natural resource.

   The shellfish industry needs adequate shore establishments to support the land-based phase of shellfish farming. These include adequate docking facilities, and shore front areas with clean waters for the establishment of shellfish hatcheries. In some cases, the shellfish industry must compete with non-marine oriented industries for clean water locations, forcing it to absorb high overhead costs in terms of land acquisition and taxes.

4. *Control of Predators* — In the past years there has been an increase in the population of shellfish predators. There has been a drastic

increase in the oyster drill population in Gardiner's Bay and in all Long Island waters in general. There has also been an influx of a highly prolific and fast growing barnacle in the Gardiner's Bay and Shelter Island areas that smothers seed oyster crops. Finally, there has been a very rapid increase in starfish, and one starfish can destroy an estimated 200 to 400 seed oysters a year.

The use of chemicals and high frequency sound waves to eliminate these predators has been confined mostly to laboratory experiments. The shellfish industry has helped itself through research and improved research management techniques. The industry, however, is unable to support the level of basic and applied research necessary to solve these problems.

If these problems are solved, it is estimated that the present leasable acreage is capable of producing a crop of oysters valued at 100 million dollars annually.[61]

Sand and Gravel Mining

The sand and gravel industry is the area's only mining operation and has an annual payroll of of about $4,000,000.[62] Although a valuable natural resource, it can be found throughout much of the north shore of Long Island. About 90 per cent of the sand and gravel produced comes from upland mining operations, but zoning controls have limited upland activity and sand and gravel dredged from bays and harbors has found a profitable market. During 1965, Suffolk County produced 6.5 million tons of sand and gravel and was the largest producer in New York State. Nassau County was second with 4 million tons.

The existence of restrictive zoning ordinances on upland sites means that future sand and gravel mining may depend on dredging. Since bottom lands are in the public domain, dredging operations for sand are usually part of a town or county public improvement, where the prime purpose is to dig a channel, improve a beach, and/or attempt to improve the circulation of a bay or harbor.

Major controversies have arisen when the public benefit was either negligible or non-existent. The Suffolk County Board of Supervisors indicated that they would support a policy of limiting the use of the county dredges to those operations that justify or prove their public benefit. Instead of requiring governmental expenditures for harbor improvements, the usual practice is for a township to permit commercial dredging. The town gets the work done and also recovers a royalty for each ton of sand and gravel taken. The improvement of Huntington Harbor could have cost 2 million dollars but, because the bottom consisted of usable sand and gravel, the town was able to contract this dredging and realized a 0.5 million dollars profit.

Usable sand and gravel bottoms exist primarily on Long Island's north shore, but it is not entirely clear that dredging in these areas has always resulted in a net gain for society. Controls on dredging often have been sloppy or non-existent and contractors dug deeper channels than called for, dredge areas not within their contract, or leave large and irregular "sink holes" in the bottom.

Furthermore, sand and gravel dredging disturbs the bottom environment. The resulting turbidity creates a silt which covers the bottom and blocks sunlight. This affects the food supply of finfish and shellfish and reduces the dissolved oxygen content of the water. Furthermore, the decay of the aquatic animals killed in the process results in the production of large BOD loads and is detrimental to other life forms.

On the other hand, it is argued that the bottom is of less ecological importance than wetlands, and since this type of operation does not affect the wetlands, the ecological loss is minor and mining operations redeposit the bottom mud back on the bottom after removing the sand and gravel. It is also argued that, by improving the flushing action of polluted harbors, the ecological condition of bays and harbors will be improved rather than destroyed.

The precise ecological effects of dredging operations are not sufficiently understood to prove either argument. However, it is the opinion of the Committee that most of the bottom lands dredged to date do not represent "mud" bottoms but, in fact, are hard or sand bottoms that are adversely affected by dredging. In addition, the so-called "mud" bottoms are not useless in an ecological sense. They provide a decomposition zone under a photosynthetic one and the elimination or disturbance of this zone may alter or destroy a valuable source of nutrients.

Duck Farming

Since the 1870's when the first white Pekin ducks were imported from China, there has been a thriving duck industry on Long Island. The duck industry is located along the shorefronts and riverfronts of the towns of Riverhead, Southampton, and Brookhaven. Today, this industry produces 7 to 8 million ducks annually having a value of 13 to 15 million dollars and provides 1,500 jobs and a 3 million dollar annual payroll.[63] About 50 per cent of all ducks grown in the United States come from Long Island. Besides the meat value, duck feathers account for 7 per cent of total revenue.

The ducklings are hatched in incubators and take two months to grow to a marketable weight of 4½ - 5 pounds. During their growth stage, ducks require a constant supply of water and most streams running through the duck farms carry off duck excrements and pollute downstream areas. Duck sludge has built up in many areas for so many years that it is now several feet thick and often requires dredging of streams and bays. The value of the duck industry to the Island is counterbalanced by the resulting cost to the general public in pollution, nuisance, loss of bathing, recreation and fishing, affected real estate values, potential public health hazard, and the public cost of pollution abatement programs, including dredging.

Because local authorities failed to cope with the problem in 1949, the State of New York passed legislation directing the abatement of duck farm pollution within a period of 10 years.[64] A clause permitted non-compliance due to poverty and this, combined with a lack of local cooperation and inadequate state enforcement, resulted in continued duck farm pollution.

During the 1950's the State did force duck farmers to dike their farms to separate the ducks from open and public waters. The State Department of Health, in cooperation with the Water Resources Board of Suffolk County, also required a system of ponds or lagoons to settle out solid waste before the effluents were returned to streams or harbors. This program has been accepted very slowly by the duck farmers, and, in many cases, the lagoon operation has not been sufficient to prevent duck sludge from continuing to pollute adjacent waterways.

Duck wastes contain coliforms, dissolved phosphates, and nitrates. These pollutants have rendered extensive areas of Moriches Bay and Peconic Bay unfit for harvesting shellfish, or have lead to a fall in shellfish production due to nutrient pollution and resulting algae growth. It seems an almost inescapable conclusion that nutrients from duck farm waste result in a bloom of *Nannochloris.* Studies conducted by the Adelphi Institute of Marine Science show that bay water will support a bloom of this algae when small amounts of duck sludge are added to otherwise clean water.[65]

Suffolk County has funded a study to determine the best method for removing these effluents, and a pilot project plant is being established to determine the effectiveness of this program.[66] This process involves chlorination to kill bacteria, the introduction of chemicals to coagulate dissolved matter, and aeration to restore the water's oxygen content. This treatment should remove 90 per cent of the dissolved phosphates and nitrates, but it will not be installed on all of the duck farms until 1968, at least. The cost to the individual duck farmer has been estimated to be $47,000, although 60 per cent of this cost may be financed by State and Federal pollution control agencies.

Recreation and Tourism

Americans spend vast sums of money on recreation. Recreation stands number four on the consumer's expenditure list, exceeded only by food, shelter and overall transportation.[67] Swimming is a major outdoor recreational activity and large numbers of people participate in fishing, boating, and water skiing.

Recreational goods and services are an important part of the Long Island economy. Much of this activity is marine-related and depends on a healthy marine environment. This includes such activities as boat building, sales and services, fishing gear, boat rentals, party boat operations, swimming, diving equipment sales, and a good part of the recreational housing market.

Boating and Marinas — In 1965, it was estimated that there were about 175,000 pleasure boats used in the Nassau-Suffolk Region, including inboard and outboard motor boats and sail boats. It is estimated that Long Islanders spend some 59,300,000 dollars per year on boat purchases, upkeep, dock rentals, and other

operating costs. They consume approximately 12 million gallons of gas each year, which alone accounts for a 3,600,000 dollar industry. The sale of new boats is an estimated 30 million dollar industry and about 2.3 per cent of the total pleasure boats in the United States are found on Long Island.[68]

The average marina in the United States does an annual $87,000 average gross. The boating industry will undoubtedly continue to prosper in the future, but its health depends directly on the maintenance of relatively clear waters and adequate channels. The boating industry is tied to the sport fishing industry, which depends not only on clear waters, but water capable of supporting marine life. Many pleasure boat operators work against themselves when they dump garbage and human waste into the bays and harbors. The use of shipboard toilets is particularly obnoxious in the shallow waters of Great South Bay, where inadequate tidal flushing results in the concentration of wastes in the water and on the bottom. The result is further nutrient and bacterial pollution of these areas.

Sport Fishing — Sport fishing is a common pastime and recreational outlet for the Island's residents. The sale of fishing tackle, bait, operation of party and charter boats, and other fishing activities, probably amounts to a conservative 45 million dollar industry for Long Island.[68] This sport depends largely upon the ecological health of the bays and harbors where the large portion of sport fishing is carried out, and on the maintenance of navigable channels, particularly in Great South Bay.

Other Recreation — The sale of swimming, diving, and beach equipment is an important business on Long Island, probably producing 2.3 million dollars in annual sales.[70] An even larger business derived from the marine environment is the construction, sale, and rental of seasonal homes. According to the 1960 Census, there were 42,236 seasonal housing units in the region, with 33,823 units located in Suffolk. As there would be little of this housing if there were no marine environment, we can estimate that seasonal homes and apartments contribute 50 million dollars to the Island's economy.

Total — The total value of the recreation sector of Long Island's marine-related economy is conservatively estimated at over $150 million per year:

Activity	Millions
Boating	$ 59.3
Fishing	45.0
Vacation housing	50.0
Other recreation	2.5
Total	$156.8

Home Building and Real Estate

The marine environment is important to industries which are not directly related to it. Close proximity to harbors, bays, and the waterfront can raise property values by substantial amounts. The desirability of waterfront property for development often works against the preservation of the marine environment since it often requires the filling in of valuable wetlands, and sewage seeps from waterfront homes add to the pollution problem. It is difficult to estimate the total value of waterfront property on Long Island, or the total incremental land costs due to proximity to the water. In San Diego, a house sells for $8,000 more if it is on the waterfront. Apartments in Columbus, Ohio, rent for $15 more per month if they have a view of a 7½ acre "lake" which the builder salvaged from an abandoned sand pit. On Long Island, waterfront property commands a premium of about $5,000 to $15,000 over non-waterfront lots.[71] It seems likely that if current trends continue, all of the wetlands adjacent to the mainland will be filled and used for home building.

Fortunately, builders represented by the Long Island Home Builders Institute have proved to be a progressive trade group. They have a general awareness of, and a desire to preserve certain aesthetic and productive aspects of the marine environment. This may be achieved through the use of sound land planning practices including cluster zoning to provide access to the waterfront while preserving large amounts of open space. According to Richard D. Schoenfeld, President of the Pickwick Organization, Inc., and an officer of the Institute:

> It is essential that while compatibility between marine environment interests and builder interests could be achieved, it must be remembered that builders are people-oriented. Popular demand and availability

> of suitable land to accommodate increased population is the builder's first concern. In no event does the average builder wish to see the marine environment unnecessarily deteriorated or destroyed. Swimming, boating, visual beauty, and to some extent, fishing, are perhaps the major aspects which are quickly brought to mind by the average builder's reflection on the worth of the marine environment to his own property. One would imagine that it is not beyond the capability of the Nassau-Suffolk Regional Planning Board and its subcommittee on oceanography to produce hard fact in support of a program to insure the maintenance of a marine environment program in all its aspects, including some which might escape the builder.[72]

Some of the conflict between the real estate and building industries and their impacts on the marine environment can be attributed to governmental inertia.

The issues of dredging for land-fill with subsequent wetland losses, come to light after the private investor has purchased the particular property, conducted engineering studies, and in some cases, started construction. It is at this stage that governmental action occurs, if at all. The elimination of conflict and the wise use of resources requires two-way cooperation and public agencies must make their policies and programs known in advance. In the case of wetland preservation, the relevant governemntal unit should develop conservation plans that identify the lands to be saved. Furthermore, land having a definite conservation value should either be acquired by public acquisition or preserved through modern land development practices, i.e., cluster zoning, density zoning, easements, or the purchase of development rights.

Deep Water Ports

Suffolk and Nassau Counties receive almost all of their imported goods from a New York City point of access whether shipped by water or land. Some petroleum products come in directly at such points as Port Jefferson, Northville, Inwood and Roslyn. Some general cargo, such as seed potatoes, comes in through Greenport.

Suggestions have been made to establish a major port facility in Suffolk County which would provide for the movement and handling of general cargo. This facility would face competition from the Port of New York, Port of Newark, and Port Elizabeth.[73]

While a general cargo facility can be important to the County's development, consideration should also be given to a port-oriented industrial complex offering waterfront industrial sites. Most waterfront land in the nation's seaports must be devoted to actual cargo handling, and, due to surrounding urban land uses, the cost of land is too great for it to be utilized for industrial purposes. Many industries would be attracted to industrial sites offering waterfrontage for transportation and access to cooling water. Some of these industries are food processing, chemicals, petroleum refining, glass and stone products, and transportation equipment.[74]

In the future, the construction of a large-scale desalinization plant which would produce fresh process water and electricity, could attract other industrial uses.

Although marine transportation has a very limited potential, the advent of the Fire Island National Sea Shore and the anticipated increased volume of visitors will create a demand for additional ferry services from the mainland.

Economic Summary

The marine-related economy of Long Island accounted for $180 million in 1965. Recreation was the most significant sector.

Value of Marine-Related activity, Nassau-Suffolk Region, 1965 (Total value of annual final product estimates).

	Millions
Recreational Activities	$106.8
Seasonal Housing	50.0
Commercial Fishery: Finfish	3.0
Shellfish	7.0
Duck Farming	14.0
Sand and Gravel	0.4
	$181.2

These marine-related businesses generate demands in non-marine businesses, and their total impact is much greater than outlined here. The future value of these activities depends to a great extent on the quality of the marine environment. Programs of wetland conservation and management; reserach directed towards the solution of existing problems; pollution elimination; and training adequate skilled manpower, all contribute to human well-being and economic gain. Improved shellfishing conditions alone can conservatively yield an additional 100 million dollars annually. No attempt has been made to estimate the potential returns from the other existing activities, let alone the return from new industries.

It is clear that government, education, and industry working together to meet the common challenge can offer a bright future for Long Island.

Part TWO

THE NASSAU-SUFFOLK REGIONAL COMPREHENSIVE PLAN

INTRODUCTION

Nassau and Suffolk Counties possess a unique combination of assets — almost 1,000 miles of shorefront; woods, fields, ponds, clean air and waters; moderately priced housing, good schools and community services; and accessibility to New York City.

Today, these attributes, which have attracted more than two and one-half million residents, are threatened. Beaches and parks are overcrowded; fresh and marine waters are increasingly polluted; woodlands and fields are giving way to developments; older downtown areas are declining; and travel to New York City is frustrating whether one uses the Long Island Railroad or the Long Island Expressway. Although the vast majority of residents live in sound houses, housing problems exist for Blacks, Puerto Ricans, and Indians; for welfare clients and migrant workers; for the young, the aged, and the large family of moderate income.

Residents are familiar with the land use pattern consisting of detached single-family houses served by large shopping centers, with office and industrial parks scattered along the highways. Such dispersal or "urban sprawl" wastes the open land, and spreads houses, jobs, and shopping so thinly that private cars must be used for every errand, no matter how trivial. Little variety of housing type or cost is provided. This is the antithesis of a rational development pattern, one that would preserve open space, encourage the elimination of deterioration and obsolescence, and provide adequate housing, linked to jobs and shopping by a balanced transportation system.

The staff of the Nassau-Suffolk Regional Planning Board, aided by consultants, has prepared a comprehensive development plan for Long Island. The publications listed in the annotated bibliography contain the major findings of the studies and provide the documentation for this summary of the Plan.

The Plan is responsive to the future demands of the population and reflects the fact that the natural environment is not limitless. The number of people who can be accommodated is limited by environmental constraints (air, water, and soils), transportation, and the need to preserve open space and shorefronts for conservation and recreation

The Plan is not a static document. In order to remain relevant, it should be adapted to changing conditions and values. In this fashion, and with public interest and support, the Plan will contribute to the proper development of existing and new communities and the preservation of the Island's assets.

Approximately 2.6 million people live in Nassau and Suffolk Counties today: 1.5 in Nassau and 1.1 in Suffolk County. It is expected that the population will reach at least 3.3 million by 1985. Most of the growth will occur in Suffolk, whose population will exceed that of Nassau before 1985.

As the population grows, its composition and needs change. There will be increasing proportions of young and elderly. Reflecting this, the average household size will be somewhat smaller. Apartments will serve the requirements of these people better than detached single-family homes.

To provide decent housing for all, three changes are essential. First, the rate of housing construction must increase in order to accommodate the population growth and replace over 30,000 obsolete and substandard units. Altogether, 400,000 new housing units should be built by 1985.

Second, the emphasis in the provision of new housing must shift away from single-family detached homes, towards town-houses and apartments. Of the new housing units, 62,500 in Nassau County and 66,000 in Suffolk County, should be apartments. Apartments are scarce today in both counties and the amount of land presently zoned for them bears little relation to the need.

Third, to assure sound housing for households of low to middle income, Nassau County will need 25,000 public assisted housing units by 1985, and Suffolk County will need 51,000 units. Of these, about 21,000 units in Nassau and about 23,000 in Suffolk are needed to make up present deficiencies. The required units can be provided in many ways, including garden

apartments and town-houses in park-like settings. Ocassionally older single-family homes or apartments can be rehabilitated and used for housing families of low and moderate income. There is every indication that the State will provide this housing should the municipalities fail to act.

The number of jobs on the Island must keep pace with its population. Today, there are over 700,000 jobs in the two counties; by 1985 there will be more than two-thirds again as many jobs. Many of these new jobs will require new construction. It is estimated that Nassau County needs 1,800 acres of land for new manufacturing establishments, 2,300 acres of wholesaling, and 750 acres for eleven million square feet of new office floor space. Suffolk needs 1,500 acres for manufacturing, 1,350 acres for wholesaling, and 550 acres for eight million square feet of office floor space.

Land is also needed for recreation and for conservation. Open space must be acquired in anticipation of needs. The open space acquired now is all that is likely to be available to serve the population in 1985, in 2000, in 2100, and the years beyond.

In Nassau County there is a current shortage of 11,000 acres of park space. The addition of 125,000 or more persons by 1985 will increase the deficiency to about 15,000 acres. Suffolk County, not seriously short of park space today, will stay ahead only if it continues its present vigorous program of acquisition.

Long Island's residents contend with a transportation system characterized by bottlenecks and accidents on the highways, delays and cancellations on the railroad, and infrequent and inaccessible buses.

The traffic exceeds the available capacity on 260 miles of State and county roads. This means it's stop-and-go every rush hour. More traffic will mean virtual paralysis. An additional 177 miles of State and county roads are now operating at design capacity. Although traffic usually flows at acceptable levels, any growth in traffic will create increasingly frequent slowdowns.

Despite the overcrowded highways, most Long Islanders rely on automobiles, whether en route to work, to school, or to do shopping.

Buses are not yet an answer. Service is slow and infrequent, routes are uncoordinated, and bus stops often inconvenient. Buses attract few riders and the bus companies, privately-owned, cannot afford to extend routes or greatly improve service without public subsidy.

The Long Island Railroad is only available for east-west travel. It is used primarily by commuters — six of every seven riders are workers bound for Manhattan. Even so, the railroad carries only 60 percent of all Manhattan-bound commuters.

Automobile ownership is increasing rapidly, as is the number of trips per person. If present trends continue, the total traffic in the two counties will be more than half again the present load by 1985. The volume of east-west traffic at the Queens-Nassau line will increase by one-third. At the Nassau-Suffolk line, the 1985 east-west traffic will equal today's traffic at the Nassau-Queens line.

Two steps must be taken if this trend towards increasing use of the automobile is to be changed: first, the establishment of a highly efficient, frequent, and convenient mass transportation system consisting of coordinated rail and bus service; second, the grouping of all new land uses near transportation centers, at densities greater than those prevalent on the Island today. To attract riders, mass transportation must offer a better alternative than the car. If a person must use his car, he will use it for the entire trip. Therefore, new housing and jobs must both be located along mass transportation corridors so that substantial numbers of people can utilize mass transit and thus lessen the need for additional roads.

Freight is another problem. The Island's dead-end geography raises the cost of freight shipments. Bridging Long Island Sound will mitigate the dead-end situation for some truck freight shipments, enabling the Island to qualify for a change in the rate structure that will make the two counties competitive with other areas.

Based on the expected population increase, the demand for rail freight could double by 1985. If rail freight facilities are not developed to meet this growth, truck freight movements into or leaving the two counties will increase by more than 60 percent using the very roads that are now most congested.

Airport facilities will also need expansion. The use of aircraft will more than double by 1985, producing an additional one million take-offs and landings yearly.

There are less than 15,000 acres of vacant land in all of Nassau County. This is only six to seven percent of the land area and is insufficient to satisfy all of the projected needs. The land use priorities below are based on a determination as to which of Nassau County's needs must be met within the county, either on vacant land or through rebuilding on under-utilized land, and which of those needs can be allowed to spill over into nearby areas of Suffolk County.

Suffolk County, with 41 percent of its land vacant, has sufficient land to satisfy its own needs, absorb some of Nassau's, and still preserve the open character of the eastern towns – but only if development is carefully planned and controlled.

Land for parks and conservation has been accorded the first priority in both counties. This land must be acquired in anticipation of need – once graded, paved, and built upon, open land is lost forever. Excess acreage can always be released later, but a lack of open land cannot be rectified. Nassau County, with a projected 1985 shortage of 15,000 acres of park lands, has less than 15,000 acres of vacant land. Therefore, whenever there is a choice of use involving land areas large enough and suitable for recreation, they should be so used. Existing open space, even when privately owned, should be carefully preserved. In both counties, sufficient recreation land should be provided in new communities through the clustering of development.

This priority will be easy to overlook since, unfortunately, the most valuable recreation land is frequently the best for home sites as well. Conservation land appears to cry out for "improvement", and hard-pressed taxpayers are anxious to attract revenue-producing facilities.

Land for apartments has been accorded the second priority in Nassau County. In fact, no residential land should be rezoned to industrial, commercial, or office use unless it appears beyond a doubt that the land is unsuitable for parks or open space, or for development of multi-family units. Not all multi-family construction should take place on vacant land. Many of the new apartments should be located in the older business districts of both counties, where rebuilding at increased densities would stimulate revitalization and encourage the greater use of mass transit.

If these priorities are followed, parks, conservation, and multi-family housing will pre-empt Nassau County's vacant land. To provide the open space and apartments needed in Nassau County will require great determination, resistance to more attractive tax assets, and a willingness to permit greater apartment densities than most Nassau County communities have accepted in the past.

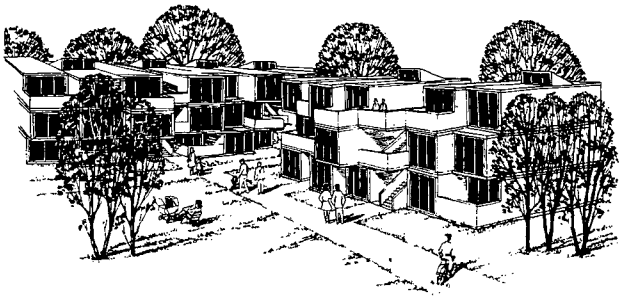
Beyond these two highest priorities in Nassau County, it will be necessary, as well as desirable, to locate as much new commercial and office space as possible in the existing central business districts. This course is dictated by the shortage of land and the need to revitalize these older centers to decrease dependence on the automobile. New office space should be strictly limited to the projected need. If the construction of large office parks continues at the current rate, Nassau County will soon have a surfeit of office space. The floor area proposed for Mitchel Field and Roosevelt Field alone amounts to over six million square feet; the additional five million square feet that will be needed by 1985 can and should be provided within existing central business districts. The present practice of building office structures on scattered parcels violates the land use priorities established for Nassau County.

Industry is also a large land-user. Much of the new industry that will employ Nassau residents must locate in Suffolk County where many accessible sites along major highways and the railroads are available to meet the needs of both counties.

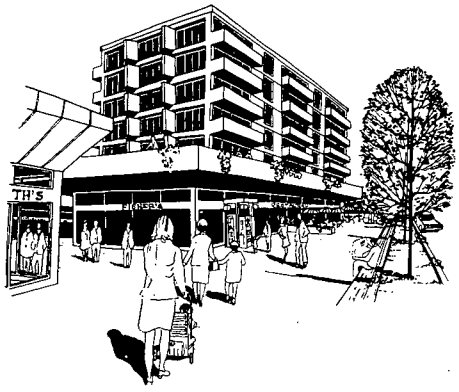
Because Suffolk County has more than enough land to accommodate both its projected 1985 needs and the spill-over from Nassau, it is not necessary to establish rigid priorities except for the preservation of open land. Suffolk County must, however, avoid over-zoning for revenue-producing land uses.

Both counties therefore require a rational plan that relates the amount of land *zoned* for clean industry, apartment, commerce, and office uses to the amount of land *needed* for such purposes. Such a plan will show locations for the various uses that will encourage proper densities and community design, enable the creation of a mass transportation network that places less emphasis on roads, and will conserve the Island's natural resources.

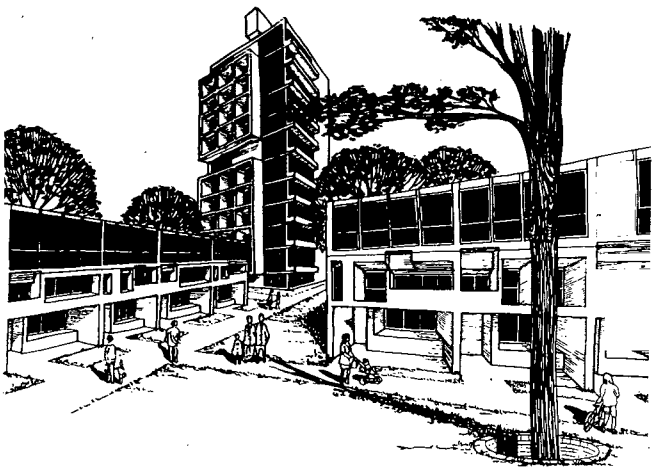
Garden Apartments



Stacked Mobile Homes



Six-Story Apartments



High-Rise Apartments

CORRIDORS, CLUSTERS, AND CENTERS

Three concepts — corridors, clusters, and centers — are the essence of the Plan. These concepts are the guideposts against which individual projects should be judged. In deciding on the merits of a specific proposal, each community should be guided by the goals, the three concepts, and the locational criteria derived from them.

Not every new development will conform fully to the corridors, clusters, and centers concepts. In fact, even if starting today, these concepts were rigorously and absolutely followed, they would not substantially change the appearance of the western third of the Island over the next fifteen years, except in the heart of some of the larger centers. Nassau County and the western-most portion of Suffolk are already almost fully developed. About half of the new housing in Nassau will be single-family homes on scattered lots. This in-filling will merely accentuate the present development pattern. But, over time, the concepts of this Plan, if followed, will accommodate necessary growth while respecting the needs of the people and their environment, and will encourage the use of mass transit by placing greater densities of housing, jobs, and shopping within walking distance of mass transit facilities.

CORRIDORS

Consider the geography of Nassau and Suffolk counties — long, narrow, attached at one end to one of the world's major cities, surrounded everywhere else by water. Clearly, the most valuable recreation land is at the waterfront; the best location for housing is adjacent to the recreation areas. Equally clearly, the most logical location for industry and other employment is along the center spine of the Island, close to its major transportation facilities. In this location, equi-distant from both the north and the south shores, jobs will be most accessible to residents, yet the inevitable harmful effects of industry — noise, traffic — will be minimized.

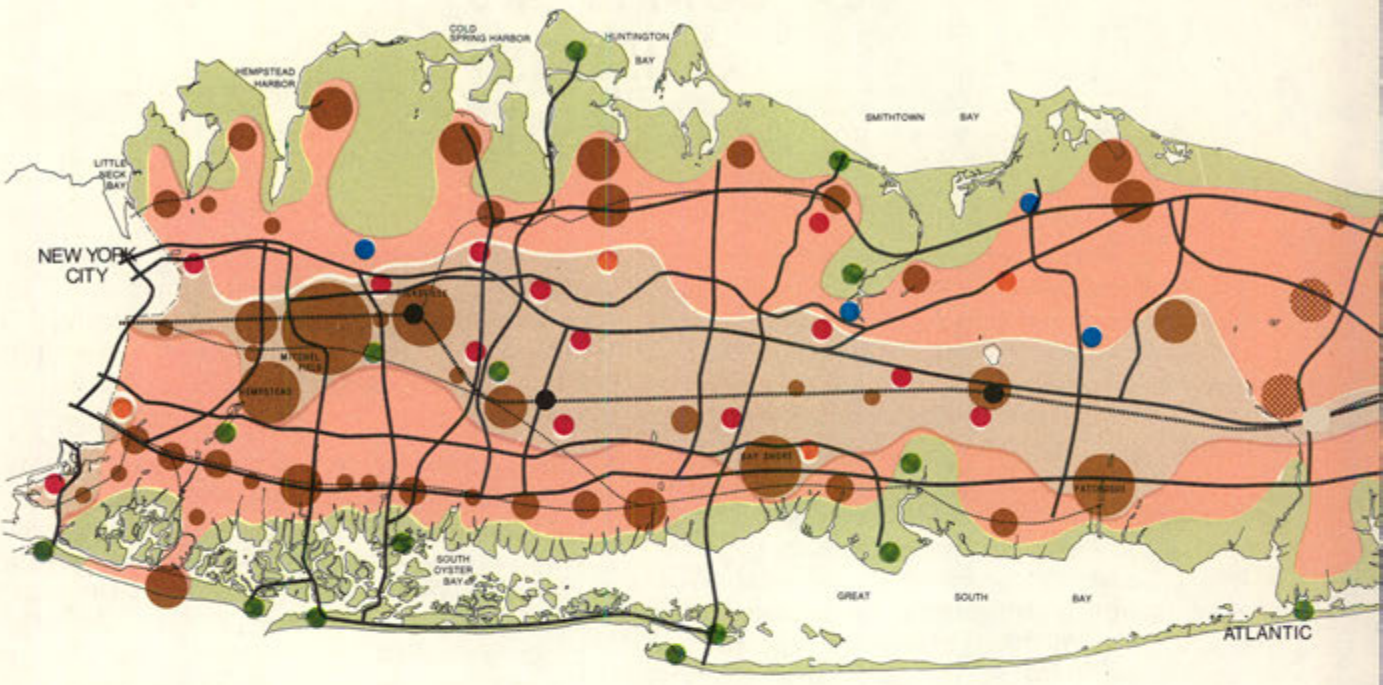
On the following map, the Island is outlined in pale green, indicating shorefront recreation, conservation areas, and low-density residential development. The green border thickens at the eastern forks, where agriculture, fishing, and recreation are of paramount importance.

Inland, adjacent to the green areas, are two broad residential corridors, one along the north shore, one along the south shore. These bands, each fairly well served by its own highways and rail, are within easy reach of both the central employment - transportation spine and of the parks and seashore. Residential densities are lower along the shore, increasing towards the central employment - transportation corridor, where existing limited-access highways, together with rapid and efficient rail service coordinated with a network of feeder bus lines, can provide rapid transportation to work, to shopping, and to other activities.

CLUSTERS

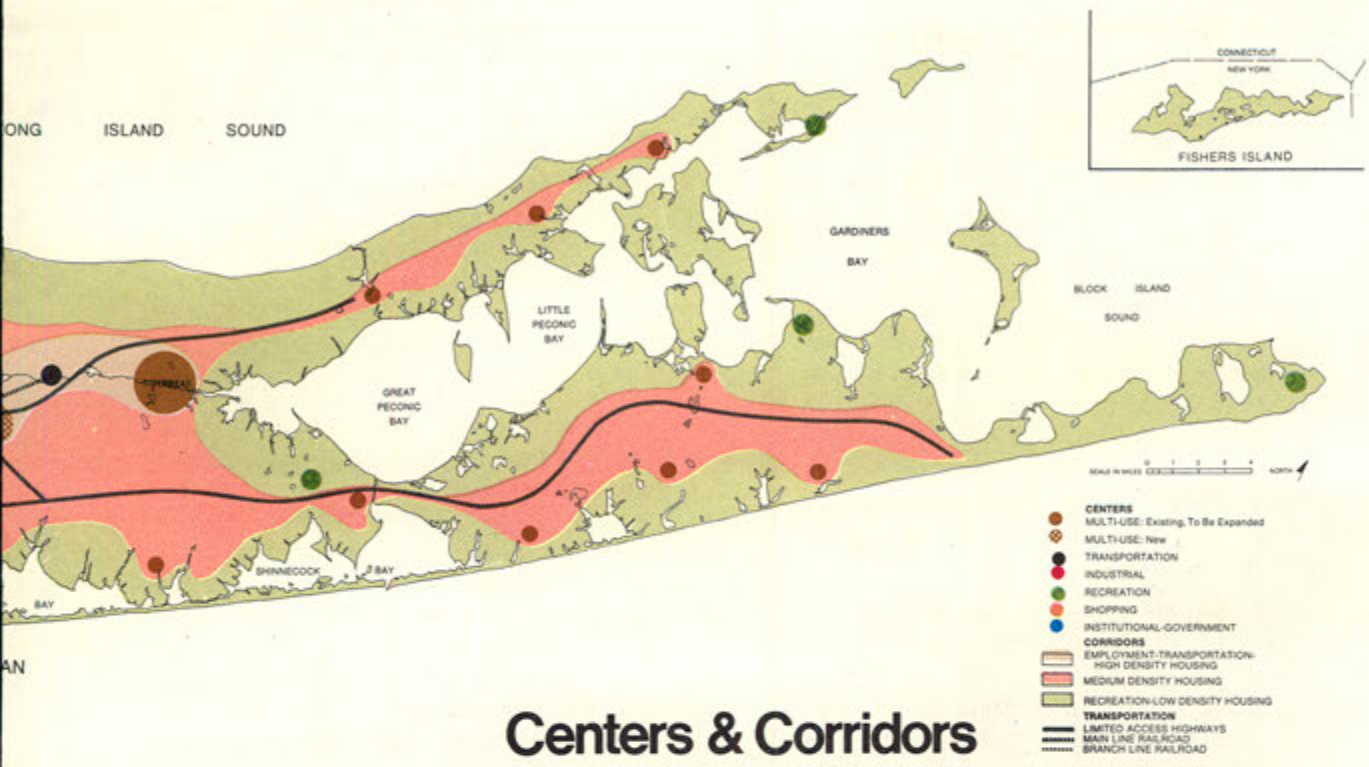
New development should be clustered wherever possible. The concept of clustering is simple: for example, suppose that instead of placing 50 homes on 15,000 square foot lots, they were placed on 10,000 square foot lots — at a saving of 5,000 square feet per parcel. The 250,000 square feet thus saved throughout the development could then be used for playgrounds, greenways, and other community open space. Both the original house *purchase price* and the annual taxes might be less, yet the *value* of the house might be greater due to the enhanced quality of its environment. Of course, if the original lot were one acre or larger, clustering to one-quarter acre would save a greater amount of open space without increasing the overall density.

Clustering should apply to entire neighborhoods. Local streets would serve only those structures within the neighborhood. Collector streets would delineate neighborhoods while linking them with the community center or downtown.



Clustering also allows for the combining of town-houses and apartments with single-family detached houses while maintaining the overall original permitted density. This is important because apartments will help to ease the critical housing shortage in the two counties and to slow the rapid rise in the cost of housing. Single-family homes in established neighborhoods may become more readily available where nearby apartments provide for the changed needs of the present occupants of these homes. Apartments relieve the mounting cost of public services, because the cost of public utilities, fire and police protection, and roads is lower per unit for apartments than for single family dwellings. In addition, new apartments on Long Island are a tax asset to schools as they generally pay more than three times as much in taxes as the cost of educating the children from these units.

The proper use of clustering techniques is one of the most effective tools for open space preservation at no acquisition cost to the community. Through clustering of adjoining developments and the dedication of contiguous acreage, alert communities can acquire extensive open space systems. Linear parks, which can be created by judicious planning of adjoining cluster developments, can be valuable for watershed protection, hiking, horseback riding, cycling, passive recreation, preservation of spots of particular scenic beauty or ecological significance, and for the articulation and delineation of communities. The Smithtown-Islip greenbelt is an example of such a linear park.



Centers & Corridors

CENTERS

The centers concept is an extension of the concept of clustering. Centers are accessible concentrations of activity.

The centers depicted on the map above are of two types: the *single-use center,* exemplified by an educational institution such as Stony Brook, a government center as at Hauppauge, or a grouping of industrial establishments such as that along the Long Island Expressway in Plainview; and the *multi-use center* containing a variety of land uses and activities, such as those proposed for Mitchel Field and for the revitalized downtowns along the major east-west transportations routes. These multi-use centers can be large or small (those proposed range from a regional center at Mitchel Field to a local center in Southold) but in every instance they include housing and shopping, and in the case of all but the local centers, they also include other activities and facilities — employment, education, transportation, special services and recreation — all placed in an accessible location.

Activity centers can be formed through the revitalization and expansion of an existing nucleus such as an older central business district or a small business district, or through the creation of an entirely new center as the focus of a planned new community.

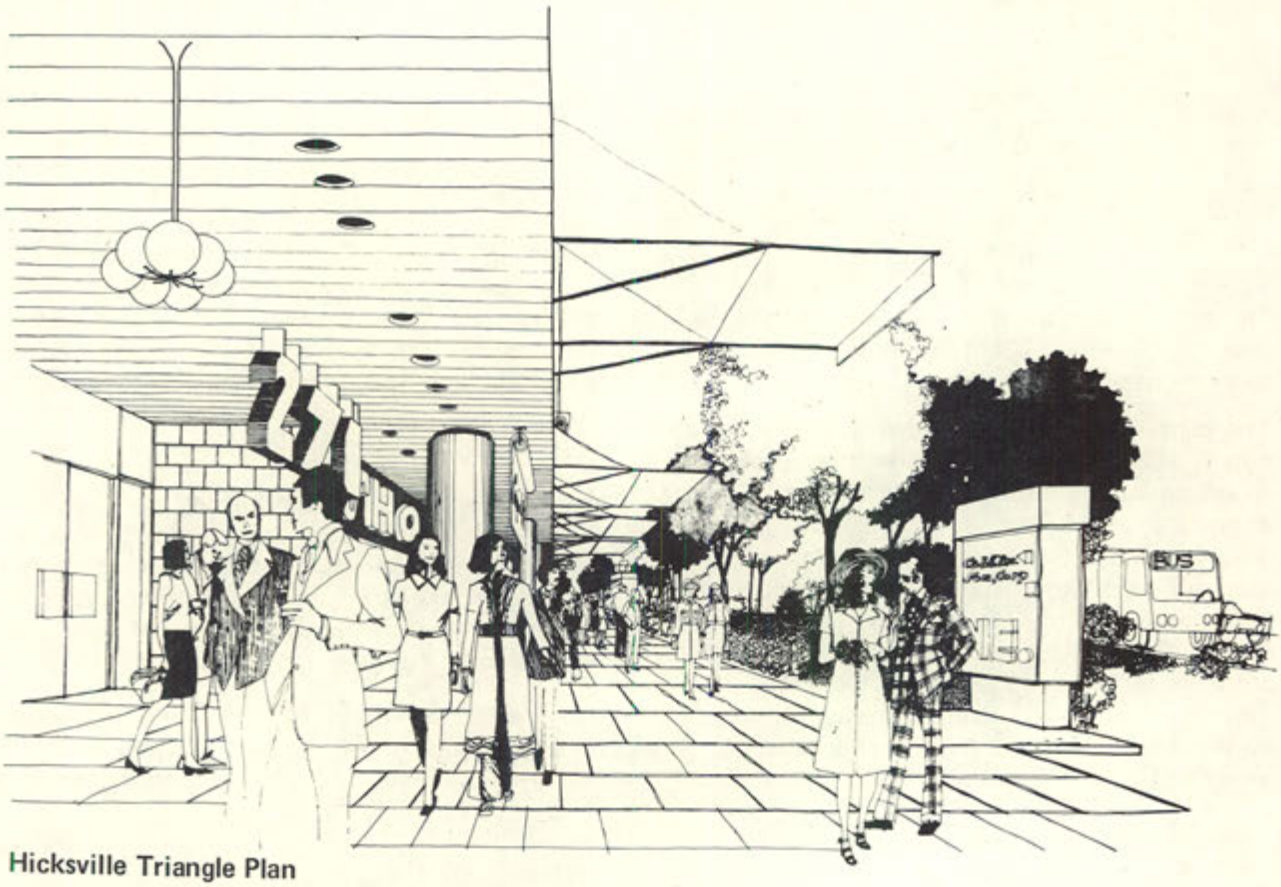
Every effort should be made to transform those older central business districts situated near the major transportation routes into activity centers.

Many of these business districts have deteriorated because of their inability to compete with the new outlying shopping and office centers. Ease of access and ample parking space have lured customers from the older traffic-clogged downtowns to new convenient shopping centers along the major roads. Lower income residents have moved into the aging and decaying housing bordering the business district. The tremendous existing investment in railroads and public utilities is underutilized even while roads, water mains, sewers, and power lines are extended to serve new commercial and residential growth in other areas. Better access to the downtown areas and improved parking, together with a substantial increase in permitted densities, will stimulate private renewal, provide needed housing, and promote economic and social integration.

New activity centers should be planned 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. For example, three entirely new activity centers are proposed for eastern Brookhaven, at Middle Island, Yaphank, and Manorville.

The central corridor of the Island should contain the major employment centers and other traffic generators. To serve this traffic, transportation centers are planned for Mineola, Hicksville, East Farmingdale, Ronkonkoma, Yaphank, and Calverton, at the points where the main line of the railroad crosses major north-south highway routes. The north and south shore corridors should contain as little industry as possible, and the commercial and office centers within the outer corridors should be smaller than those projected for the central spine.

Activity centers will encourage the use of public mass transportation by providing concentrations of commercial activity, employment, and housing. The central line of the railroad would be improved to provide high speed transportation; provision of such a system would encourage greater density of uses near the railroad stations which would, in turn, reinforce the economic justification for the original creation of the high-speed line. The concentration of a large proportion of the projected population increase in centers would permit the retention of the open character of the remainder of the Island.



Hicksville Triangle Plan

LAND USE PLAN

PARKS-CONSERVATION AND AGRICULTURE

Proposed Areas for Public Acquisition

The additional parklands proposed for Nassau County include a large new park at Woodbury; smaller ones at Woodmere, at Bayville, and at the Naval Devices site at Sands Point; extensions of an existing park at Lido Beach; harbor reclamations at Manhasset Bay, Hempstead Harbor and Cold Spring Harbor; wetlands preservations at Mitchell's Creek and Udall's Cove in the Great Neck area, Centre Island, and others; and lands gained through development at Mitchel Field and through clustering in the North Shore area. Acquisition of some North Shore estates, and of the Mott, Lattingtown, and Stillwell Lane Woods is recommended. These proposals fall short of the 15,000 acres needed, but there is no other suitable land available in Nassau County.

In Suffolk County, three state park acquisitions are recommended, amounting to approximately 3,000 acres. The first, and largest, is for a new park with camping facilities at Flanders; the second and third are for additions to existing parks at Montauk Point and Wildwood.

New county parks are proposed at Wading River, Iron Pier, and Fresh Pond on the North Shore; at Reeves Bay, Robins Island, Nichols Point, Gardiners Island, and Napeague in the Peconic Bay - Gardiners Bay area. Two Atlantic shorefront areas are also recommended for county acquisition: an eastward extension of the county holdings at Shinnecock Inlet and a westward extension of county lands along the barrier beach near Hampton Bays. A minor addition to Blydenburgh Park; extension of the Smithtown-Islip greenbelt; and several additions to Peconic County Park, including the Bald Hill acreage, are also recommended. These proposals, greatly augmented by an open space system obtained through clustering, will provide for all presently anticipated needs in Suffolk County and will help to offset the shortage of open space in Nassau County.

Both counties should obtain first options for the purchase of golf courses and other large semi-public or private tracts that are particularly well suited for recreational use. In southern Nassau, where the golf courses represent virtually the only potential public park sites, the county should exercise this option immediately whenever a golf course is offered for sale or development.

Wetlands, Waterways, and the Seashore

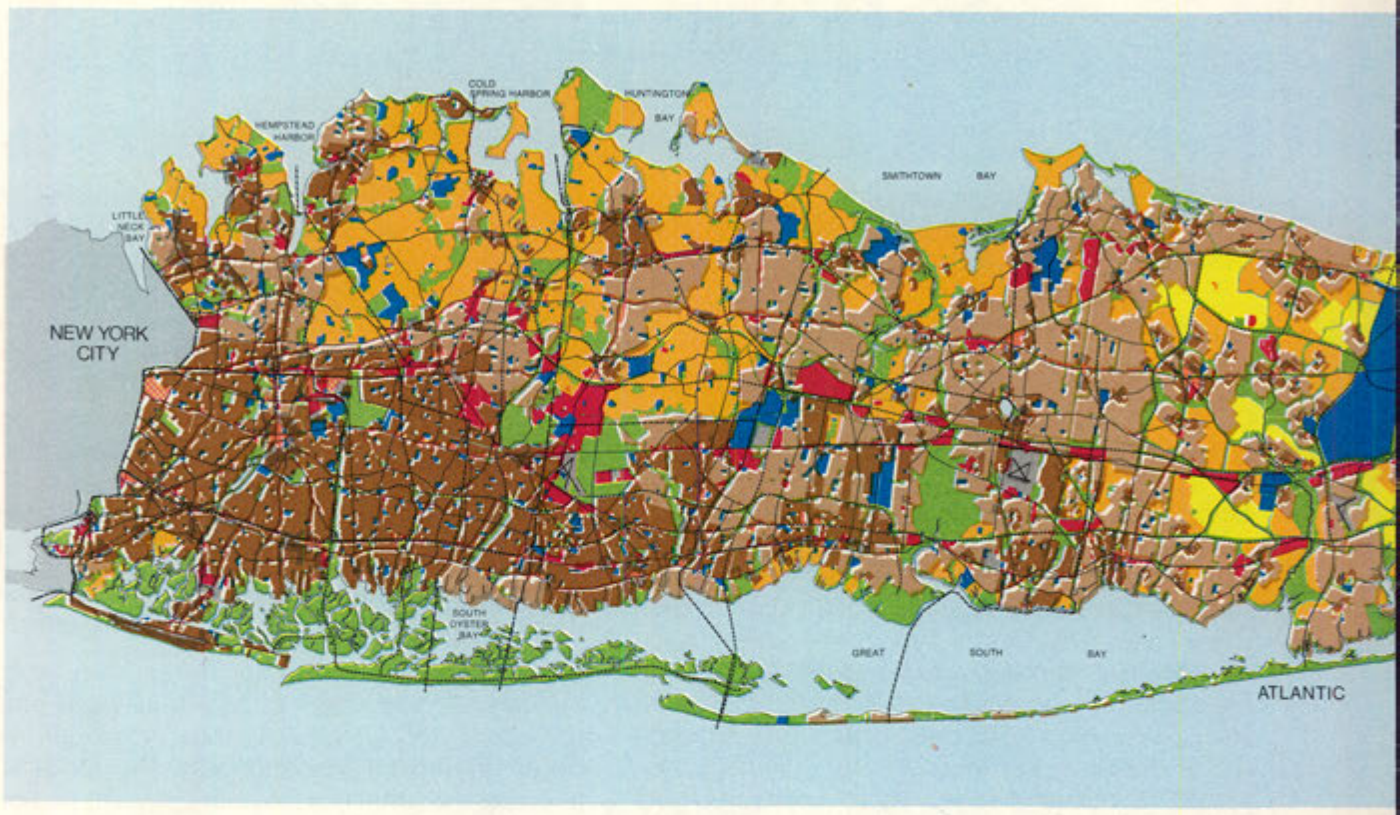
The ecological balance of the Island must be protected; an equilibrium must be maintained if man is to live in harmony with his environment.

Threatened by dredging and filling, and by the discharge of partially treated effluent and other pollutants, the wetlands require protection. All major shorefront wetlands and the remaining unprotected ponds, creeks, and streams in both counties should be protected and preserved in perpetuity. Dredging, sand mining, and filling should be permitted only where these processes will not damage the marine environment, and preferably only where necessary for channel improvement, as in Port Jefferson Harbor. Pollutants must be eliminated; partially-treated sewage effluent can no longer be discharged into Great South Bay without serious permanent damage to the marine environment. Furthermore, water thoroughfares — similar to major roads — should be established to direct motor-driven pleasure boats passing through the wetlands into areas where their propeller wash, noise, and fumes will be least harmful.

Beaches and other shorefront land should be publicly acquired where feasible, and public access to the shorefront should be improved.

The Eastern Towns

Eastern Suffolk County serves two important functions: the provision of recreation and the provision of food for the Metropolitan Region and beyond. Future growth in eastern Suffolk must be limited if the desire to preserve its present functions and atmosphere is to be achieved. This aim is in accord with the ecological constraints of a limited fresh water supply.



To preserve the rural and resort character of the eastern towns, land banking, clustering, and small centers are proposed.

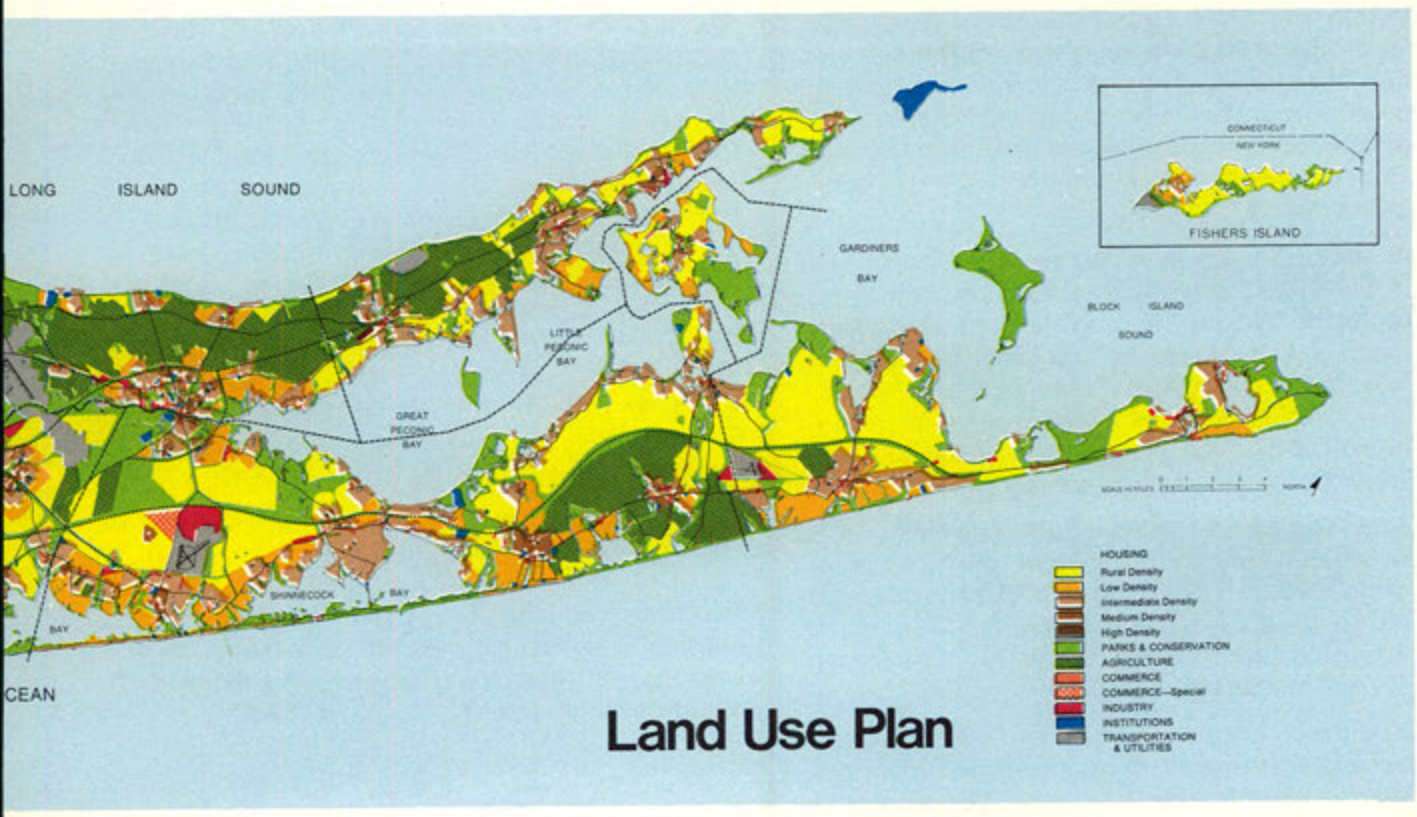
Agriculture should be protected through the public purchase and leaseback of a minimum of 30,000 acres of the most productive farmland in the towns of Riverhead, Southold, and Southampton. No lesser measures can prevent the loss of virtually all of this extraordinarily productive acreage. Land prices are rising rapidly; the farmland must be purchased quickly before all of it is lost to development.

Many of the large parcels of land which are now farm and woodland are shown on the Land Use Plan as Rural Density Housing – that is, unified development of clustered housing and neighborhood shopping at overall densities low enough to retain the present rural character.

New seasonal housing should be clustered. New seasonally-oriented commercial uses should be located in or adjacent to existing centers such as Jamesport, Greenport, Hampton Bays, Southampton, Sag Harbor, and East Hampton, all of which are planned as local multi-use centers, primarily for housing and shopping.

The North Shore

The North Shore area of eastern Nassau and western Suffolk should continue to be developed at low densities to preserve its present open appearance. Equally important, all future development should be clustered to preserve open space, woods, and scenic views. The Land Use Plan therefore shows this area as intended for low-density clustered residential development, with an overall average density of one house or less per acre.



HOUSING

Residential Densities

Several residential densities are shown on the Land Use Plan. Different dwelling types can be provided in each of these categories. Thus, in any residential area shown on the map, new development could combine clustered single-family homes, town-houses and apartments, as long as the overall density remained within the range for each category. These ranges are as follows: Rural — one dwelling unit or less per acre in planned unit development; Low — one dwelling unit or less per acre; Intermediate — two to four units per acre; Medium — five to ten per acre; and High — eleven or more per acre.

Single-Family Housing

Half of the new housing in Nassau County will be single-family houses as a result of in-filling on scattered parcels. In Suffolk County, single family development will continue to predominate, but should be clustered and served by sewers.

Multi-Family Housing

Multi-family housing should not be scattered. The optimum location for apartments is near public transportation and shopping. The site must be served by water and sewers. Ideally, apartments should be located in an accessible activity center, preferably an older central business district. Locations near recreation are desirable, such as those near a large park or near the seashore.

Within the older central business districts, elevator apartments are suggested rather than garden apartments. The accompanying increase in density is particularly important to encourage private renewal of blighted areas and to provide support for an improved public transportation system.

In Nassau County, the Plan proposes apartments in the fifteen older business districts; in the new center at Mitchel Field; in the area of the New York State University, C. W. Post College, and New York Institute of Technology at Old Westbury and Brookville; and elsewhere in the county on parcels that are usable, well-located, and presently zoned for apartments.

Between now and 1985, 42,500 apartment units should be built in the incorporated and unincorporated portions of the Town of Hempstead and in the City of Long Beach, 8,000 in North Hempstead, and 12,000 in the Town of Oyster Bay and the City of Glen Cove.

In Suffolk County, 60 percent of the recommended apartments should be provided in the existing older business districts. The rest should be part of the proposed centers at Middle Island, Yaphank, and Manorville, of the cluster developments at Patchogue Manor and Brentwood in the Town of Islip, and Elwood in the Town of Huntington, and of the proposed redevelopment of North Amityville in the Town of Babylon.

Between now and 1985, 11,000 apartment units should be built in the incorporated and unincorporated areas in the Town of Babylon, 15,000 in the Town of Islip, 10,000 in the Town of Huntington, 5,500 in the Town of Smithtown, and 20,000 in the Town of Brookhaven. In eastern Suffolk, 1,000 apartment units should be built in the Town of Riverhead, 2,500 in the Town of Southampton, and 500 each in the Towns of East Hampton and Southold. Apartments are not suggested for the Town of Shelter Island.

Publicly-Assisted Housing

Publicly-assisted housing must be provided throughout most of Nassau and Suffolk Counties to assure decent homes for residents of low to middle income. Furthermore, the continued growth of industries and offices, which are among the Island's largest taxpayers, may depend on an adequate supply of housing for workers.

The staff of the Nassau-Suffolk Regional Planning Board has prepared a guide to localities, summarized below, setting forth, by towns, the number of dwelling units to be constructed in the first phase of a publicly-assisted housing program. In Nassau County the quantities are: Hempstead, including the City of Long Beach – 10,400 units, North Hempstead – 2,000, Oyster Bay, including the City of Glen Cove – 2,900. In western Suffolk County, the quantities are: Babylon – 2,625 units, Islip – 2,700, Huntington – 1,575, Smithtown – 350, Brookhaven – 4,475; in eastern Suffolk: Riverhead – 725, Southampton – 1,000, East Hampton – 275, and Southold – 725.

The preferable location for publicly-assisted housing, whether for low or middle-income families or for the elderly, is near public transportation, shopping and services. The construction of housing at convenient, accessible locations will increase job opportunities and will tend to minimize living expenses.

COMMERCE

Commercial uses should be concentrated in accessible activity centers, either in the older central business districts, which already have utilities and transportation and where the proposed apartment development will provide customers, or in new planned activity centers. No shopping complexes should be built, except in activity centers.

Concentrations of retail, office, and service uses in the centers should offset demands for additional strip commercial uses (a series of stores and small shopping centers in a narrow strip along highways) and for new shopping centers. This is of particular importance in Suffolk County, where the large amount of vacant land fosters undesirable development. In Nassau County, many of the marginal strip commercial areas should eventually be eliminated through conversion to other uses such as offices or community facilities.

Office buildings should be clustered near transportation and shopping. In fact, the major concentrations of offices should be located in the largest, most accessible centers; the smaller concentrations, which should be limited to professional offices and business offices serving

local needs, may be located in residentially-oriented centers. Offices and industry are currently vying for the same land, most of which is at the outer edges of urban growth. Offices should locate within the urban core, freeing the larger outlying sites for industry.

In Suffolk County, major office uses should be developed in the established older business districts such as Riverhead, Patchogue, Port Jefferson, and Bay Shore, and in the proposed new activity centers.

The Special Commercial category shown on the Land Use Plan comprises race tracks, miniature golf, bowling alleys, drive-in theaters, and other commercial recreation facilities.

INDUSTRY

New clean industry, including manufacturing, research and development, and wholesaling, should be located along the central transportation spine of the Island. The concentration of industry adjacent to the proposed high speed rail line and the Long Island Expressway will reduce travel time for workers and facilitate the distribution of goods. Valuable recreational and residential land will also be protected from industrial intrusion or traffic.

No large-scale new industrial developments should be permitted in Nassau because of the limited amount of vacant land and the urgent need for open space and housing sites. Large-scale new industrial development can be accommodated in Suffolk but should be directed to the central corridor. Suffolk has 22,000 acres zoned for industry, double the quantity of land that will be needed by 1985.

Although the Land Use Plan shows a reduction from the amount of land currently allowed for industry in Suffolk County, the acreage proposed still more than meets the estimated need for both counties. Major industrial nodes are proposed at Lake Success, Jericho, Syosset, Plainview, Melville, Deer Park, Hauppauge, Bohemia, Ronkonkoma, Yaphank, and Calverton.

INSTITUTIONS

Public and private institutions serving both regional and local needs occupy large tracts of land in Nassau and Suffolk. Decisions respecting the future of most of these educational, research, and medical establishments are made outside of Nassau and Suffolk counties in response to regional, state, or national goals and resource allocations.

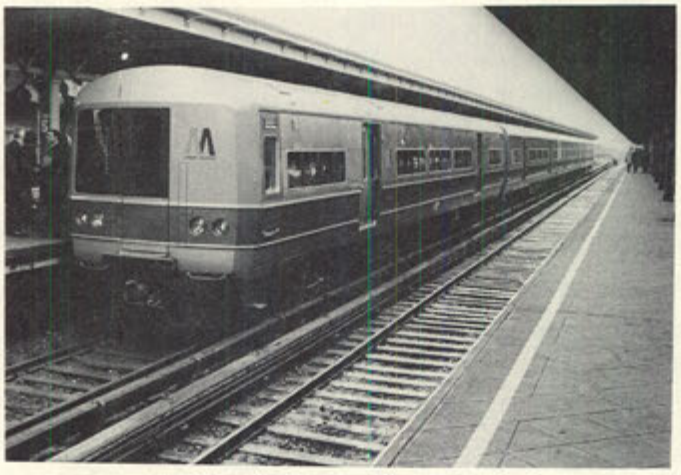
The Plan shows modest expansions of C. W. Post College and the New York Institute of Technology in the Brookville-Old Westbury area and of the State University of New York at Stony Brook, an addition to the Brookhaven National Laboratory acreage to connect the two separate portions of the site, and a site for an annex to the Suffolk County Community College near the Riverhead County Center.

Minor site reductions are shown for the state hospitals at Edgewood-Pilgrim State, Kings Park, and Central Islip, and for the Veterans Administration Hospital at Northport. To meet the needs of hospital workers, the construction of low and moderate income housing is recommended on the released portions of these sites. Should changes in the care of mental and physical disabilities result in the release of an entire site, a fuller range of clustered housing is recommended.

TRANSPORTATION AND UTILITIES

The Transportation and Utilities category shown on the Land Use Plan includes the existing airports that are to be retained and the existing or proposed non-residential clear zones around them. The Plan also shows the proposed relocation of the Mattituck Airport. Existing and proposed power plants, sewage disposal and intermunicipal solid waste disposal sites are also indicated.

Air



Rail

Highway

TRANSPORTATION PLAN

The goal of the Transportation Plan is to develop a balanced system, provide more efficient mass transportation, and at the same time, overcome existing congestion on the roads. A central concept of the Land Use Plan discussed above is the encouragement of the use of mass transportation through the development of centers. The present trend toward ever increasing reliance upon the automobile must be reversed, if we are to retain open space and protect the natural environment.

HIGHWAYS

Regardless of the course of future development, existing bottlenecks on the highways must be eliminated. With the exception of scenic roads, which should not as a general rule be "improved", new construction or expansion of transportation facilities should be considered first along the existing rights-of-way. Adherence to this principle will mitigate the adverse effects of providing additional highway capacity. Additional limited access highway lanes will minimize the need for widening secondary arterial, collector, and local streets and also help to make truck freight shipping more effective and competitive.

Present volumes of traffic warrant the construction of eight additional east-west lanes of limited access highway at the Queens-Nassau line to alleviate existing traffic delays. Six of these lanes, to serve the southern corridor, could be provided on an improved Sunrise Highway, rebuilt as a limited access road from Valley Stream to Babylon. The other two lanes are planned as an expansion of the Long Island Expressway.

Park-and-Ride centers are recommended adjacent to the Long Island Expressway at Roslyn Heights, Plainview, Melville, and Dix Hills in order to encourage carpools and thus reduce the number of vehicles using the Expressway.

A western Nassau expressway, incorporating County Boulevard, is proposed from Sunrise Highway to the Long Island Expressway, and eventually to Port Washington. This expressway should relieve congestion in Mineola and accommodate the traffic that will result from the construction of a regional center at Mitchel Field.

In Suffolk County, Route 110 should be rebuilt as a six-lane limited access expressway. A northern corridor expressway is recommended from Cold Spring Harbor to Port Jefferson. Jericho Turnpike should be widened, and the Nesconset Port Jefferson Highway (Route 347) should be reconstructed as a limited access highway, with a spur at Hauppauge to tie it to the Long Island Expressway. Nicolls Road should be completed from the Nesconset-Port Jefferson Highway to Sunrise Highway. In addition, a Wading River expressway is proposed to serve the transportation center at Calverton.

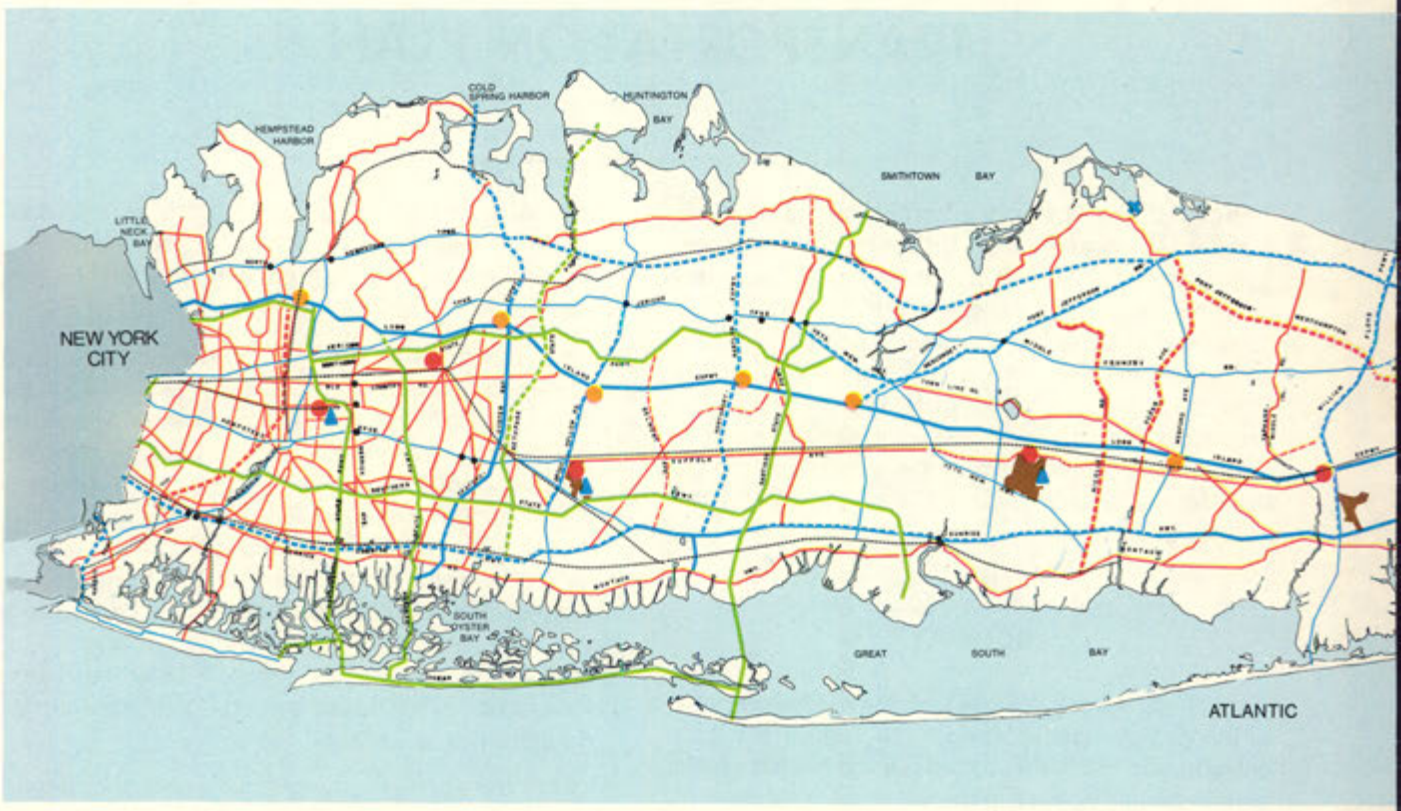
Most of the above highway improvements merely correct existing deficiencies. They do not provide for the rapid growth in the use of the automobile indicated by present trends. If the concepts of the Plan are not followed, if the present development trends continue, and if the proposed major improvements to the mass transportation system are not made immediately, then, by 1985, fourteen new limited access lanes will be required at the Queens-Nassau line and six more at the Nassau-Suffolk line, as well as extensive widenings of State and county roads.

RAIL AND BUS SERVICE

High speed rail service is recommended along the main line of the railroad with a series of transportation centers providing easy transfer to other modes of travel and access to high density employment centers.

The Metropolitan Transportation Authority, which operates the Long Island Railroad, has proposed development of a high-speed main line with transportation centers at Republic Airport, Hicksville, and Ronkonkoma. Unfortunately, according to their published reports, the MTA has not given the highest priority to these improvements.

The MTA should develop consolidated freight terminals and improve methods of loading and



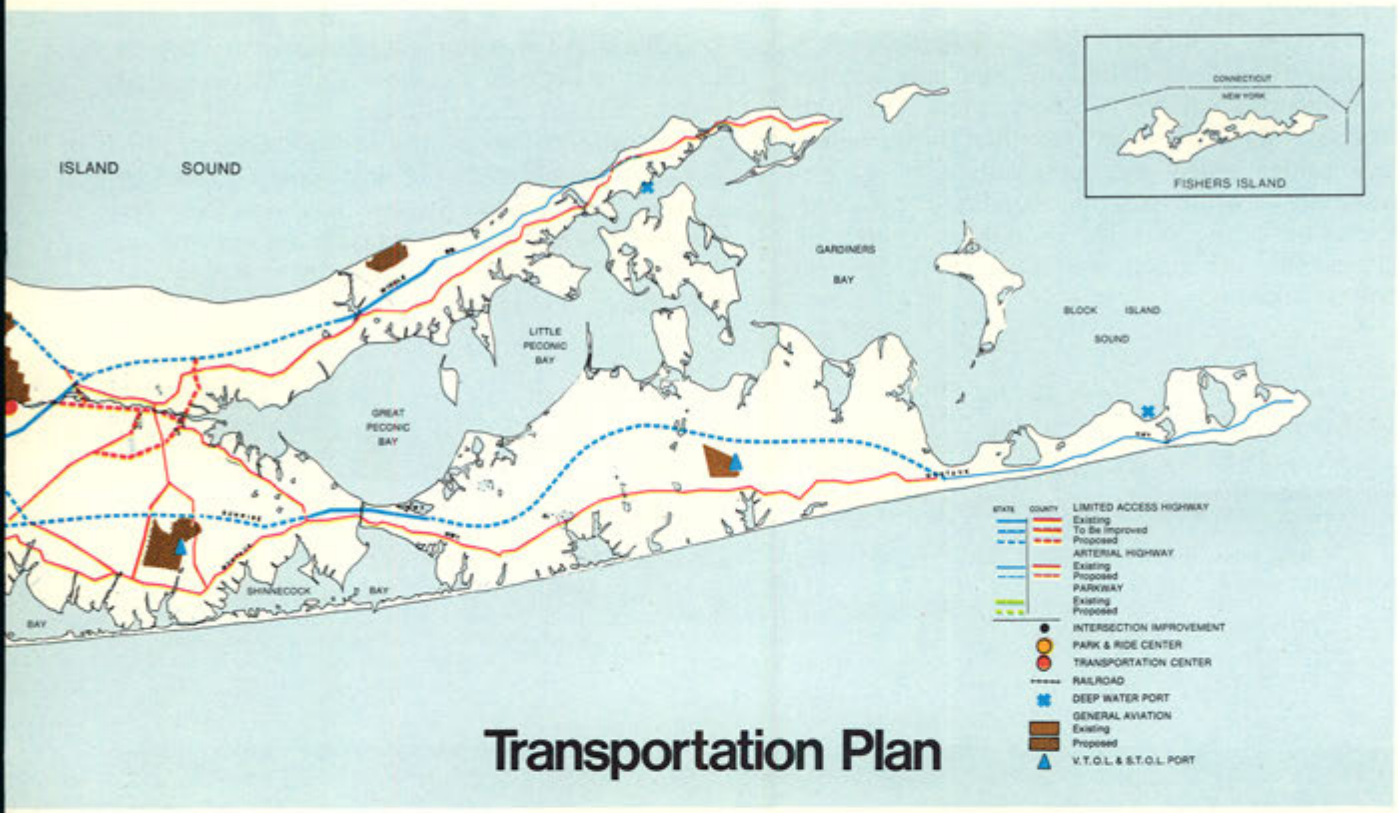
unloading. A more equitable distribution of freight revenues (controlled by the Interstate Commerce Commission) should enable the MTA to continue to provide necessary freight service.

Rail service is infrequent on several lines of the railroad: the Port Jefferson branch, from Northport to Port Jefferson; the Montauk branch, east of Patchogue; and the main line, east of Riverhead. Instead of providing more frequent rail service in these areas, where low population densities produce few railroad-riding commuters, it is proposed to convert the existing railroad rights-of-way to exclusive lanes for buses. Buses could then travel rapidly, directly, and economically to transportation centers.

Extensive subsidized improvements to the bus systems are proposed, including increased service, extensions of routes into areas currently unserved, and coordination of routes through the creation of a bi-county department of franchises. Substantial bus system improvements will relieve the highways, expand employment opportunities for the needy, and provide greater mobility for the increasing numbers of the young, the old, and the infirm.

AIR AND SEA

The Transportation Plan shows a change in the character of most of the Island's port facilities to permit greater recreational and conservation use of the harbors. Through the use of larger tankers, inland oil storage facilities, and pipeline distribution, a significant amount of recreational water frontage can be retrieved, truck traffic to



harbor areas reduced, and the scenic qualities of shoreline enhanced.

The demand for general aviation facilities for private and corporate flights will continue to increase rapidly during the planning period. General aviation facilities at Republic, MacArthur, Brookhaven, Suffolk County, and East Hampton Airports should be improved and expanded. The expansion of commercial and cargo facilities at MacArthur Airport is proposed. Air freight facilities should be developed at Calverton, if possible. Vertical and Short Take-off and Landing (V.T.O.L. and S.T.O.L.) sites are recommended at all general aviation airports and at Roosevelt Raceway.

REGIONAL ISSUES

The Nassau-Suffolk Comprehensive Development Plan can neither ignore nor resolve two transportation issues that seriously affect the entire New York Metropolitan Region. The resolution of these, while not part of the local decision-making process, will have a strong impact on Long Island.

The first is the question of bridging Long Island Sound. The locations for bridges shown on the Transportation Plan reflect the results of bridge studies authorized by the New York State Legislature. In response to a proposal submitted by Dr. William J. Ronan to Governor Rockefeller, calling for two Long Island Sound crossings, the Nassau-Suffolk Regional Planning Board, by a

resolution adopted March 30, 1967, recommended in principle the construction of a bridge from Oyster Bay to Rye and another from central Suffolk to Connecticut. The State has recently authorized a further study. Before any bridge plans are complete, however, the generally low-intensity development of the north shore of both counties should be protected. Otherwise, the open character of these areas will be impaired.

The second is the question of a jetport. It is possible that Calverton will be chosen as a fourth or fifth jetport for the New York Metropolitan Region. To protect the potential usefulness of Calverton and also of the Suffolk County Airport, an extensive buffer area must be reserved around and between the two facilities. Development within the restricted zone should be limited to non-residential land uses such as recreation, agriculture, and industry.

Republic Airport Transportation Center

IMPLEMENTATION

The Comprehensive Plan envisions an orderly development of Nassau and Suffolk counties. Implementation of the following recommendations move the Plan from vision to reality.

COUNTY ADOPTION OF THE REGIONAL PLAN

Each County legislature, after discussion and public hearings, should adopt the applicable portion of the Nassau-Suffolk Comprehensive Development Plan. The Plan should serve as a guide to budgetary and planning decisions by all departments of county government. The counties should have the right of first refusal on any properties delineated on the Plan for park or conservation uses. Local governments are urged to cooperate by not enacting zoning actions contrary to this purpose.

LOCAL PLANNING ACTIVITIES

All local planning decisions should reflect the major concepts of the Plan. Zoning should continue to be the responsibility of local government. However, to insure that zoning actions do not conflict with state, local, or county planning policies, existing state legislation providing for county zoning review should be strengthened. In particular, each county planning commission should be given review powers over critical areas such as the shoreline, adjacent wetlands, and proposed county parks.

BI-COUNTY PLANNING ACTIVITIES

The Nassau-Suffolk Regional Planning Board should continue its advisory functions, including research, the up-dating of planning proposals, the dissemination of planning information, and inter-agency coordination. The Board should be granted review powers to resolve land use and zoning questions affecting communities along the Nassau-Suffolk border, and should be notified of all proposed zoning changes in the two counties and have the privilege of appearing where necessary on behalf of the Plan. Public agencies with bi-county planning responsibilities, such as the proposed water resources planning board, should operate under the aegis of the Board.

FISCAL REQUIREMENTS

Current reliance on the property tax for financing local public services, particularly schools, is the most formidable obstacle to successful implementation of a rational land use plan. Steps must be taken to relieve the burden on the local property taxpayer. This can be achieved without the loss of local initiative in several ways, including the transfer of certain functions to higher levels of government, the use of additional revenue sources, and the creation of a county-wide taxing district for school revenue purposes.

CITIZEN PARTICIPATION

Long Island has an opportunity to shape a future that is both pleasant and productive. The Nassau-Suffolk Regional Planning Board has directed the preparation of the Comprehensive Development Plan. It is up to you, the citizen, to see to its implementation – to study it, discuss it, modify it if necessary, and to urge its acceptance upon all those whose decisions affect the quality of life on Long Island.

Part THREE

DETAILED WORK PROGRAM

TASK 2

STATEMENT OF TASK

The contractor shall identify specific relationships between Plan land uses, their implied activities, and the coastal marine environment. This shall include, where necessary, an investigation of those specific cause-environmental condition-effect relationships required to support or supplement the data base. The environmental conditions necessary for specific land uses and activities will be identified along with an initial assessment of their known or implied environmental impacts. These data will be prepared in a format useful for subsequent analysis in Tasks 3 and 4. Data specific to the various geographic areas of Long Island will be used wherever possible.

Objectives

1) To identify, locate, and quantify those land uses and related activities specified or implied in the Plan.
2) To identify the types of environmental loads and those implied impacts associated with the Plan's land uses and related activities. For the purposes of this study, environmental loads will be defined as those outputs arising from various activities which may imply an adverse affect on a specific marine environment or the public health.
3) To identify those environmental, legal, and public health standards applicable to the environmental loads implied by the Plan's land uses and activities. In the absence of established standards, cause-environmental condition-effect relationships will be utilized in an attempt to determine gross significance criteria.
4) To identify those environmental conditions and natural resource characteristics which act as developmental constraints on land uses and activities in the coastal zone.

Knowledge Base

The land use information required for Task 2 will be derived from maps prepared as part of the Plan. Environmental knowledge will be obtained from several sources including the research program sponsored by the Regional Marine Resources Council. The Center for the Environment and Man, Inc., and its predecessor, the Travelers Research Corporation, investigated a number of coastal zone and marine resource management problems of Long Island relating to finfish, shellfish, wastewater disposal, solid waste disposal, thermal pollution, oil pollution, pesticides, dredging, coastal erosion, agricultural wastes, and wetlands. These studies range from a general overview of cause-effect relationships, such as, Ellis, R., et al., *Functional Step One, The Classification of Marine Resource Problems of Nassau and Suffolk Counties,* (April, 1969); to detailed analyses as found in Green, R., *Wetlands on Long Island,* (February, 1972); Dowd, R., *Dredging on Long Island,* (February, 1972); and Bartholomew, F. and McGuinness, W., Jr., *Coast Stabilization and Protection on Long Island,* (February, 1972). These reports are applicable to the identification of environmental cause-effect relationships and contain extensive bibliographies. The Regional Marine Resources Council has also assembled specific technical and scientific information generated through a series of seminars. These have covered topics such as shellfish management, advanced wastewater treatment, wetlands management, coast stabilization and dredging, and oil spill prevention and clean-up. Other studies supported by the Council include Davies, D., Axelrod, E., and O'Connor, J., *Erosion of the North Shore of Long Island,* (Stony Brook, N.Y., SUNY, Marine Sciences Research Center, Technical Report Series #18, June, 1973); Gross, M., Davies, D., Lin, P., and Loeffler, W., *Characteristics and Environmental Quality of Six North Shore Bays, Nassau and Suffolk Counties, Long Island, New York,* (Stony Brook, N.Y., SUNY Marine Sciences Research Center, Technical Report Series #14, January, 1972); Hair, M. and Buckner, S., *An Assessment of the Water Quality Characteristics of Great South Bay and Contiguous Streams,* (Garden City, N.Y., Adelphi University Institute of Marine Science, February, 1973); and O'Connor, J. and Terry, O., *The Marine Wetlands of Nassau and Suffolk Counties, New York,* (Stony Brook, N.Y., SUNY Marine Sciences Research Center, April, 1972).

The Council has recently published *Guidelines for Long Island Coastal Management* which treats four priority marine environmental problems. Current efforts are underway to develop guidelines for managing hard clam resources

and for oil spill prevention and clean-up. Additional studies supported by the Nassau-Suffolk Regional Planning Board deal with the susceptibility of coastal areas to oil pollution, and the determination of near shore surface circulation in the New York Bight.

The contractor will utilize other studies of Long Island water resources, including Holzmacher, McLendon & Murrell, *Comprehensive Public Water Supply Study, Suffolk County, N.Y.,* (Melville, N.Y., Holzmacher, McLendon & Murrell, Consulting Engineers, Inc.); Greeley and Hansen, *Nassau County, New York, Report on Water Supply,* (Chicago, Ill., Greeley and Hansen, Engineers, 1963); and a number of reports by the U.S. Geological Survey. Elements of the Chesapeake Bay Research Program, especially as they relate to wetlands and the impact of waste disposal, may have relevance to this project. Similarly, current research on petroleum residuals in Delaware Bay may be transferable to the Long Island region. Flood plain studies supported by the Department of Housing and Urban Development and the Department of the Army, Corps of Engineers, may provide a further useful input.

Relation of This Task to Other Tasks

This task supplies planning, land use, and environmental data, and organizes them for subsequent analysis in Task 4. These data describe the land uses and activity levels implied or indicated in the Plan, their environmental loads, and possible environmental impacts.

General Methodology

This task is devoted to the identification and quantification of specific relationships between Plan land uses, implied activities, and their associated environmental loads. When these are determined, a scientific team will seek to identify or establish acceptable limits beyond which the marine environment and/or the public health may be adversely affected. Along with a determination of the environmental loads implied in the Plan it will be necessary to investigate those characteristics of the resource base that act as constraints on the land uses and activities occurring in the coastal zone.

The basic methodology applicable to this task is an extension of the cause-environmental condition-effect framework developed by Travelers Research Corporation, and consists of the quantification and subsequent evaluation of environmental loads and resource base constraints. Specifically, the Plan's land uses and implied activities are analogous to the "causal" statement in Travelers' analysis. In similar fashion, the development and quantification of environmental loads and resource characteristics are extensions of the "environmental condition" statement. The "effect" statement is addressed through the determination of the environmental and public health implications of specific loads, and of those activities limited or prohibited by specific characteristics of the resource base. A fully developed statement of quantitative "effects", however, depends on the analysis carried out in Task 4.

Environmental loads arising from the activities implied in the Plan will be identified on a per unit basis. Individual houses, for example, will generate wastewater and solid waste loads. Using a per unit scale, the engineering-scientific team will be able to specify and later aggregate the expected environmental loads by type. Specific cause-effect relationships may be used to determine the probable impacts and tolerable limits of certain activities or environmental loads.

WORK PLAN

Work Element 1

Objective

The objective is to identify, locate, and quantify those land uses and related activities specified or implied in the Plan.

Methodology

The identification of Plan land uses and activities entails the analysis of those land use classifications employed by the planning staff in the preparation of the Plan and its supporting documents. Existing land use designations may, in some cases, require disaggregation into discrete components.

The quantification of land uses in a form suitable for subsequent analysis will be accomplished through the application of a uniform grid to the individual land use maps generated as part of the overall planning process. This grid will permit the identification of land uses on a per acre basis for specified locations.

Moreover, it permits the aggregation of land use acreages by type at desired scale. Thus, the products of individual grid cells can be aggregated to generate total environmental loads.

Findings

The location and quantification of land uses and activities at a scale suitable for subsequent analysis in Task 4.

Product

Plan data in a form suitable for subsequent analysis.

Work Element 2

Objective

The objective is to identify the types of environmental loads associated with Plan land uses and activities.

Methodology

Based on the land uses and activities identified in Work Element 1, a team consisting of environmental scientists, engineers, public health specialists, and planners will conduct a detailed review of technical handbooks and scientific literature relating to industrial and technical processes to determine the types and magnitudes of the expected environmental loads. The environmental loads arising from a single residential unit, for example, will consist of domestic wastewater and solid waste, as well as those generated through its electrical and space heating demands. Household demands will, in turn, generate another series of environmental loads.

The relevant level of analysis for industrial and institutional uses may not be the individual establishment. This may require the development of representative or statistical groups of typical establishment mixes. Environmental loads, then, will be determined only at the level required for analysis in Task 4. In instances where unusual environmental loads and/or energy demands can be expected from atypical land uses or activities, e.g., Brookhaven National Laboratories, these will be analyzed separately. The probable environmental loads expected from land uses and activities for selected areas can be calculated from the application of the grid and per unit output coefficients. Task 4 can then generate the wastewater loads expected from *n* acres of *x* density at location *g*. In the same way, individual electrical demands will be summed into an aggregate demand which will then lead to the calculation of the required electrical capacity. The environmental loads resulting from this level of power generation can then be determined.

Findings

An identification of specific types, rates, and unit amounts of environmental loads implied by the Plan.

Product

A report indicating the environmental loads associated with various land uses and levels of activity.

Work Element 3

Objective

The objective is to identify the environmental, legal, and public health standards applicable to those environmental loads associated with the Plan land uses and activities.

Methodology

When the environmental loads implied in the Plan are specified and aggregated, it will be necessary to determine limits for each type or class of output, beyond which environmental damage or public health problems may arise. Residential wastewater, for example, will contain BOD and coliforms, and it is necessary to know acceptable levels for each. Similarly, the tolerable thermal loads from power plants must be identified in terms of the capacity of the receiving waters to dissipate heat.

The land uses and activities identified in the Plan will give rise to a large number of environmental loads. It is necessary then, to develop criteria which will enable the scientific-engineering team to differentiate between those probable environmental impacts which are of sufficient importance to warrant changes in proposed land uses, activity levels, or technologies, and those which are not. Acceptable limits of environmental loads cannot be determined in *a priori* fashion. Rather, they will be identified by the science-engineering team from public health standards, statistical and scientific data, and statutory limits. Some criteria have been developed in work sponsored by the Nassau-Suffolk Regional Planning Board and Marine Resources Council, such as

Guidelines for Long Island Coastal Management, (Hauppauge, N.Y., Nassau-Suffolk Regional Planning Board, September, 1973); O'Connor, J., *Dredging and Spoiling on Long Island,* (Stony Brook, N.Y., SUNY Marine Sciences Research Center, Technical Report #19, November, 1973); and O'Connor, J., *Preliminary Considerations in Estuarine Monitoring Around Long Island,* (Stony Brook, N.Y., SUNY Marine Sciences Research Center, Technical Report Series, in-press).

Findings

Relevant environmental, legal, and public health standards will be identified from existing material.

Product

A list of environmental loads and associated limits will be produced for internal use in Tasks 3 and 4.

Work Element 4

Objective

The objective is to identify those environmental conditions and natural resource characteristics which may act as development constraints on land uses and activities in the coastal zone.

Methodology

Some Long Island coastal environments, such as barrier beaches, wetlands, and estuaries, are so rare, fragile, or productive that it may be necessary to limit development to ensure their continued existence. Moreover, certain environmental conditions in Nassau and Suffolk Counties act as constraints on various types of land uses and activities. There are coastal areas, for example, whose physical or locational characteristics imply hazardous conditions affecting specific land uses, e.g., unstable bluffs along Long Island's north shore, and the tidal flood plains along the south shore constitute major constraints on residential development. The threat of significant flooding, however, implies little hazard to recreational use where the costs of rebuilding will be minimal. A science team consisting of a marine biologist, hydrologist, physical oceanographer, and planners will identify the types of constraints associated with different natural environments. Maximum use will be made of existing material and inventories developed for the Board and the Council, including the network analyses developed by Travelers Research Corporation, and previous work completed by various Federal and State agencies.

Findings

An identification of physical-environmental constraints on development in the Long Island coastal zone.

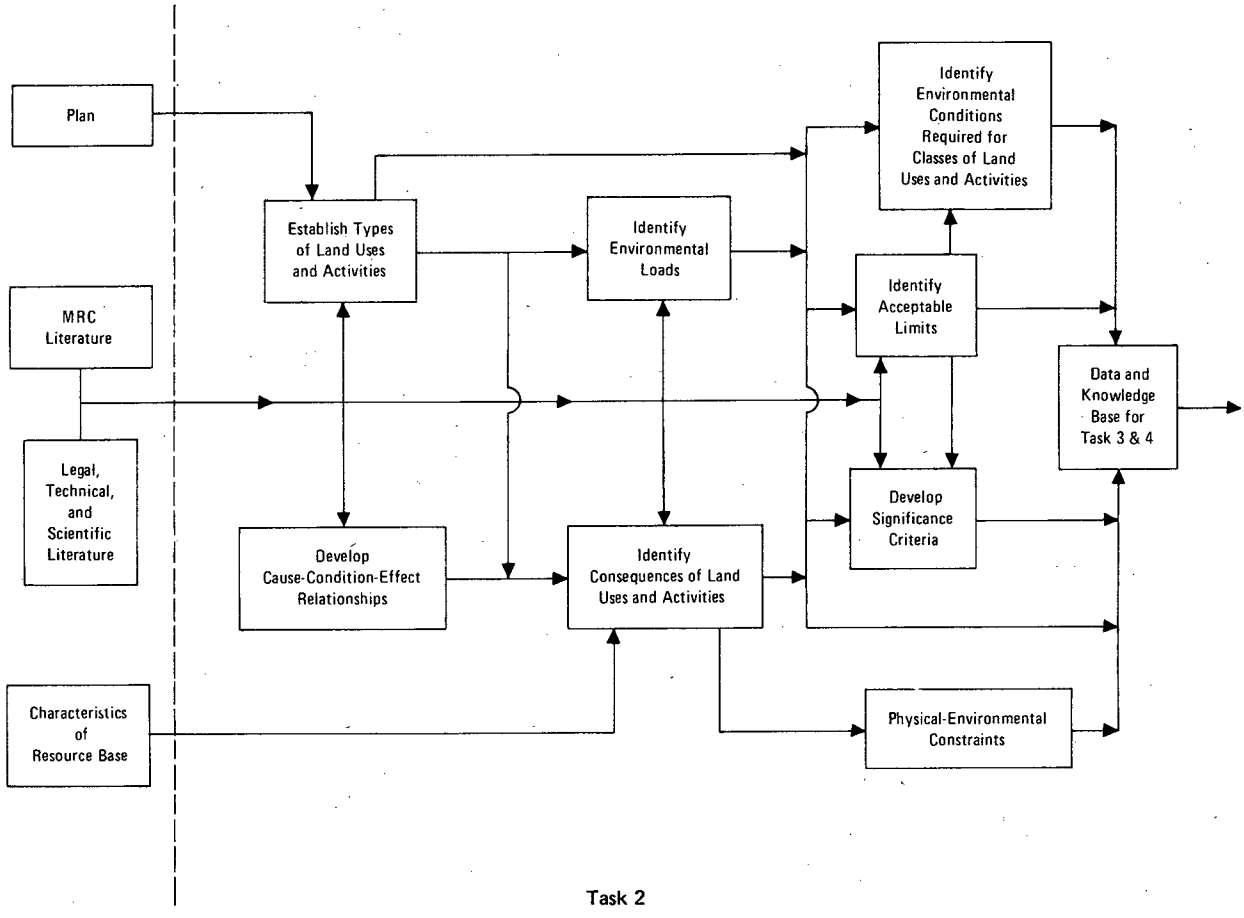
Product

A report specifying the nature, location, and developmental significance of each constraint. The report will include maps identifying critical environmental areas.

Final Product

A data base suitable for use in Tasks 3 and 4.

DISCIPLINES OR SKILLS REQUIRED		LEVEL OF EFFORT (MAN DAYS)
Professional		
Administration		30
Comprehensive Planning		40
Engineering		90
Environmental Planning		90
Hydrology		30
Law		25
Marine Science		135
Public Health		20
Systems Analysis		60
	Total	520
Support Skills		
Clerical		55
Key Punch		25
Planning Aide		50
	Total	130
	Task 2 Total	650


Plan
MRC Literature
Legal, Technical, and Scientific Literature
Characteristics of Resource Base
Establish Types of Land Uses and Activities
Develop Cause-Condition-Effect Relationships
Identify Environmental Loads
Identify Consequences of Land Uses and Activities
Identify Environmental Conditions Required for Classes of Land Uses and Activities
Identify Acceptable Limits
Develop Significance Criteria
Physical-Environmental Constraints
Data and Knowledge Base for Task 3 & 4

Task 2

TASK 3

STATEMENT OF TASK

The Contractor shall develop an analytical framework capable of yielding solutions to the problem of maximizing Plan objectives subject to various environmental constraints. In addition, a systematic procedure for storing, retrieving, and manipulating large amounts of diverse environmental data will be developed. The Contractor will also investigate the applicability of other models which can help to explain the implications of specific environmental loads, resource modifications, and their cause-condition-effects.

Objectives

1) To design a programming model capable of yielding results in terms of the maximization of various planning objectives relative to applicable environmental constraints.
2) To develop a procedure for storing, retrieving, and manipulating data on environmental loadings at any required combination and scale.
3) To investigate the applicability of other models and relevant analytical frameworks which may assist in determining the magnitude and incidence of environmental loadings, and which describe the impacts of resource base modifications identified in Task 2.

Knowledge Base

The methodologies dealing with complex problems of constrained maximization have been developed by Kuhn, H. and Tucker, A., "Nonlinear Programming," in Newman, J., ed., *Proceedings of the Second Berkeley Symposium on Mathematical Statistics and Probability,* (Berkeley, Cal., University of California Press, 1951); and Dantzig, G., *Linear Programming and Extensions,* (Princeton, N.J., Princeton University Press, 1963); and other mathematicians. Applications and extensions of these mathematical models into resource allocation strategies have been developed by Dorfman, R., Samuelson, P., and Solow, R., *Linear Programming and Economic Analysis,* (New York, N.Y., McGraw-Hill Co., 1958); and Wu, Y. and Kwang, C., "An Analytical and Graphical Comparison of Marginal Analysis and Mathematical Programming in the Theory of the Firm," in Boulding, K., and Spivey, A., eds., *Linear Programming and the Theory of the Firm,* (New York, N.Y., MacMillan, 1960); as well as by other economists. Further extensions of mathematical programming techniques into specific resource allocation problems with environmental constraints have been discussed by Isard, W., et al., *Ecologic-Economic Analysis for Regional Development,* (New York, N.Y., Free Press, 1972); and Russell, C. and Spofford, W., Jr., "A Quantitative Framework for Residuals, Management Decisions," in Kneese, A. and Bower, C., eds., *Environmental Quality Analysis,* (Washington, D. C., Resources for the Future, 1972); and Hoffman, K., "A Unified Energy Framework," in Searle, M., ed., *Energy Modeling,* (Washington, D. C., Resources for the Future, 1973).

Information management systems capable of storing, retrieving, and manipulating large amounts of diverse data have been in existence for several years. Many of these systems exist in package form, i.e., GIPSY (General Information Processing System), DABICS (Westinghouse Data Base Management System), or the IBM Information Management System. It will be possible to employ or modify an existing data management system to satisfy the demands of Task 3.

Available models and analytical frameworks which can depict the transport, diffusion, and magnitude of environmental loads, and which can describe the impacts of resource modifications will be used to supplement the programming model. The relevance of these supplemental models cannot be overlooked as they may help explain the probable impact of land uses, activities, and their modifications. A study of the San Francisco Bay area conducted by the College of Engineering and School of Public Health, University of California (Berkeley), developed a linear programming model capable of minimizing the cost of achieving a given water quality goal. Their method was limited, however, because quality standards were expressed in terms of the maximum allowable quantities of waste discharged. The model was subsequently refined by the development of a dispersion model which was then integrated with the general programming model. This is similar to the requirements of Task 4. In fact, the programming model developed in Task 3 can be supplemented in parallel fashion with the pollution

susceptibility model developed by the Marine Sciences Research Center, Stony Brook. Other potentially useful models include the U.S. Geological Survey's analog model of Long Island groundwater which can portray changes in surface water flows induced by various groundwater withdrawal practices, models of barrier beach dynamics which compare the geomorphic and ecological interactions of natural and altered barrier islands in North Carolina, and oxygen sag models which assist in establishing tolerable loads of BOD in receiving waters. A description of models describing water transport can be found in Ortolano, L., *The Movement and Quality of Coastal Waters: A Review of Models Relevant to Long Island, New York,* (July, 1970). The cause-condition-effect framework is described in Ellis, R., et al., *Functional Step One, The Development of A Procedure and Knowledge Requirements for Marine Resource Planning.*

Relation of This Task to Other Tasks

This Task establishes a methodology which can order, classify and combine large amounts of data to facilitate the determination of Plan alternatives required in Task 4. Tasks 2 and 3 will start simultaneously. This is necessary in order to ensure that the data collected in Task 2 is in a form suitable for subsequent mathematical analysis, and to ensure that the programmer is aware of the limitations of the available data.

General Methodology

Models or analytical frameworks have been formulated to assist in the decision-making process. Some models are relatively simple, and are used to organize data for a specific purpose, e.g., an inventory control model. Others, however, begin with a specific objective statement and then proceed to develop various strategies for attaining the stated objective. Many of these decision problems are sufficiently complex to require the use of sophisticated mathematical programming techniques. Models applicable to the analytical tasks of this project will run from a straightforward accounting procedure to a model which follows the general strategies of linear programming. An existing procedure for storing, retrieving and performing simple operations on the data will be selected for use in Work Element 1. The general methodology which will be used to solve problems relating Plan objectives to environmental constraints will be based on a mathematical programming technique which seeks optimal solutions by testing a large number of feasible solutions in an iterative procedure until the single best solution is reached. This is called the "simplex algorithm" and forms the basis for solving many linear programming and resource allocation problems. A literature search will be conducted to identify those models, frameworks and engineering data which can be used to supplement and refine the analysis of specific environmental loads, their relevant constraints, and resource base modifications. These models will generally be drawn from the technical literature and will be supplemented by material developed specifically for application in the Nassau-Suffolk region.

WORK PLAN

Work Element 1

Objective

The objective is to design a programming model capable of yielding results in terms of maximizing various planning objectives relative to environmental constraints.

Methodology

A systems analyst will be responsible for developing an analytical framework suitable for use in Task 4. Several types of mathematical programming models have been developed to deal with problems of constrained maximization and resource allocation. Possibly the most applicable model capable of dealing with the problem of maximizing the objectives of a comprehensive regional plan, when subjected to various environmental and physical constraints, is the linear programming framework developed by Dantzig. This methodology, however, does not readily accommodate those non-linear constraints that may represent various environmental conditions and resource base limitations. In such cases, extensions of the basic linear programming methodology may be required. As the ability to arrive at useful solutions to these models depends on the existence of sufficient empirical data, the science team and the program analyst may have to develop a number of "environmental proxies" which will be used both as a surrogate data input and as the basis for any required sensitivity analysis.

A more technical description of the linear programming framework which is applicable to this task can be found at the end of Task 3.

Findings

A suitable model based on mathematical programming techniques, developed to handle environmental data and produce required solutions.

Product

A report describing the model, its rationale, relevant literature, data requirements, and procedures.

Work Element 2

Objective

The objective is to develop a procedure for storing, retrieving, and manipulating data on environmental loads at any required combination and scale.

Methodology

Task 2 will generate a large amount of numerical information. A method must be devised which can store and selectively retrieve this material in various classifications and subject it to any required operations. The manipulation of these data entails a relatively simple accounting procedure, well within the capability of a straightforward computer assisted program. When individual environmental loads are aggregated, however, the result may not be linear. In the same sense, the various technologies which generate environmental loads may also deviate from linearity. Thus, the shape of these "production functions" must be roughly determined with emphasis on any significant departures from linearity. A simple mathematical procedure may be sufficient to aggregate environmental loadings when they are produced in a linear fashion but, when their sums depart from linearity, the problem of evaluating them can become much more complex. Systems analysis and engineering input will be used to evaluate any departures from linear relationships and develop required corrections.

Findings

A procedure capable of storing, retrieving, and manipulating data produced in Task 2.

Product

A paper describing the procedure, its rationale, and applicability.

Work Element 3

Objective

The objective is to investigate the applicability of other models and relevant analytical frameworks which may assist in determining the magnitude and incidence of environmental loads and modifications of the resource base identified in Task 2.

Methodology

Engineers, scientists, and systems analysts will conduct a search for supplementary models which may help to explain the incidence and magnitude of specific environmental loads and resource base modifications. Some of these models, for example, the U.S. Geological Survey's groundwater model, are site specific to Long Island, while others, such as the technique for determining allowable BOD levels in receiving streams, have broad engineering applicability. Similarly, the cause-condition-effect framework may serve as a useful supplementary tool for identifying the probable consequences of modifications to the resource base itself, and for other problems where the established data base appears inadequate.

Findings

Supplemental models will be identified and integrated when possible with the overall programming model developed for use in Task 4.

Product

A report describing these supplemental models, their intended use, and transferable elements.

Final Product

A detailed report describing the various models developed and utilized in Task 3, their framework, literature, and applicability.

DISCIPLINES OR SKILLS REQUIRED		LEVEL OF EFFORT (MAN DAYS)
Professional		
Administration		20
Comprehensive Planning		20
Economics (Modeling)		10
Engineering		25
Environmental Planning		40
Hydrology		15
Marine Science		20
Public Health		10
Systems Analysis		120
	Total	280
Support Skills		
Clerical		25
Drafting (including map drafting)		15
Key Punch		5
Planning Aide		10
	Total	55
	Task 3 Total	335

TASK 3 TECHNICAL APPENDIX

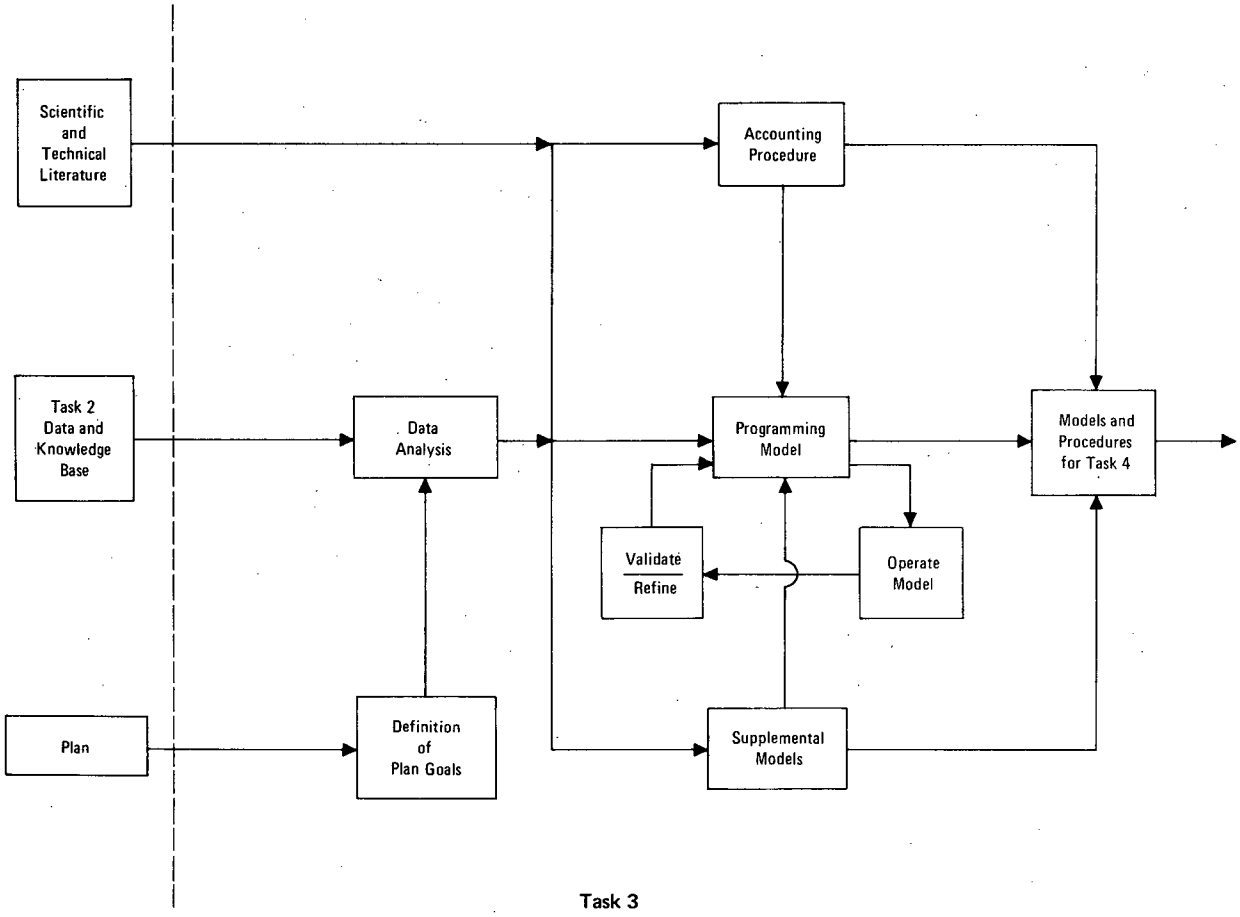
The use of a linear programming framework, e.g., the analysis of problems in which a function of a number of variables is to be maximized (or minimized) when these variables are subject to a number of restraints in the form of inequalities, enables the analyst to bring to bear the powerful computational and solution methods developed to deal with complex resource allocation problems. The use of a linear programming framework seizes on the strategic relationships that control the phenomena it describes and enables us to manipulate various elements in such a way as to arrive at optimal-feasible solutions. This approach extends the classical optimization procedures in a significant way.

The major task of a model applicable to the requirements of Task 4 is to yield optimal-feasible solutions to problems defined by a linear objective function subject to a set of linear constraints. It is expected that the solution to this problem can proceed along the lines of the general computational framework developed by Dantzig, the "simplex method" (Dantzig, G., *Linear Programming and Extensions).* This method hunts for solutions through successive iterations wherein one variable is substituted for another. New solutions are alternatively determined and tested until it is no longer possible to improve the solution. In the analysis required for Task 4, the various successive iterations will take place in terms of minimizing the environmental loads expected from various land uses and activities in various combinations. In most maximization problems it is useful to associate a closely related minimization problem where the original, or primal problem is reversed, i.e., where an objective is to be maximized in the primal, it is to be minimized in the dual. The nature of this duality is related to this task as it requires a consideration of those land use and activity modifications which will either further the Plan's objectives subject to environmental constraints or minimize environmental impacts subject to meeting the Plan's objectives. The nature of the dual problem is discussed in Gale, D., *The Theory of Linear Economic Models,* (New York, N.Y., McGraw Hill Co., 1960); and Baumol, W., *Economic Theory and Operations Analysis,* (New Jersey, Prentice-Hall, 1965).

Although a linear programming framework involving the simplex algorithm may be the most straightforward computational method capable of dealing with Task 4, it is expected that, when the precise nature of the environmental constraints and Plan objectives is understood, it may be necessary to deviate from strict linear relationships. If it is necessary to consider various aspects of non-linear programming, they will be introduced only as required and in their least radical form. For example, the generalized separable programming algorithm developed by Miller, C., "The Simplex Method for Local Separable Programming," pp. 89-100, in Graves, R. and Wolfe, P., eds., *Recent Advances in Mathematical Programming,* (New York, N.Y., McGraw-Hill Co., 1963), can handle nonlinear constraints by developing linear approximations for non-linear relationships which are then solved as a linear programming problem. If the environmental constraints and Plan objective functions can only be expressed in non-linear terms, it is possible to employ a gradient type of analysis which will involve successive movement in feasible regions towards Plan objectives. Many

variants of this idea exist. Some of the more useful are the gradient projection technique as described in Goldfarb, D., and Lapidus, L., "A Conjugate Gradient Method for Non-Linear Programming Problems with Linear Constraints," *Industrial and Chemical Engineering Fundamentals,* VII, pp. 142-151, 1968; and the penalty function method combined with variable metric gradient descent schemes described in Fiaccho, A., and McCormick, G., *Non-Linear Programming,* (New York, N.Y., John Wiley & Sons, 1968); or Beltrami, E., *Non-Linear Analysis and Optimization,* (New York, N.Y., Academic Press, 1970).

As the coefficients in the optimization model are based on observable data, there may be a degree of uncertainty regarding their values. It is then appropriate to perform a sensitivity analysis to determine whether or not unreliable or otherwise unstable data are a significant problem. In particular, small changes in environmental constraints can be evaluated through the appropriate dual multipliers.



Task 3

TASK 4

STATEMENT OF TASK

The contractor shall identify alternatives which can satisfy various Plan objectives subject to the requirement of minimizing the effects of those adverse environmental loads implied in the Plan.

Objective

To arrive at alternative solutions to an allocation problem which treats the dual aims of maximizing the Plan objectives and minimizing adverse environmental loads. It is possible to identify many land use and technical alternatives to this development plan. Some will further the Plan's objectives with various levels of implied environmental damage; other alternatives will minimize environmental damage but result in shortfalls in the achievement of Plan objectives. It is necessary then, to develop both sides of this problem so that reasonable tradeoffs in terms of political and economic feasibility can be evaluated. It is even possible that the Plan, as originally conceived, may represent a close to optimal solution in terms of the tradeoffs between Plan objectives and adverse environmental impacts. There is, however, no way for such an *a priori* judgement to be made at this time.

Knowledge Base

The knowledge base for this task is the analytical framework developed in Tasks 2 and 3.

Relation of This Task to Other Tasks

Using the data and procedures developed in Tasks 2 and 3, this task will identify Plan alternatives that will serve as an input to the economic and political analyses of Task 5. Tasks 2, 3, and 4 are linked by their data demands, analytical processes, and outputs.

General Methodology

Task 4 produces the required solutions to a resource allocation problem from the use of the numerical data developed in Task 2 in the programming model developed in Task 3. This programming model will be supplemented by other relevant models which help to explain the incidence and magnitude of specific environmental loads.

WORK PLAN

Work Element 1

Objective

The objective is to aggregate expected environmental loads at the required scale.

Methodology

A computer programmer will use the data management system developed in Task 3 to aggregate the environmental loads identified in Task 2.

Findings

Data on environmental loads at the required scale.

Product

Data in a form suitable for Task 4 analysis.

Work Element 2

Objective

The objective is to identify technically feasible engineering alternatives to service the activities and levels of demand implied by the Plan, and to investigate those technology mixes which may be capable of minimizing environmental loads. These engineering alternatives shall include environmental modifications, e.g., the creation of new inlets, channel modifications, coast stabilization measures, and wetlands creation.

Methodology

Land uses and activities will require the existence of a physical infrastructure, e.g., wastewater treatment facilities, transportation networks, etc. Their technical requirements must be identified in terms of location, probable scale, and applicable techniques. The application of available or emerging engineering techniques and environmental modifications will be investigated to determine the extent to which they can minimize the environmental loads implied by the Plan. In the case of groundwater/wastewater problems, for example, it may be necessary to investigate the use of alternatives such as secondary treatment with ocean disposal, secondary treatment with groundwater recharge, tertiary treatment with groundwater recharge, or even cesspool disposal with tertiary treatment of the fresh water supply at the wellhead. Engineers will determine those

activities and technologies at the scale required to support the Plan's land uses. Use will be made of engineering data in the relevant fields, such as wastewater disposal, power plant technology, and water supply.

Findings

Identification of technically feasible alternatives for various support activities and a description of feasible environmental modifications and their probable effects.

Product

A report identifying technical alternatives by type, probable effectiveness, and probable availability.

Work Element 3

Objective

The objective is to determine the nature and extent of the required changes in Plan land uses and activities stemming from the environmental conditions and resource limitations specified in Task 2. In addition, those changes in land uses and activity levels which will be necessary to accommodate the population and activities displaced when these constraints are recognized, will be identified.

Methodology

When the environmental constraints and resource limitations specified in Task 2 are applied to the 1985 land use map, specific land uses or activity levels in certain areas may be unacceptable. Residential land uses, for example, may be curtailed on barrier beaches, in flood plains, on unstable landforms, or in the noise envelope surrounding the region's airports. Planners and systems analysts will identify these areas of conflict and the nature and extent of the changes required to accommodate the populations and activities displaced when environmental constraints are recognized. Applicable supplemental models identified in Task 3 will be used to help determine the required changes. This is an extension of the work discussed in Florida Coastal Coordinating Council, *Coastal Zone Management in Florida — 1971,* (Tallahassee, Fla., Florida Coastal Coordinating Council, 1971).

Findings

Required modifications to the 1985 land use map reflecting environmental constraints and natural resource limitations.

Product

A series of maps with supporting data.

Work Element 4

Objective

The objective is to produce alternatives which can best satisfy Plan objectives while minimizing their implied environmental effects.

Methodology

Based on the methodologies developed in Task 3, it will be possible to run a programming model to yield feasible solutions to the problem of minimizing environmental loads subject to Plan constraints. The model will produce alternatives which will either further the Plan's objectives subject to environmental constraints, or minimize environmental impacts subject to meeting the Plan's objectives. This requires the translation of Plan objectives and environmental constraints into suitable mathematical formats. While it may be theoretically possible to secure a single solution to the programming problem, it will be necessary to search for a number of second-best solutions in terms of land use mixes that minimize implied environmental damage, technology mixes that can reduce environmental loads, and Plan objectives which can be satisfied in the face of environmental constraints.

The requirement that Task 4 produce a number of feasible alternatives arises from practical considerations. Task 5 requires that the model generate more than one alternative, although none may be optimal. If this requirement is not met, and the model produces only a single solution, it may be discarded as a result of the Task 5 analysis.

Findings

Various solutions to a constrained optimization problem.

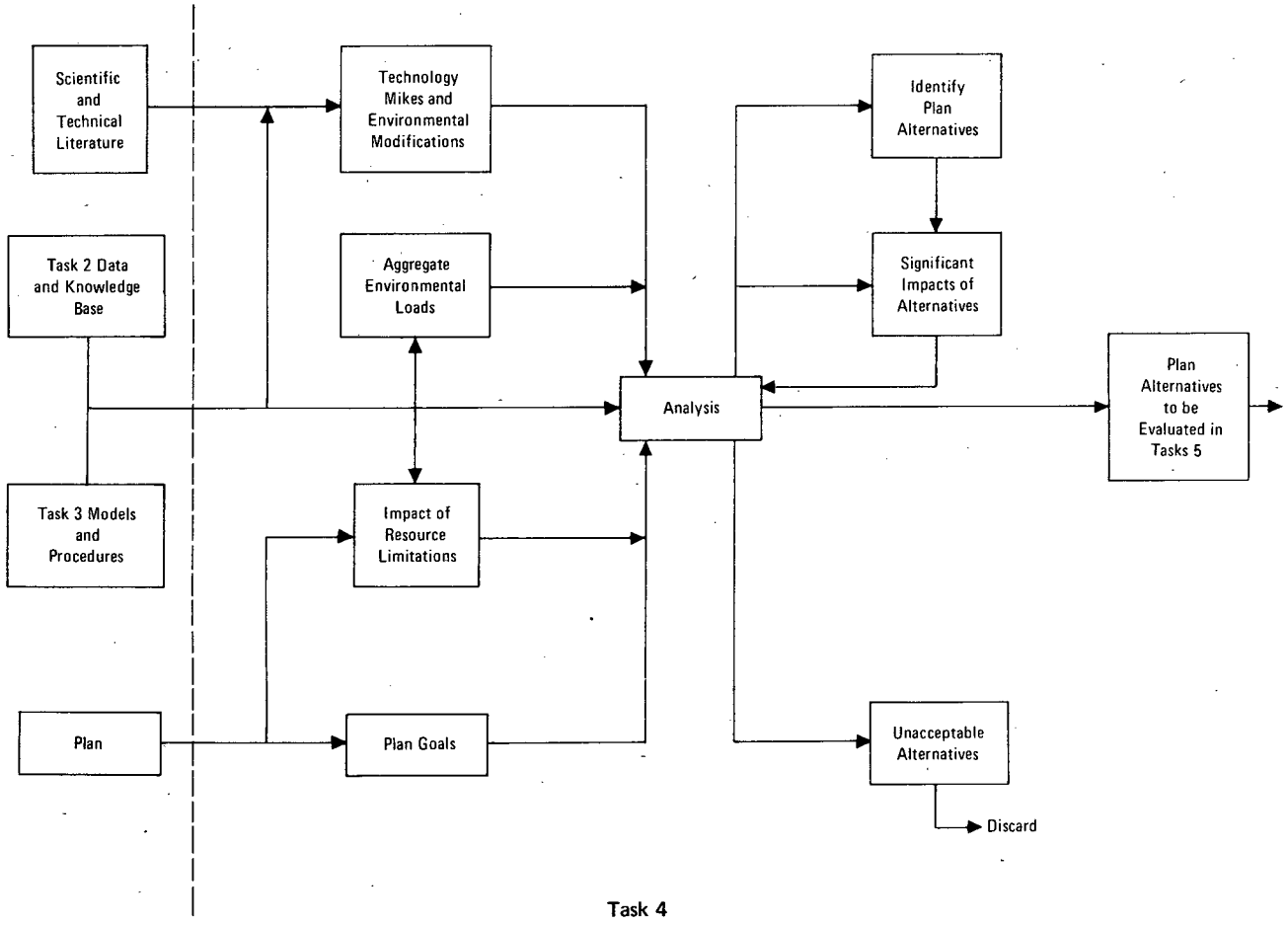
Product

A paper describing the various alternatives suitable for use in Task 5.

Final Product

A report detailing the nature of the solutions and their relevant trade-offs suitable for subsequent analysis in Task 5.

DISCIPLINES OR SKILLS REQUIRED	LEVEL OF EFFORT (MAN DAYS)
Professional	
Administration	25
Comprehensive Planning	45
Economics (Modeling)	10
Engineering	60
Environmental Planning	60
Hydrology	40
Marine Science	70
Public Health	30
Systems Analysis	40
Total	380
Support Skills	
Clerical	75
Drafting (including map drafting)	35
Planning Aide	25
Total	135
Task 4 Total	515



Task 4

TASK 5

STATEMENT OF TASK

The contractor shall evaluate the feasibility and desirability of Plan alternatives in terms of their cost, probable benefit, and political acceptability.

Objectives

1) To evaluate those alternatives developed in Task 4 in terms of their economic merit.
2) To evaluate those alternatives developed in Task 4 in terms of their socio-political feasibility.

Knowledge Base

The analysis of socio-political feasibility is less developed than the evaluation of economic merit, where techniques of benefit-cost and cost-effectiveness analyses are reasonably well established. In contrast, the assessment of socio-political feasibility has often been based on intuition and unsubstantiated generalizations.

This task will combine economic analysis with those elements of other disciplines which have addressed the problem of socio-political feasibility. This problem is discussed in Meltsner, A., "Political Feasibility and Policy Analysis," *Public Administration Review,* (XXXII: 6, Nov. - Dec., 1972); Cavala, B., and Wildavsky, A., "The Political Feasibility of Income by Right," *Public Policy,* (XVII: 3, 1970); Gergen, K., "Assessing the Leverage Points in the Process of Policy Formation," in Bauer, R., and Gergen, K., eds., *The Study of Policy Formation,* (New York, N.Y., Free Press, 1968); Dror, Y., *Policy Analysis: A Theoretic Framework and Some Basic Concepts,* (Santa Monica, Cal., RAND, 1969); and Boaden, N., *Urban Policy Making,* (New York, N.Y., Cambridge University Press, 1971). The Nassau-Suffolk Regional Planning Board, as the primary Long Island governmental agency engaged in the analysis, interpretation, and presentation of U.S. Census data, has developed considerable amounts of economic and demographic data useful for this task.

There is an extensive literature on the techniques of benefit-cost and cost-effectiveness analysis. Much of this literature is summarized in Prest, A. and Turvey, R., "Cost Benefit Analysis: A survey," in American Economic Association and Royal Economic Society, eds., *Surveys of Economic Theory,* (New York, N.Y., St. Martins Press, 1966). Some useful extensions of this analytical approach can be found in Dorfman, R., *Measuring the Benefits of Government Investment,* (Washington, D.C., Brookings, 1965).

Relation of This Task to Other Tasks

Task 4 provides the alternatives to be analyzed in Task 5. Task 5 will subject these alternatives to an evaluation of their economic and political merit. Those alternatives which survive this evaluation will constitute the basic input into Tasks 6 and 7.

General Methodology

Task 5 comprises three separate efforts: an initial assessment of Plan alternatives to eliminate those which are *prima facie* infeasible, an evaluation to determine the economic merit and desirability of specific Plan alternatives, and an evaluation of the socio-political feasibility.

The basic methodological techniques used in this task are:

1. Benefit-Cost and Cost-Effectiveness Analysis
   These techniques have been developed to assist in the determination of the relative merit of alternate and often competing ways of accomplishing a specific objective, especially in those cases where there is no effective set of market signals, or where the action or objective is in terms of collective goods, e.g., public roads, clean air, pure water, etc. It is generally possible to estimate the costs of a particular activity or program, and, where the benefits derived from the activity or program cannot be specified, an analysis of its worth is possible only in terms of the least-cost way of accomplishing the objective. By introducing a benefit side to the analysis, it may be possible to identify programs where a least-cost solution is not appropriate. In many cases it is expected that the identification of benefits cannot be determined with precision, but even a rough qualitative analysis can assist a decision-maker more than a least-cost solution by itself.

2. Aggregate Data Analysis
   This is a widely utilized and readily available methodological technique. With Nassau-Suffolk census data on tapes and packaged computer programs available, demographic analysis can be performed using standard statistical tests such as partial and multiple correlation and factor analysis. These procedures will permit the study of the political characteristics of selected geographical units as they relate specific policy orientations to environmental issues.
3. In-depth Interviewing
   This is a method of gathering knowledge relating to the interactions among policy makers, their values, and objectives. This information is essential to the analysis of political feasibility. This method of interviewing has been selected in preference to a sample survey of the general population because it is less expensive and generally produces more relevant indicators regarding political decision making. See, for example, Dexter, L., *Elite and Specialized Interviewing,* (Chicago, Ill., Northwestern University Press, 1968).

WORK PLAN

Work Element 1

Objective

The objective is to develop a procedure which will allow the choice of those Plan alternatives which should be subjected to further analysis.

Methodology

Criteria will be established to determine *prima facie* infeasibility of Task 4 alternatives. These criteria will be developed by the planning staff and consultants. Included in these criteria may be factors relating to constitutionality, legality, and the cost implications of suggested alternatives.

Findings

Prima facie criteria for the rejection of some Plan alternatives and the identification of those Plan alternatives which will be subjected to further evaluation in Task 5.

Product

A report for internal use.

Work Element 2

Objective

The objective is to determine the economic merit of specific Plan alternatives.

Methodology

The economic analysis applicable to Task 5 will focus on the evaluation of technically feasible ways of accomplishing defined objectives. It is necessary to specify these objectives at a level of detail which recognizes the technical substitutability of activities and processes. For example, if the objective is to maintain a certain water quality standard, the resulting analysis may evaluate the relative merits of controlling wastewater effluent versus controlling dockside oil spillage. Although they both further the objective of high water quality standards, their technologies and purposes are so diverse as to preclude a useful evaluation of one against the other. By ordering the probable large number of technically feasible alternatives in terms of the specific environmental conditions that they are designed to affect, the possibility of an inappropriate evaluation will be minimized. This will also permit an evaluation of Plan alternatives to take place in a rough qualitative fashion even if the data output of Tasks 2, 3, and 4 should prove incomplete.

Findings

Feasible alternatives will be identified and classified according to their technical substitutability.

Product

Information for internal use in Task 5.

Work Element 3

Objective

The objective is to establish the applicability of various benefit-cost methodologies to the evaluation of Plan alternatives.

Methodology

A literature search will identify those benefit-cost models, or analytical frameworks, that may be useful in an evaluation of Plan alternatives. As it is probable that these models will have to deal with a poorly developed data base, it will be necessary to determine how they can be translated into forms suitable for qualitative analysis.

Findings

An identification of applicable economic models.

Product

A technical paper comprising a discussion of the models, their general applicability to this analysis, and an annotated bibliography of the relevant economic literature.

Work Element 4

Objective

The objective is to further reduce the large number of alternatives identified in Task 4 in order to maintain the evaluation task within manageable proportions. This will permit an economic evaluation of Plan alternatives to take place in a rough qualitative fashion should the data input from Tasks 2, 3, and 4 prove inadequate.

Methodology

Alternatives will be ordered according to criteria, such as, purpose, frequency of occurrence, and engineering technique. Thus, the technically feasible Plan alternatives identified in Task 4 will be classified and grouped by major type.

Findings

The classification of Plan alternatives according to common objectives.

Product

Information for internal use in Task 5.

Work Element 5

Objective

The objective is to identify and evaluate the probable benefits and costs of technically feasible Plan alternatives.

Methodology

The basic methodology consists of the application of benefit-cost frameworks suitable for specific analytical problems. The identification and evaluation of the probable benefits and costs of Plan alternatives constitute the heart of the economic evaluation task. In many cases it is expected that data will be incomplete to the point where only a rough qualitative analysis will be possible. In cases where benefits and/or costs cannot be identified with sufficient precision, the evaluation of alternatives will be in terms of the probable least-cost way of achieving a defined objective. There will be no attempt to evaluate the benefits and costs of general allocation problems, e.g., beach erosion vs. wetlands protection.

Findings

A determination of the degree of applicability of the benefit-cost framework to Plan alternatives and a discussion of Plan alternatives in terms of their probable benefit-cost and/or cost effectiveness.

Product

A technical paper detailing the analytical results, rationale, and supporting literature.

Work Element 6

Objective

The objective is to determine the sociopolitical feasibility of the proposed Plan alternatives as they relate to the interests of affected persons or constituencies.

Methodology

A classification of significant aspects of Plan alternatives will be made according to their purpose, type, and financial implications. An analysis will then be made of persons or constituencies likely to be affected by various Plan alternatives. The first step will include a description of constituencies, i.e., identifiable groups or organizations whose response to coastal management alternatives may be expected to have a significant bearing on the possible implementation of various alternatives. These constituencies are both geographic and functional. Geographical constituencies are the units of local government. Functional constituencies include business firms, industries, and other interest groups.

The geographical constituencies will be evaluated on the basis of their past responses to coastal zone issues. Towns will be classified on the basis of their responses to state initiatives for the establishment of environmental councils. Municipalities which have purchased areas to preclude development will be distinguished from those which have not. Votes on environmentally related issues, such as environmental bond proposals, will be examined and classified. Interviews with governmental and nongovernmental officials will be used to supplement and verify indicators developed in the three preceding steps.

When villages and towns have been classified, statistical procedures will estimate the correlation between their social and political characteristics, e.g., population density, growth, and income levels, to relevant coastal

zone issues. Those constituencies showing pronounced positive or negative correlations will be selected for intensive study. Their decision-making processes and probable reactions to specific Plan alternatives will be examined and assessed wherever possible.

Functional constituencies will be identified from documentary records and interviews with selected individuals. This procedure will be used to gather information regarding issue orientations, values, resources, and strategies of functional constituencies.

Findings

1. The criteria for classifying Plan alternatives to facilitate socio-political analysis.
2. The relationship between demographic and socio-political characteristics of a sample of Long Island geographical units, their actions on a series of relevant environmental political issues, and an estimate of the causal factors which determine these relationships.
3. An identification of those functional constituencies that can be expected to play an important role in Long Island coastal zone management issues and in the implementation of Plan alternatives.
4. The criteria for estimating the feasibility of selected Plan alternatives according to the relevant characteristics of geographical and functional constituencies.

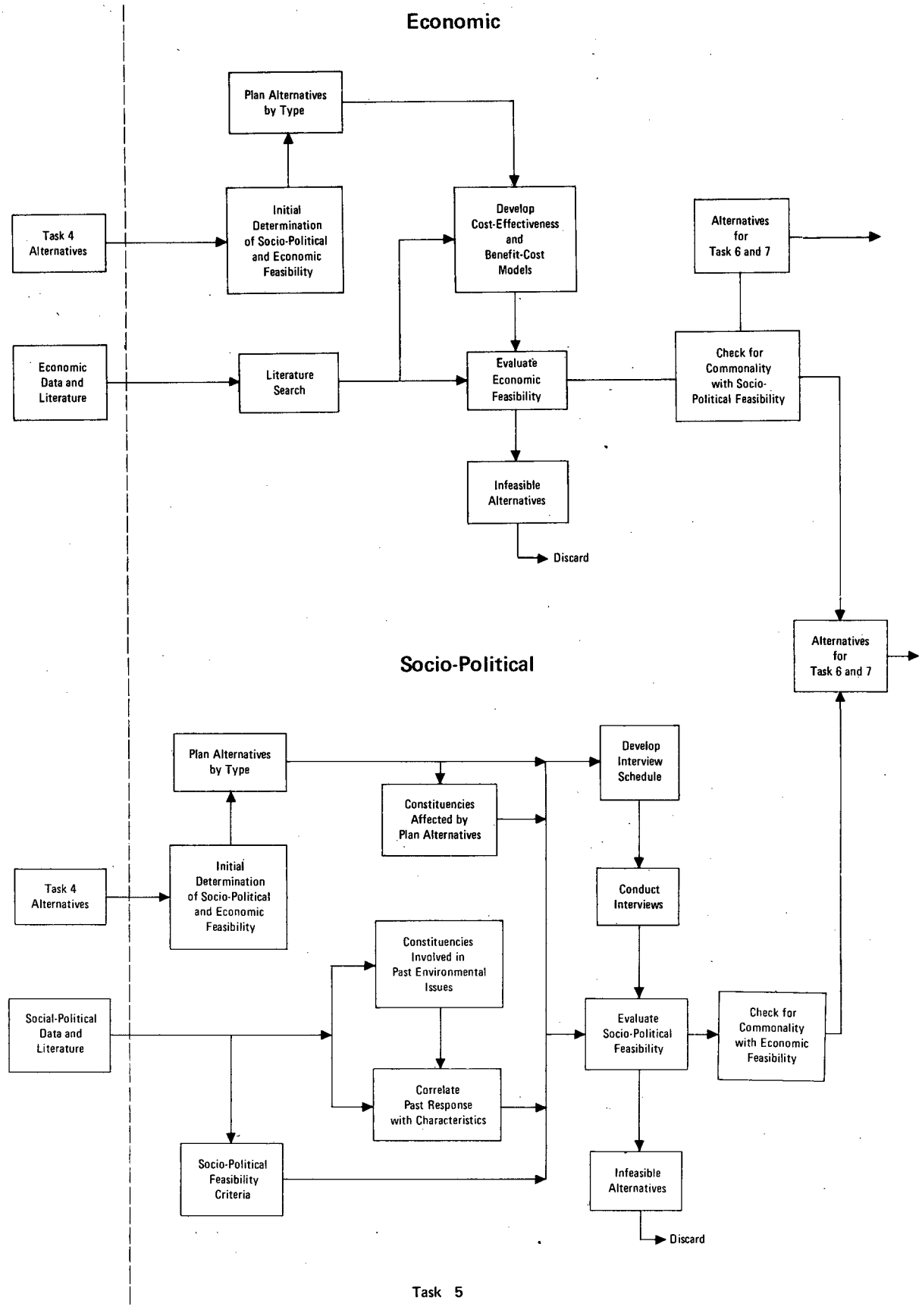
Product

1. A report explaining the various classification criteria, the characteristics of selected geographical constituencies, their past actions on environmental issues, and the identification of those geographical constituencies which may be expected to support or oppose specific Plan alternatives.
2. A report identifying and analyzing those functional constituencies significant to Plan implementation and coastal zone management.

Final Product

A report identifying those Plan alternatives which are technically, economically, and politically feasible.

DISCIPLINES OR SKILLS REQUIRED	LEVEL OF EFFORT (MAN DAYS)
Professional	
Administration	10
Comprehensive Planning	120
Computer Analysis	20
Economics	150
Engineering	30
Environmental Planning	10
Law	35
Political Science	110
Sociology	40
Welfare Economics	30
Total	555
Support Skills	
Clerical	175
Drafting (including map drafting)	20
Key Punch	5
Planning Aide	100
Total	300
Task 5 Total	855


Economic
Plan Alternatives by Type
Task 4 Alternatives
Initial Determination of Socio-Political and Economic Feasibility
Develop Cost-Effectiveness and Benefit-Cost Models
Alternatives for Task 6 and 7
Economic Data and Literature
Literature Search
Evaluate Economic Feasibility
Check for Commonality with Socio-Political Feasibility
Infeasible Alternatives
Discard
Alternatives for Task 6 and 7
Socio-Political
Plan Alternatives by Type
Develop Interview Schedule
Constituencies Affected by Plan Alternatives
Task 4 Alternatives
Initial Determination of Socio-Political and Economic Feasibility
Conduct Interviews
Constituencies Involved in Past Environmental Issues
Social-Political Data and Literature
Evaluate Socio-Political Feasibility
Check for Commonality with Economic Feasibility
Correlate Past Response with Characteristics
Socio-Political Feasibility Criteria
Infeasible Alternatives
Discard

Task 5

TASK 6

STATEMENT OF TASK

The contractor shall compile an inventory of the existing legal, administrative, and institutional tools available for the implementation of Plan alternatives. He shall also indicate the needs for governmental action, including the modification of regulatory structures, as well as needs for public information, education, and participation in the implementation process.

Objectives

1) To identify the types of governmental action required for the implementation of Plan alternatives.
2) To assess the legal capability of existing institutions and structures in respect to Plan implementation.
3) To identify those additional institutional arrangements required to implement the Plan.
4) To determine the need for public information, education, and participation required to support efforts at implementing the modified plan.

Knowledge Base

Ever since the origin of the city planning movement in the United States, the weakest link in the planning process has been the inability to guide plans through the political processes of local and regional government and establish them within an effective administrative framework. The planning literature provides a variety of explanations. They include a frequent absence of planning expertise, a lack of scientific data supporting planners' recommendations, the absence of political support for the planner, and competition among administrative agencies. These are discussed in Altschuler, A., *The City Planning Process: A Political Analysis,* (Ithaca, New York, Cornell University Press, 1965); and Rosenberg, F., *On Planning and Its Uses in Government,* (Hauppauge, N.Y., Nassau-Suffolk Regional Planning Board, 1971). Growing interest in environmental problems, and the consequent enactment of quality standards that are frequently difficult to enforce, has made the problem of planning implementation both more complex and crucial. This is especially true in coastal zone areas where ownership is frequently uncertain and jurisdictional gaps and overlaps exist. Moreover, there often seem to be no logical and consistent methods for developing, maintaining, and implementing a planning effort. Research into these problems is just beginning. See, for example, Ketchum, B., *The Water's Edge: Critical Problems of the Coastal Zone,* (Cambridge, Mass., MIT Press, 1972); Hite, J., and Stepp, J., eds., *Coastal Zone Resource Management,* (New York, N.Y., Praeger, 1971); and Hite, J., and Laurent, E., *Environmental Planning: An Economic Analysis,* (New York, N.Y., Praeger, 1972).

The research and practical experience of the Nassau-Suffolk Regional Planning Board, acquired during its efforts to implement the Plan, will be utilized in this task. In addition, Nassau-Suffolk Regional Planning Board research undertaken on behalf of the Nassau-Suffolk Comprehensive Health Planning Council to identify those governmental and non-governmental agencies dealing with environmental and public health problems, provides a base for a similar survey of those agencies related to the coastal zone. Moreover, various publications, either sponsored, written, or researched by the planning staff and its consultants, provide a source of data and recommendations relating to coastal planning in the two counties. Davies, D., Axelrod, E., and O'Connor, J., *Erosion of the North Shore of Long Island,* includes recommendations for the implementation of a specific aspect of coastal management. McGuinness, W., Jr., Pitchai, R., and Northrop, G., *Technology Transfer in The Marine Environment of Long Island,* (February, 1973), includes a description of the process by which the Marine Resources Council developed its coastal management guidelines, and a preliminary inventory of Federal and local agencies dealing with coastal management. Ortolano, L., *Quality Standards for the Coastal Waters of Long Island, New York,* (April, 1970), includes data on statutory responsibility for establishing and maintaining coastal standards. Green, R., *Wetlands on Long Island,* includes an assessment of procedures relating to wetlands management. McGuinness, W., Jr., *State of the Art for Selected Marine Resources Problems on Long Island,* (February, 1972), indicates those areas where research is

needed to improve policy formulation and implementation. The Marine Resources Council publication, *Guidelines for Long Island Coastal Management,* includes management guidelines and research priorities.

Relation of This Task to Other Tasks

The initial phases of Task 6 do not depend on input from earlier tasks, and can be undertaken concurrently with them. A sample of types of Plan alternatives is required, however, and will be selected from Tasks 4 and 5. The recommendations regarding administrative mechanisms in Task 6 will contribute to the development of selection criteria to be used in Task 7. In addition, this material will be utilized in Task 8 relating to the development of transferability criteria.

General Methodology

A literature search of legal and administrative documents in combination with established techniques of analysis in the fields of law, public administration, and political science, will constitute the basic methodology used in this task. Interviews with selected governmental and nongovernmental officials will be used to obtain detailed knowledge of important problem areas. Interviews will include, among others, members of those state and Federal agencies represented on the Regional Marine Resources Council.

WORK PLAN

Work Element 1

Objective

The objective is to identify Federal, State, and local administrative jurisdictions and their respective legal authorities for the categories established in the preceding task.

Methodology

An analysis will be made of legal and administrative documents to identify and specify the legal powers and individual and shared responsibilities of various agencies, e.g., Federal-State functions in water quality relating to the Long Island coastal zone. A classification of the probable major coastal zone management alternatives into categories will be made by type of applicable implementation, e.g., land use controls, tax policies, and public acquisition. Further documentary analysis and review will relate classes of coastal alternatives to specific governmental units and powers of implementation. The responsibility for implementing classes of alternatives will be assigned to their jurisdictions. Implementation agents and their jurisdictional powers applicable to types of Plan alternatives will be identified.

Findings

An assessment of the adequacy of existing governmental jurisdictions, powers, and administrative arrangements relating to the implementation of various Plan alternatives.

Product

A report containing an evaluation of existing mechanisms for the administration of Plan modifications and recommendations for new arrangements where necessary.

Work Element 2

Objective

The objective is to review, analyze, and evaluate the role of public information and public education programs in the implementation of environmental plans in general, and coastal management plans in particular.

Methodology

A review will be made of the technical, legal, and administrative literature dealing with the role of public participation in securing governmental action to protect the environment. Examples will be selected in which public participation appears to have been a major factor in securing governmental action, including a review of the role of public information efforts in the implementation of the Plan. Those private and public agencies which have cooperated in public information and education programs related to the implementation of the Plan will be identified. Techniques or strategies to enlist public support for Plan proposals will be identified.

Findings

An identification of those factors determining the effectiveness of public participation in obtaining governmental action to protect the environment, especially in the coastal zone.

Product

A report that summarizes the role of public participation in obtaining governmental action to protect the environment, with recommended strategies for public participation.

Work Element 3

Objective

The objective is to devise new legal and administrative structures, or modifications of existing ones, wherever needed, to permit the implementation of Plan alternatives.

Methodology

Administrative and legal requirements for Plan modifications that are not adequately covered in existing arrangements will be identified. A literature search will identify those laws and institutional devices currently employed in other parts of the United States for implementing recommendations relating to planning and environmental quality. A literature review, supplemented by interviews with public officials, will be used to evaluate these laws and institutional devices in terms of their use in implementing Plan alternatives.

Findings

New or modified laws and institutional arrangements which could be used to further the implementation of Plan alternatives.

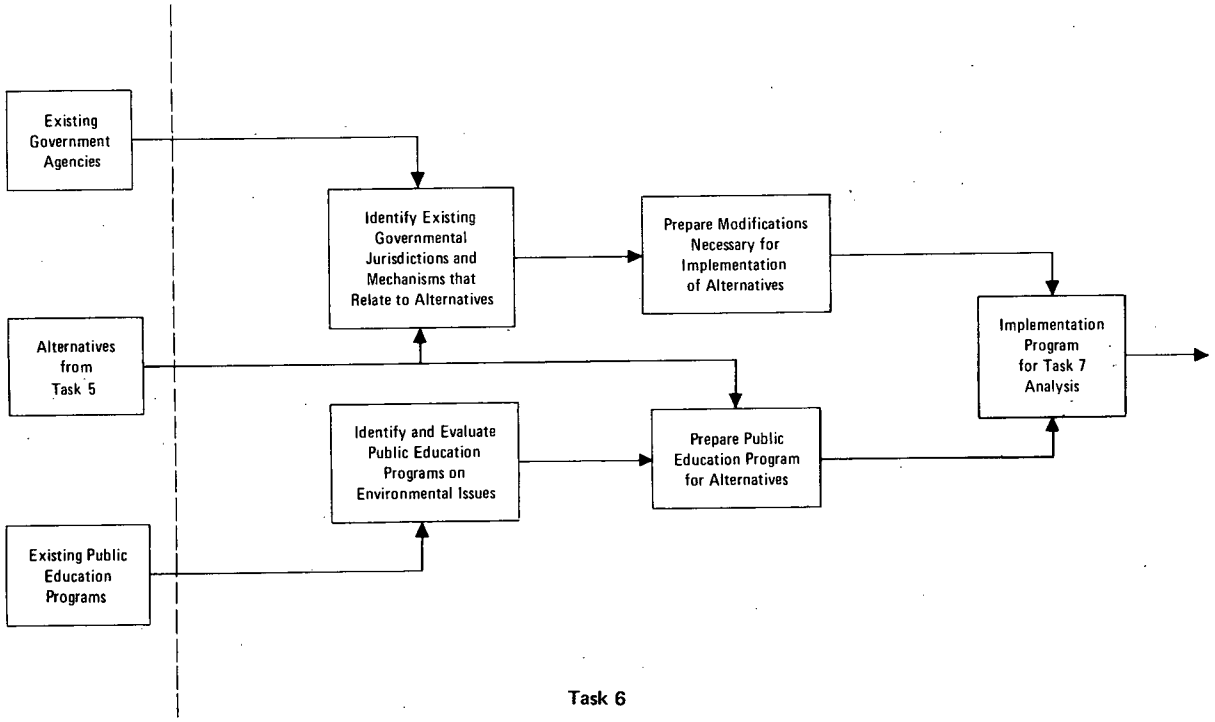
Product

A report specifying laws and administrative arrangements which could further the implementation of the Plan.

Final Product

A report specifying recommended laws and administrative mechanisms.

DISCIPLINE OR SKILLS REQUIRED	LEVEL OF EFFORT (MAN DAYS)
Professional	
Administration	30
Comprehensive Planning	110
Economics	10
Engineering	10
Environmental Planning	10
Law	45
Marine Science	10
Political Science (including Pub. Adm.)	100
Sociology	10
Total	335
Support Skills	
Clerical	125
Drafting (including map drafting)	20
Planning Aide	25
Total	170
Task 6 Total	505



Task 6

TASK 7

STATEMENT OF TASK

The contractor shall select a comprehensive and consistent set of Plan alternatives.

Objective

To develop a set of those Plan alternatives most capable of satisfying the goals of the Plan, while preserving or enhancing the environmental quality of the coastal zone.

Knowledge Base

The Nassau-Suffolk Regional Planning Board is attempting to relate regional planning and environmental science in a comprehensive and systematic manner. In the past, scientific input to comprehensive planning has often been extremely uneven and generally limited to those sections of a plan where the planning staff possessed specific interest or expertise, or to special problem areas requiring the application of scientific knowledge, e.g., pervasive smog conditions, seismic activity, or severe erosion. The original Plan emphasized environmental quality, but the incorporation of environmental knowledge was more often general and intuitive rather than precise and deliberate. The findings of the Marine Resources Council's predecessor, the Oceanographic Committee, are reflected in the Plan, while some of the current results of the Council's research do not appear.

The research efforts of the Marine Resources Council and its seminars; the Nassau and Suffolk County water supply, sewer, and solid waste disposal studies; and the literature searches undertaken in previous tasks, contribute to the knowledge base which the staff and their scientific consultants can bring to bear on the selection and justification of Plan revisions.

Relation of This Task to Other Tasks

Task 7 completes the analytical aspects of this project and relies on inputs from all prior tasks.

It is anticipated that the Task 6 draft working paper and background materials will be available at the start of Task 7. Experience gained with the methodology in Task 7 is expected to produce guidelines for inclusion in the Handbook to be prepared in Task 9.

General Methodology

The general approach is that customarily employed in plan formulation; namely, the weighing of available alternatives and the selection of a series of recommendations that comes closest to achieving previously identified goals. It involves analysis, synthesis, testing, consideration of the relevant trade-offs, the development of a final plan, a statement of its rationale, and an implementation program.

WORK PLAN

Work Element 1

Objective

The objective is to identify goals and objectives contained in the Plan, coastal zone management legislation, and Marine Resources Council guidelines.

Methodology

Planners and political scientists will analyze the Plan and coastal zone management legislation to identify goals and objectives by subject, e.g., housing, wetlands, time frame, and probable beneficiaries. Environmental scientists and planners will review guidelines and other findings of the Marine Resources Council and its consultants to identify environmental goals not expressly stated in the Plan or in coastal zone management legislation. Planners will develop a matrix describing those goals and objectives that are the basis for Plan modification. It should show each goal by subject, probable beneficiary, and time frame.

Findings

A diverse collection of social and environmental goals and objectives related to the needs of a variety of subjects and persons. These may include, for example, the need to provide adequate housing for the economically disadvantaged, and the desirability for protecting the nesting areas of migratory birds.

Product

A matrix and explanatory text for inclusion in the final report.

Work Element 2

Objective

The objective is to develop a system that will permit the ordinal ranking of Plan alternatives in terms of their ability to minimize environmental conflicts while maximizing the achievements of Plan goals.

Methodology

Planners will devise an ordinal ranking scheme to indicate a positive, neutral, or negative contribution to the realization of planning and environmental goals. Environmental scientists and planners will then apply this scheme to Plan alternatives, ranking them relative to the attainment of immediate and long range goals.

Findings

A scheme indicating the rank of Plan alternatives by function or subject.

Product

A statement describing the ranking scheme and its application.

Work Element 3

Objective

The objective is to select a preliminary set of Plan alternatives.

Methodology

Planners and environmental scientists will select one alternative from the top ranked alternatives in each subject area. They will consider the ordinal rank of Plan alternatives in terms of goal achievement and will weigh the economic and social trade-offs and the problems of implementation.

Findings

A first-cut selection of Plan alternatives and a documentation of the basis for the choices that were made.

Product

A preliminary mix of selected Plan alternatives and the rationale for their choice.

Work Element 4

Objective

The objective is to evaluate the selected mix of Plan alternatives and identify potential environmental or planning conflicts.

Methodology

Analytical techniques developed for Tasks 3 and 4 will be applied.

Findings

The possible conflicts or undesirable effects arising from the combination of individually desirable Plan alternatives.

Product

A description of the findings for inclusion in the working paper.

Work Element 5

Objective

The objective is to improve the selected mix of Plan alternatives by replacing those that contribute to conflicts, or other undesirable effects, with those next-best alternatives capable of meeting Plan and environmental objectives.

Methodology

Environmental scientists and planners will select Plan alternatives to minimize potential conflicts or undesirable effects. They will consider the alternatives relative to Plan goals and their probable effectiveness in minimizing conflicts or undesirable effects.

Findings

A second cut (next-best) selection of Plan alternatives.

Product

A statement describing the revised set of Plan alternatives, the changes that were made, and the reasons for the additions or deletions.

Work Element 6

Objective

The objective is to iterate Work Elements 5 and 6 until the mix of Plan alternatives comes closest to satisfying Plan goals while minimizing their adverse environmental effects.

Methodology

Analytical techniques developed for Tasks 3 and 4 will be applied.

Findings

The identification of Plan alternatives with fewest potential conflicts or undesirable effects.

Product

A working paper identifying remaining problems related to a Plan alternatives mix.

Work Element 7

The objective is to propose a set of implementation strategies for the selected mix of Plan alternatives.

Methodology

Planners, economists, environmental scientists, lawyers, and political scientists will evaluate selected alternatives in respect to their political and economic implications. Drawing on the information assembled in Tasks 4, 5, and 6, the staff will draft recommendations for the implementation of the selected Plan alternatives. These recommendations may include, but will not be limited to, proposals for new legislation or new institutions, changes in various activity levels, and increased enforcement of existing environmental laws. Documentation will include a comparison of existing and proposed implementation strategies.

Findings

A set of recommendations for the implementation of the selected alternatives.

Product

A discussion of implementation problems, strategies and techniques, as they relate to the recommendations. These will be included in a working paper.

Work Element 8

Objective

The objective is to indicate the probable changes that may be expected to result from the implementation of various Plan alternatives.

Methodology

The Task 7 team will attempt to estimate the probable changes to be expected from complete or partial implementation of various Plan alternatives. Wherever possible, those changes most essential to the achievement of improved environmental quality will be indicated.

Findings

The probable results of the implementation of various Plan alternatives likely to have the greatest impact on environmental quality.

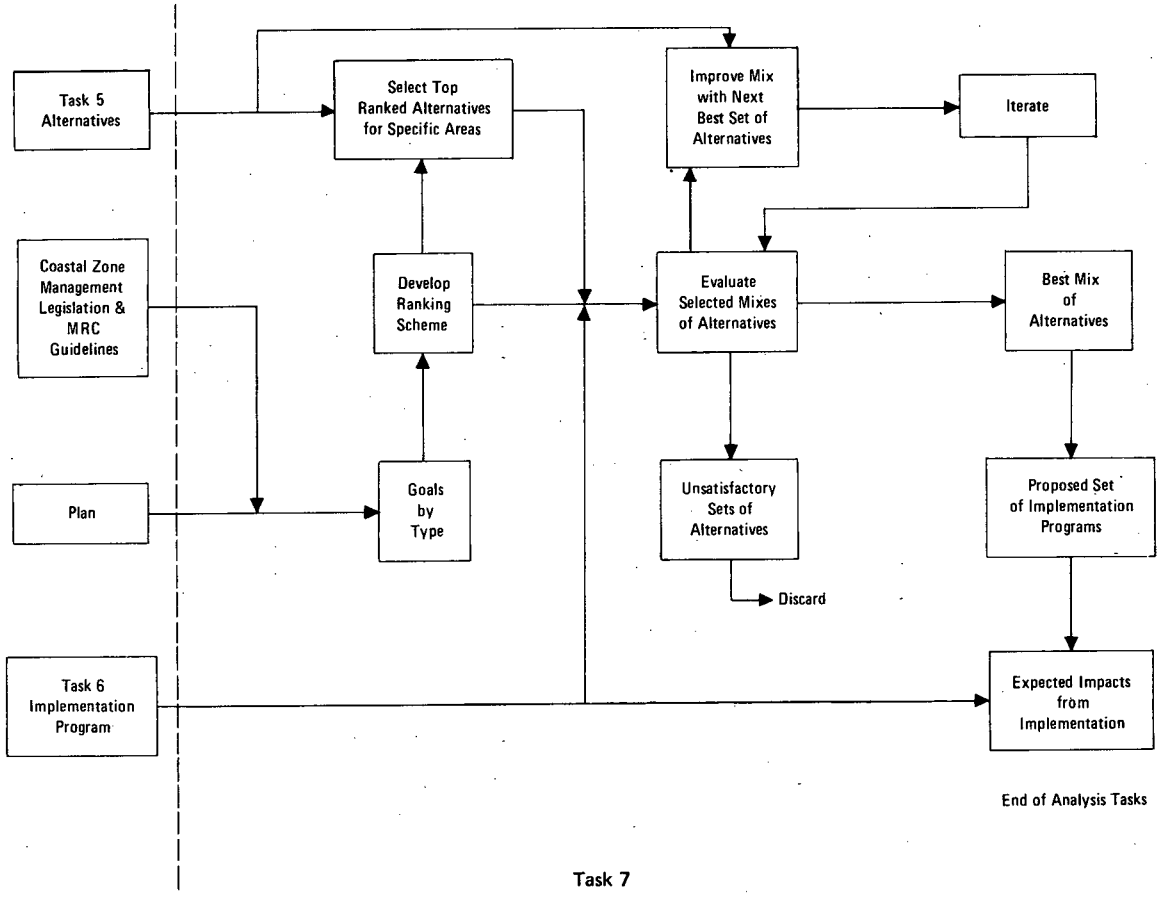
Product

A statement for inclusion in the working paper.

Final Product

A report detailing proposed changes to the Plan along with detailed substantiating information that can rationalize Planning Board actions to modify and amend the existing Plan.

DISCIPLINES OR SKILLS REQUIRED	LEVEL OF EFFORT (MAN DAYS)
Professional	
Administration	20
Comprehensive Planning	50
Economics	15
Engineering	25
Environmental Planning	25
Law	10
Marine Science	40
Political Science (including Pub. Adm.)	15
Sociology	15
Total	215
Support Skills	
Clerical	100
Drafting (including map drafting)	95
Planning Aide	10
Total	205
Task 7 Total	420


Task 5 Alternatives
Select Top Ranked Alternatives for Specific Areas
Improve Mix with Next Best Set of Alternatives
Iterate
Coastal Zone Management Legislation & MRC Guidelines
Develop Ranking Scheme
Evaluate Selected Mixes of Alternatives
Best Mix of Alternatives
Plan
Goals by Type
Unsatisfactory Sets of Alternatives
Proposed Set of Implementation Programs
Discard
Task 6 Implementation Program
Expected Impacts from Implementation
End of Analysis Tasks

Task 7

TASK 8

STATEMENT OF TASK

The contractor shall assess the transferability of the components of the Nassau-Suffolk approach for use in the solution of similar problems in other geographic areas. This shall include institutional and technical aspects of transferability and indicate those elements of the process for linking regional developmental planning and coastal zone management programs that have national, regional, and local applicability.

Objective

To determine whether the methodology, or portions thereof, used by the Nassau-Suffolk Regional Planning Board can be applied to the integration of marine environmental knowledge, comprehensive planning, and coastal management in other parts of the country, and, to evaluate the specific guidelines, standards, and recommendations for implementation in respect to their transferability.

Knowledge Base

Planning literature is replete with examples of how planners have dealt with components of plans, e.g., housing, airports, transportation, and wetlands preservation. Relatively little work has been done on the integration of marine environmental science and comprehensive planning. Therefore, Task 8 represents an attempt to develop a knowledge base to achieve such integration.

Relation of This Task to Other Tasks

This task depends on Tasks 2-7. The earliest phase of this task can begin at the onset of the project. Subsequent phases of Task 8 will require the interaction between the Task 8 staff and those responsible for Tasks 2-7.

General Methodology

This task requires the compilation of data relating to other coastal areas of the United States in order to aid in the selection of a limited number of areas for examining transferability techniques. Breaking out the components of the Nassau-Suffolk methodology will permit an evaluation of the transferability of individual components, of specific findings, and institutional arrangements.

WORK PLAN

Work Element 1

Objective

The objective is to select areas to be used for testing transferability.

Methodology

A review will be made of available data describing specific areas in terms of their geography, demography, economic base, and location in the coastal zone. Information will be obtained from planning and environmental journals, from the U.S. Bureau of the Census, and other Federal and State agencies. Criteria for the final selection of geographic areas will include the extent and availability of data, and the range of physical, developmental, and institutional conditions.

Findings

A selection of geographic areas characterized by a variety of physical and developmental conditions.

Product

A report indicating those geographic areas selected for the evaluation of transferability and the rationale for their selection.

Work Element 2

Objective

The objective is to identify the methodological components of the Nassau-Suffolk study and the requirements for their replication.

Methodology

The overall study design will be separated into its component methodologies, e.g., programming model, economic analyses, and implementation designs. For each component, the staff, data requirements, funding, and levels of expertise required to replicate the methodology will be indicated. Modifications of the

approach adopted in this study will be suggested where the experience of the study team indicates that applicability could be increased without seriously affecting the product.

Findings

Information required to permit local or regional agencies in other coastal areas to evaluate the applicability of this study approach in dealing with their own environmental and planning problems.

Product

A paper documenting the methodologies, specific information, and analytical requirements used in this study.

Work Element 3

Objective

The objective is to assess the transferability of specific Nassau-Suffolk guidelines, standards, and recommendations.

Methodology

For each of the guidelines, standards, and recommendations, the specific physical, economic, or other conditions that may be expected to affect transferability will be identified. Some guideline statements, such as, "prohibit the disposal of dredge spoil on wetlands," are of general applicability and require no special conditions to assure their usefulness. Others, such as the recommendation to keep all new structures at least 100 feet from the edge of bluffs, are directly transferable only to those areas where the topography, soil characteristics, and geology are similar to those existing on Long Island. The staff will design a matrix which indicates the specific environmental and physical conditions under which various guidelines, standards, and recommendations are relevant.

Findings

An indication of those physical or environmental conditions that may influence the transfer of specific guidelines, standards, and recommendations. An identification of those guidelines, standards, and recommendations that are of general applicability will be included.

Product

A statement of these findings and their rationale for inclusion in the Task 8 final product.

Work Element 4

Objective

The objective is to evaluate the transferability of those specific legal and institutional arrangements applicable to coastal zone management.

Methodology

A review of legal and institutional recommendations developed in Task 6 will identify the specific legal, administrative, and fiscal conditions likely to influence their transferability. A recommendation for the local control of land uses or activities in order to reduce the level of environmental pollutants may require enabling legislation at the State level. A recommendation for monitoring water quality and aquifer levels may require the existence of an administrative agency capable of carrying out this function. A recommendation for the public acquisition of some, or all, remaining privately owned beach areas may require the availability of funds from higher levels of government. A matrix listing the legal or institutional recommendations will be developed. Special legal, administrative, or fiscal prerequisites for application in other areas will be indicated.

Findings

Legal, administrative, and fiscal conditions which may affect the transferability of implementation devices will be indicated. Proposed legal and institutional arrangements, for which no new legislation, administrative frameworks, or changes in fiscal policies are required, will be indicated.

Product

A statement of these findings and their rationale for inclusion in the Task 8 final product.

Work Element 5

Objective

The objective is to review and summarize the findings regarding transferability.

Methodology

The staff will summarize the transferability findings. Discussions will be held with regional, state, and local officials as well as with the Marine Resources Council and the Federal Advisory Committee to determine the applicability of findings and methodologies.

Findings

A determination of the transferability of findings and methodologies.

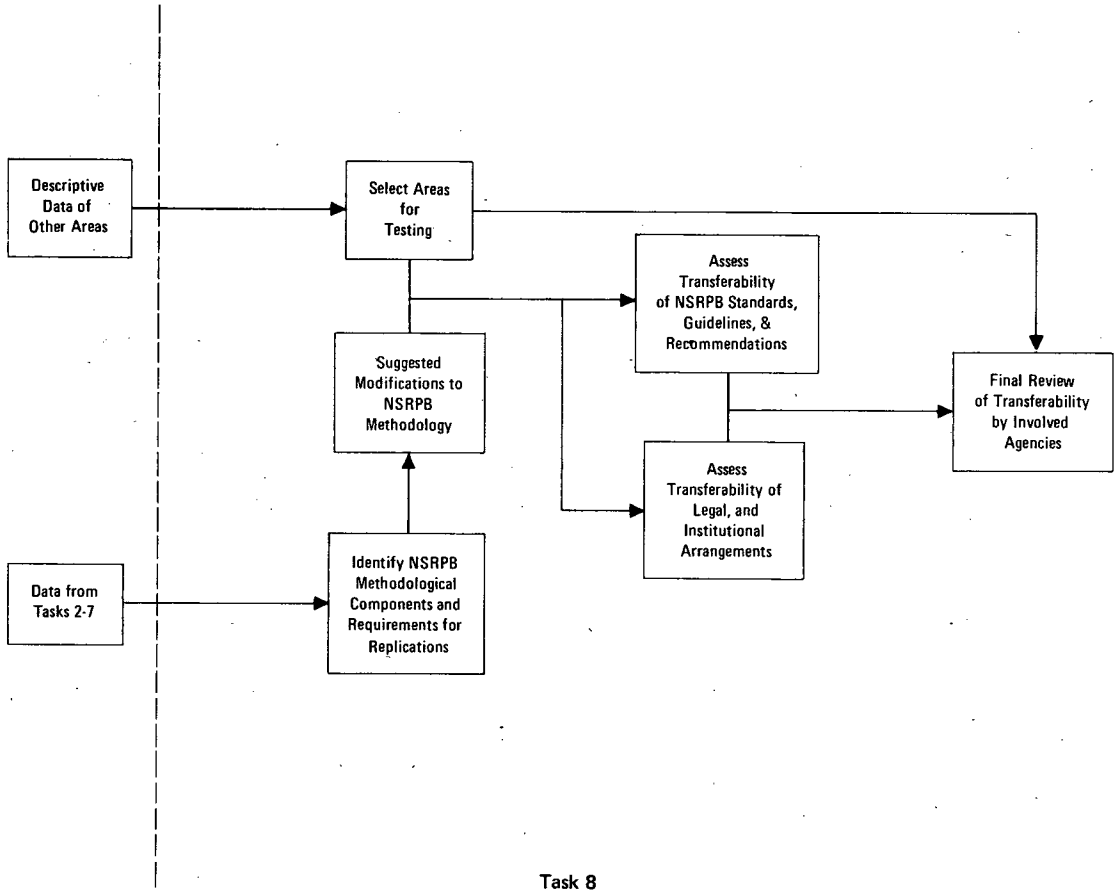
Product

A statement of findings and concensus regarding the transferability of findings and methodologies.

Final Product

A report assessing the degree of transferability of the general approach and specific methodologies for dealing with similar problems in other geographic areas.

DISCIPLINES OR SKILLS REQUIRED	LEVEL OF EFFORT (MAN DAYS)
Professional	
Administration	40
Comprehensive Planning	100
Economics	10
Engineering	5
Environmental Planning	20
Law	40
Marine Science	10
Political Science (including Pub. Adm.)	10
Sociology	10
Total	245
Support Skills	
Clerical	125
Planning Aide	100
Total	225
Task 8 Total	470



Task 8

TASK 9

STATEMENT OF TASK

The Contractor shall describe the approach developed in formulating and evaluating Plan alternatives. The process and final results will be reviewed. The Contractor shall prepare a series of guidelines and a step-by-step procedure to be followed by planning agencies in other coastal regions facing similar problems. The Contractor shall suggest modifications of the Nassau-Suffolk approach to facilitate general environmental evaluations, including environmental impact statements.

Objectives

1) To provide a summary and critique of this study, including a description of its findings and methodology.
2) To prepare a handbook containing guidelines and procedures.

Knowledge Base

The records of activities, the problems encountered, and the comments of advisors relating to Tasks 2-8 will provide the basis for the summary and critique of the entire project. The products developed in Task 2-8, together with the MRC reports, will be used as the basis for the guidelines and procedures to be included in the handbook. Existing reports, such as U.S. Department of Housing and Urban Development, *Aircraft Noise Impact,* (Washington, D.C., U.S. Government Printing Office, 1972); and Clark, J., *Coastal Ecosystems,* (Washington, D.C., The Conservation Foundation, 1974), and the San Francisco Bay Commission's findings will provide a general model for the format of the handbook.

Relation of This Task to Other Tasks

The guidelines and handbook required in this task depend on the products and results of Tasks 2-8. Assembly and examination of existing guidebooks and handbooks for the purposes of establishing a format for Task 9 will begin roughly one year after the start of Task 2.

General Methodology

The staff and consultants will make a detailed examination of the Nassau-Suffolk approach in terms of a) the methodology, models, and procedures used, b) the identification of knowledge and data gaps, and c) the identification of important problem areas.

The Nassau-Suffolk approach will be documented and discussed in relation to the work being conducted in coastal zone management by various groups in other parts of the country. A format will be developed for presenting the Nassau-Suffolk planning technique to planning groups in other areas.

WORK PLAN

Work Element 1

Objective

The objective is to document and critique the methodologies used by the staff in the integration of environmental science and comprehensive planning.

Methodology

An analysis and critique will be carried out at the completion of individual tasks and at the completion of sets of related tasks. The first of these critiques will be based on the examination of each task soon after it is completed. The staff and consultants responsible for each task and related work elements will evaluate the theoretical bases, applicable models, underlying assumptions, and preconceived biases used to generate results. Those approaches considered but rejected will be analyzed in terms of the reasons for their rejection. Those approaches used that resulted in failures and "dead ends" will be documented. Each task will be analyzed insofar as it represents one of a number of possible paths which are applicable to the particular problems that the task is designed to confront. Particular attention will be paid to the problem of integrating discrete work elements. This will include the consideration of lead time in information

handling, shortfalls, and outright failures in the required data, and possible paths devised to minimize these effects. Consideration will also be given to the mode of attack which would be used on a second attempt at a particular task. Upon the completion of the analytical tasks (Tasks 2-8), the staff and consultants will critique the overall design, methods, and integration of sets of analytical tasks. These sets will probably entail Tasks 2, 3, and 4; Tasks 5, 6, and 7; and Task 8, separately. Efforts will be focused on the design of methodologies which worked better than others, and which represent the greatest economy of effort and resources.

Findings

This task provides a complete documentation and critique of the approach used to analyze and arrive at suggested Plan alternatives. It will be incorporated into a series of working papers which will be appended to the final report.

Product

A report in summary form which evaluates the Nassau-Suffolk approach to the integration of environmental and regional planning.

Work Element 2

Objective

The objective is to prepare a handbook which provides guidelines for the integration of comprehensive planning and coastal management.

Methodology

The staff will evaluate the form and content of existing handbooks and will design an appropriate format to present the standards, guidelines and findings generated in Tasks 2-8.

Findings

A format for transmitting the results and methods of the Nassau-Suffolk study to planners in other parts of the country will be established.

Product

A report detailing the guidelines and step-by-step procedures to be followed by planning agencies that wish to merge comprehensive planning and coastal management considerations and/or reassess their plans and programs in the light of current environmental knowledge. This report will also suggest possible modifications of the Nassau-Suffolk approach to facilitate general environmental evaluations, including environmental impact statements.

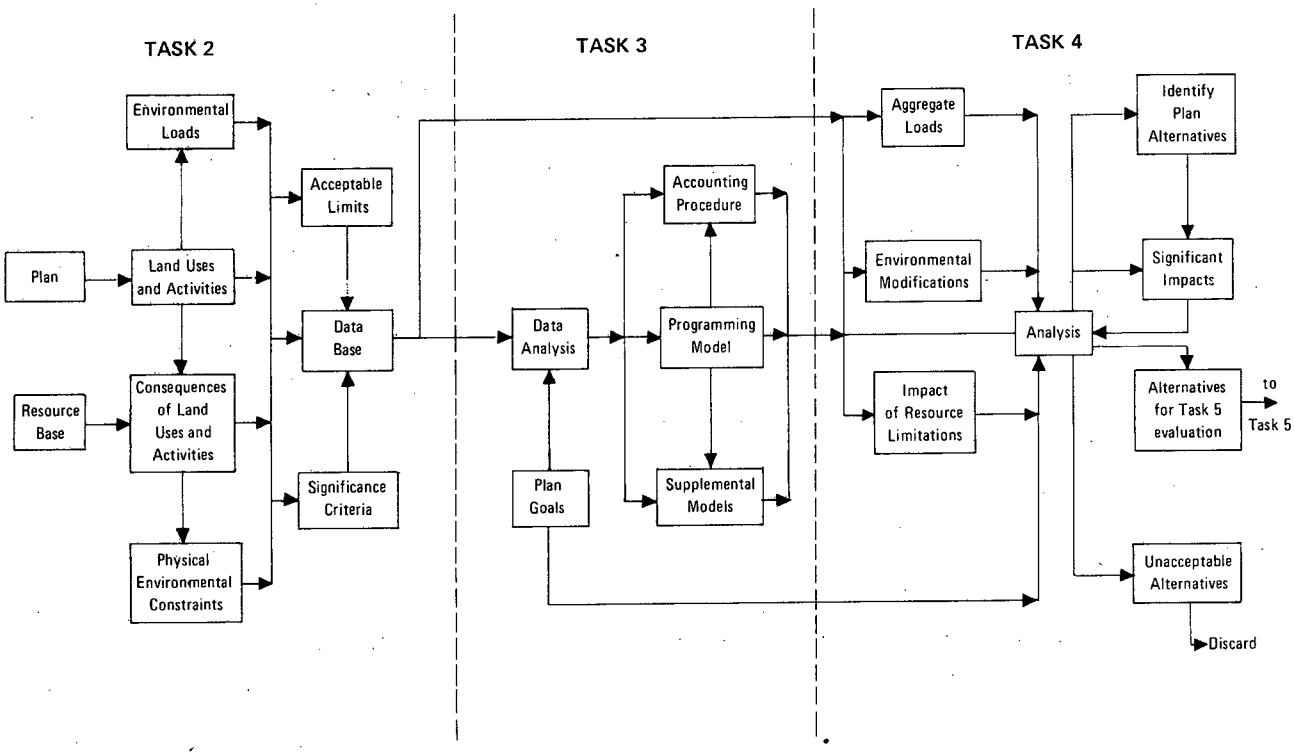
Final Product

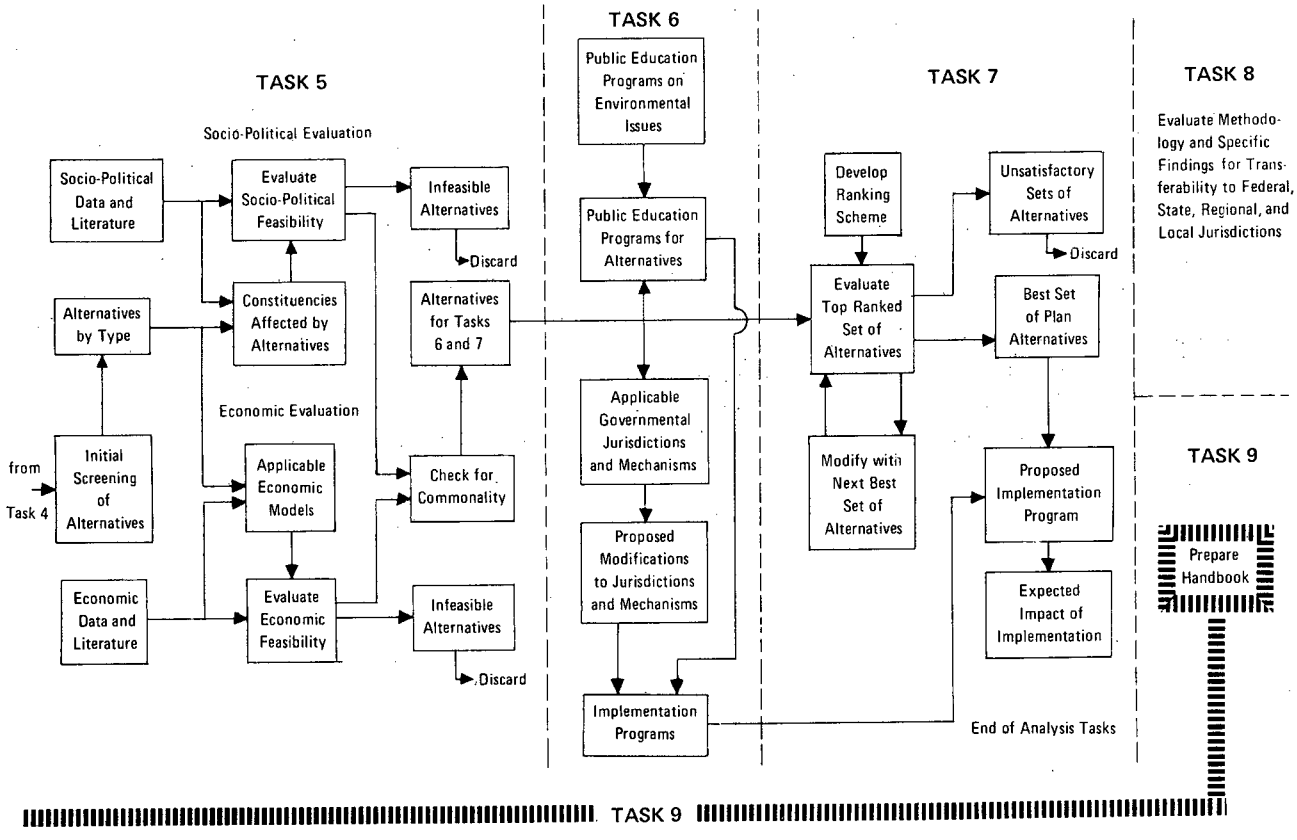
A summary report detailing:

1. Procedures and standards for use in integrating comprehensive land use planning and coastal zone management.
2. Guidelines and a step-by-step procedure that can be followed by other planning agencies.
3. Summary and complete documentation of the problem, the analytical approach used to define and evaluate alternatives, and an evaluation of the process and final results.
4. Suggested modifications of the approach to facilitate general environmental evaluations including the preparation of impact statements by planners in other regions.

DISCIPLINES OR SKILLS REQUIRED	LEVEL OF EFFORT (MAN DAYS)
Professional	
Administration	25
Comprehensive Planning	75
Economics	10
Environmental Planning	50
Law	50
Political Science	10
Sociology	10
Total	230
Support Skills	
Clerical	200
Drafting (including map drafting	100
Planning Aide	100
Total	400
Task 9 Total	630

SIMPLIFIED SCHEMATIC REPRESENTATION OF ANALYTICAL TASKS 2 THROUGH 7





PERSONNEL

Expertise Available

The members of the Nassau-Soffolk staff assigned to this project have had professional training and/or experience in the following fields: administration, architecture, comprehensive planning, demography, economics, earth sciences, environmental planning, landscape architecture, physics, political science, and sociology.

Need for Consulting Services

Consulting services will be required to provide expertise in the following disciplines or areas of specialization:

1. Computer Analysis – consultant capable of assisting systems analyst and others in development of models (Task 3), and in providing data processing services to social scientists in Task 5.

2. Engineering – consultant or consultants with experience in environmental matters, capable of assisting in the identification of environmental loads, and technically feasible Plan alternatives regarding support activities, and in assessing their effects.

3. Hydrology – consultant with knowledge of Long Island hydrologic conditions to assist engineer, systems analyst, marine scientist and others in respect to the effects of development and water use on Long Island surface and groundwater resources.

4. Law – consulting attorney with specialty in environmental law to assist scientific personnel through identification of legally established environmental standards and to aid planning personnel in the evaluation of laws, administrative mechanisms and institutional arrangements for the implementation of Plan alternatives.

5. Marine Science – consultant or consultants capable of assessing environmental impacts by analyzing cause-effect relationships involving marine ecosystems, and producing quantitative and qualitative evaluations of environmental data as they pertain to the selection of Plan modifications and alternatives.

6. Political science – consultant capable of evaluating the socio-political feasibility of Plan alternatives, and of designing implementation strategies.

7. Public Health – consultant capable of specifying public health standards applicable to a coastal environment. He must be able to identify potential health problems created by environmental pollution.

8. Systems Analysis – consultant with expertise in the design of models and management information systems with applications to planning and management problems.

9. Welfare Economics – consultant capable of providing in-depth knowledge relating to application of benefit-cost analysis to empirical data; must have detailed knowledge of model building and the applicability of models and techniques from various applications (water resource development, defense, manpower planning).

PROGRAM MANAGEMENT

To accomplish the objectives, administrative procedures must be designed for a variety of management tasks which are keyed to the large scope and complexity of this enterprise. These required management tasks concern overall program direction, work direction and organization, consultant relations, review processes, and coordination processes.

Overall Program Direction

The Project Director will be responsible for directing the work through task leaders, for selecting consultants to the program, and for establishing procedures for the review of consultant work. He will establish review and coordination processes and designate personnel to carry out these functions. He will schedule and direct the work in each task so that it can proceed without delay.

For the purposes of overall coordination and scheduling of this work, the Project Director will meet at least once each month with the task leaders and consultants who may be involved, to discuss progress, problems, and anticipated accomplishments for the following month.

Work Direction and Organization

Under the supervision of the Project Director, task leaders will have responsibility for directing and assisting the work. A major part of the task leaders' responsibilities will center on receiving, interpreting and coordinating work from various disciplines, and will provide for an interchange of information and working perspective among the staff. To accomplish this, the task leader must provide a framework which relates work elements to each other, indicating the linkages between tasks. Interdisciplinary coordination is vital given the variety of skills employed in this project. These skills include marine, biological and physical sciences, engineering, systems and economic analysis, legal, sociological and political analysis, and planning.

The administrative means for accomplishing this coordination will be varied. One method requires the formation of a work team consisting of professionals from different disciplines. Thus, the interpretation of land use data in relation to probable activity levels and environmental loads, and the analysis of these, will require the teamwork of various kinds of environmental scientists, systems analysts, and planners. Another means of coordination is the scheduling of regular meetings of task leaders with the Project Director. In addition to the above methods, Dr. Clarke Williams, Research Administrator of the MRC, will have the responsibility for coordinating the liaison between planners, engineers, and natural scientists during the project.

The task leaders will have the responsibility for reviewing the work and scheduling of consultants' efforts, for scheduling and supervising the work of staff, for uncovering substantive and procedural problems and taking measures to solve them, and for bringing unresolved and significant problems to the attention of the Project Director.

Consultant Relations

Consultants will be hired by the Project Director. When a consultant functions as a task leader, his duties and responsibilities shall be the same as those of any other task leader. When a consultant does not function as a task leader, he shall report to the relevant task leader with regard to the scheduling, methods, content, and progress of his work, and make himself available for consultation. The Project Director will be consulted in those cases in which problems of procedure or substance cannot be solved within the resources of the task leader.

Review Processes

There will be a number of review processes and levels. Ongoing staff and consultant work will be subject to review in monthly meetings. Milestones and work elements will be subject to a similar review.

As milestone products and work elements are judged satisfactory, they will be passed on to the MRC for comment. The NSRPB will be informed of the progress and scheduling of the work on a quarterly basis. Similarly, these materials will be forwarded to the Federal Project Advisory Committee for its review.

Coordination

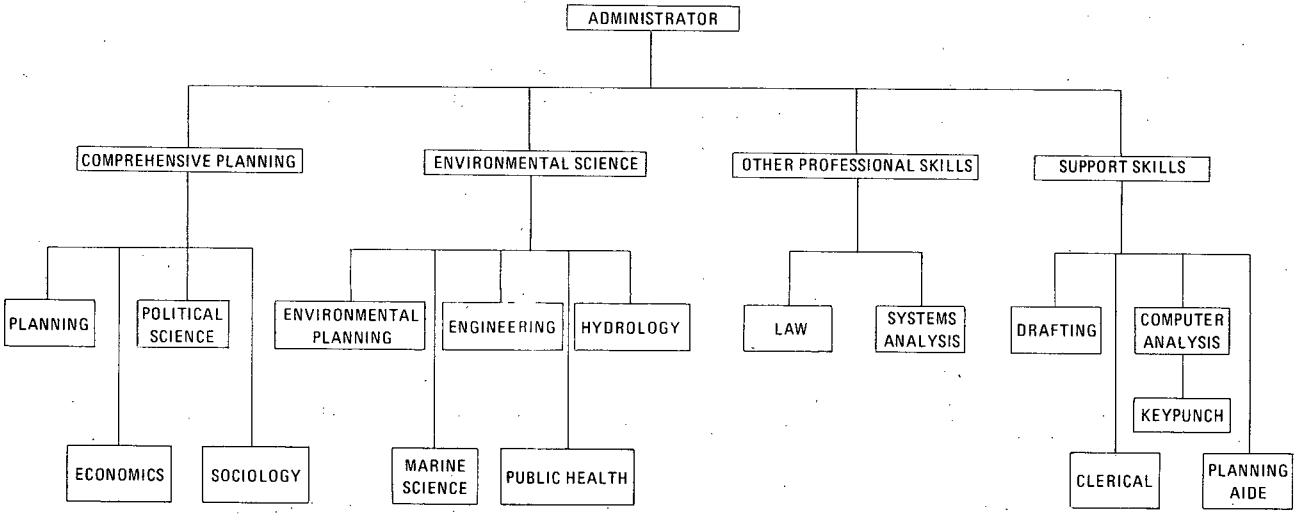
At the present time, three other agencies are concerned with the coastal zone of Long Island. They are the New England River Basins Commission, with the responsibility for the development of a comprehensive plan for Long Island Sound; the Tri-State Regional Planning Commission, which is trying to assemble planning data for the New Jersey, Connecticut, and New York coastal zone; and the State of New York, which has responsibilities and functions under the Coastal Zone Management Act of 1972.

The MRC and the NSRPB have a well established liaison with these three agencies. The Project Director serves as a member of the Coordinating Group of the Long Island Sound Study of the New England River Basins Commission. A member of his staff serves as his representative to the Coordinating Group. The data and papers from this project will be made available to the New England River Basins Commission. The NSRPB has contributed towards the work of the Tri-State Regional Planning Commission. Under the Federal Government's A-95 review procedure, the NSRPB reviews all planning and capital construction proposals receiving Federal aid in this region.

The NSRPB's Comprehensive Development Plan is part of the development plan published by the New York State Office of Planning Coordination (now Office of Planning Services). Representatives of the New York State Department of Environmental Conservation, Office of Planning Services and Department of Parks and Recreation serve as advisory members of the MRC.

The following Federal agencies are also represented on the MRC: Soil Conservation Service, U.S. Department of Agriculture; Plan Formulation Branch, North Atlantic Division, Corps of Engineers; Water Programs Grants, Environmental Protection Agency; Fire Island National Seashore, National Park Service, U.S. Department of the Interior; Operations Division, New York District, Corps of Engineers; Long Island Area Office, Division of River Basin Studies, U.S. Fish and Wildlife Service, U.S. Department of the Interior; Third Coast Guard District, U.S. Department of Transportation; U.S. Geological Survey, U.S. Department of the Interior.

FUNCTIONAL ORGANIZATION CHART



MILESTONES

There are several milestones which will indicate the progress of the project. In this project a milestone is defined as having two major characteristics: 1) the completion of a segment of work which marks the integration and utilization of data and analyses of previous work elements and tasks, and 2) the selection of major analytical concepts or methods for directing subsequent work elements and tasks. At this point, 9 milestones can be identified.

1. Completion of the Work Program (Task 1)

   Task 1 provides a detailed outline of work organization and level of effort, expected products, and required skills and resources. Approval of Task 1 by the Government Technical Representative allows the project to proceed.

2. Establishment of Acceptable Environmental Limits (Task 2)

   The establishment of acceptable environmental limits indicates that environmental loads have been identified and analyzed in terms of their public health and environmental implications.

3. Validation of the Programming Model (Task 3)

   This indicates that the programming model is capable of generating the required outputs. It is also a check on the quality and format of the data input. This draws on the data inputs from Task 2 and is a critical point for all subsequent analysis dealing with the identification of technical alternatives and land use – activity modifications.

4. Generation of Plan Alternatives (Task 4)

   The ability of Task 4 to generate an initial set of Plan alternatives indicates that the environmental loads and acceptable limits identified in Task 2 have been summed, utilizing the model established in Task 3. At this point, the technical alternatives to various activity levels will have been specified. The identification of Plan alternatives will serve as the basis for all subsequent analytical tasks.

5. Economic and Political Feasibility Analysis of Plan Alternatives (Task 5)

   Prior to Task 5, Plan alternatives have been identified solely in terms of their technical feasibility. Completion of Task 5 will reduce the number of possible Plan modifications to those which appear to be economically and politically feasible. This task will result in a set of alternatives for use in implementation analysis and in the selection of modifications to the Plan.

6. Legal and Administrative Mechanisms for Implementation of Plan Alternatives (Task 6)

   Implementation of Plan alternatives requires the use of legal and administrative mechanisms. Identification of these mechanisms permits the selection of appropriate implementation strategies. This will assist the final selection of alternatives and implementation programs in Task 7.

7. Recommended Revisions of the Plan (Task 7)

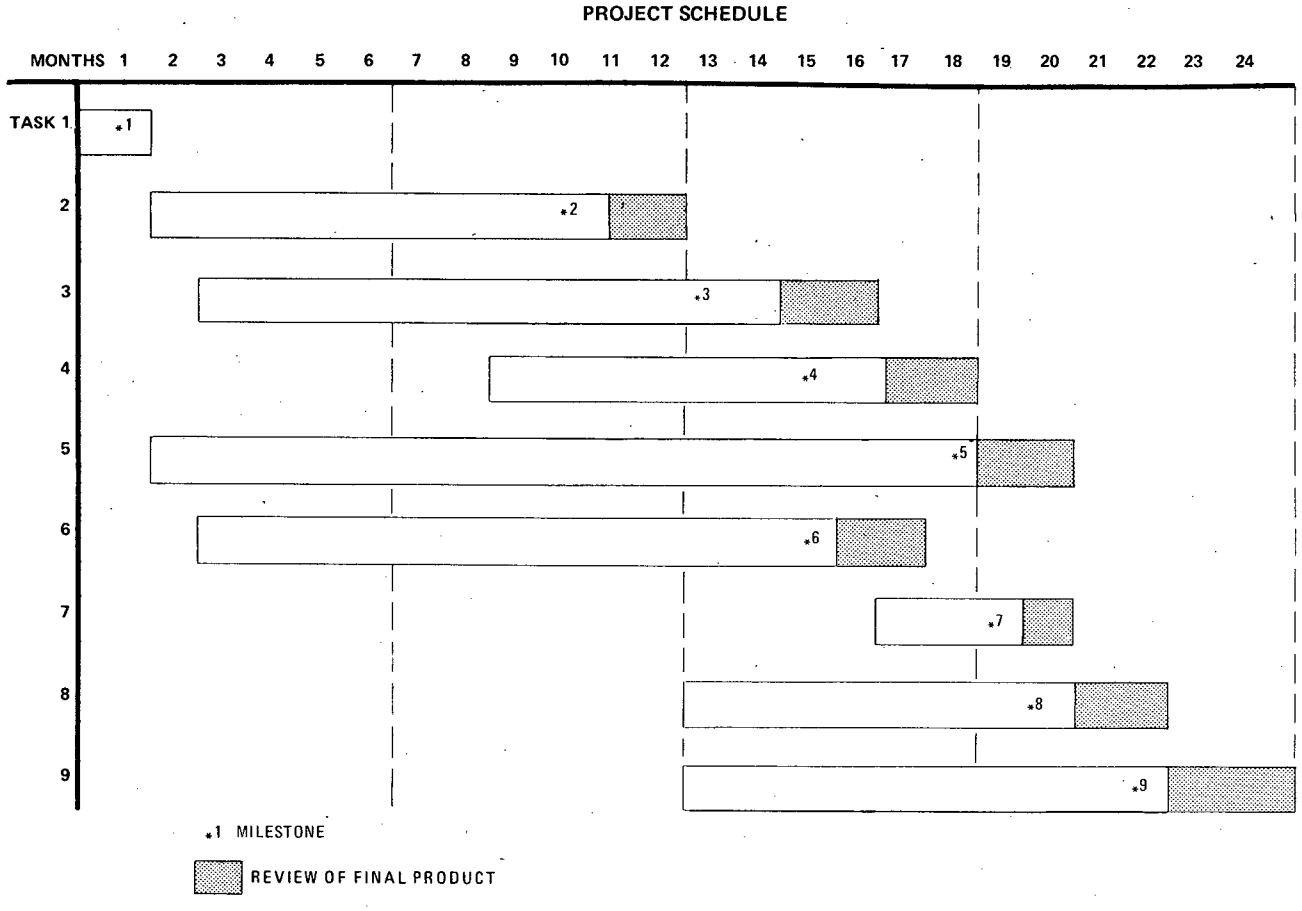
   This is the final set of recommendations on technical alternatives, Plan and activity modifications, and policy and programs.

8. Transferability Report (Task 8)

   This specifies the transferable elements of the project and the conditions affecting the degree of transferability to other areas.

9. Project Handbook (Task 9)

   This is the completion of the Handbook containing standards and guidelines for coastal management.


PROJECT SCHEDULE
MONTHS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TASK 1
2
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*1
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*1 MILESTONE
REVIEW OF FINAL PRODUCT

GLOSSARY

Analog Model

A type of model which portrays a physical phenomena in terms of some other measurable physical phenomena. An analog model of a hydrologic system may, for example, consist of electrical circuits.

Benefit-Cost Analysis

A method to assess the desirability of a project that takes account of probable consequences over time and probable side effects. It contrasts the costs of a project with the expected benefits.

Biochemical Oxygen Demand (BOD)

A laboratory measurement which expresses the depletion rate of dissolved oxygen in a water sample caused by the oxygen demands of living organisms or their decay.

Cause-Environmental Condition-Effect Relationships

When man interacts with a particular environment, he may create changes in that environment, and be influenced by these alterations. Causal factors that act to change key environmental conditions include human activities and natural phenomena. The change in environmental conditions may be a physical, chemical, or biological alteration, or may be a preemption of the space necessary for an activity by some other activity. These changes then affect man's activities in terms of their preemption or restriction.

Coastal Zone

The coastal waters and adjacent shorelands influenced by each other, including transitional and intertidal areas, salt marshes, wetlands, and beaches. The coastal zone extends seaward to the outer limit of the U.S. territorial sea (12 miles), and extends inland from the shoreline to the extent necessary to control land uses which may have a direct and significant impact on the coastal waters.

Coefficient of Partial Correlation

A statistical indicator of the relative importance of different independent variables in explaining variations in a dependent variable.

Cost-Effectiveness

A comparison of alternative courses of action in terms of their costs and their effectiveness in attaining some specific objective. It generally consists of an attempt to minimize dollar costs subject to some mission requirement, or, to maximize some output subject to a budget constraint.

Environmental Impact

Those adverse or beneficial ecological effects resulting from environmental perturbations.

Environmental Loads

Those outputs arising from various activities which may imply an adverse effect on a specific marine environment or the public health.

Factor Analysis

A statistical technique to determine whether variables are in fact, measures of one or more common underlying variables. It is a procedure whereby the number of concepts used in explaining a phenomenon can be reduced.

Geomorphic

Of, or relating to, the structure and form of terrain.

Gradient Analysis

A class of minimization techniques or algorithms which utilize the fact that the negative gradient or directional derivative yields a vector which points in a direction that minimizes the function.

Linearity/Nonlinearity

In a linear program, the algebraic expressions which occur in either the objective function (the statement indicating what is to be maximized), or in the constraints (side conditions), will be written as linear expressions with variables multiplied by constants. In a nonlinear program, the expressions may include terms such as X^5, 5^X, or cosine X. Although it is often easier to force variables into a linear form for computational ease, there are significant problems in making linear approximations in the presence of nonlinearities.

Mathematical Programming

A mathematical technique for the determination of optimal solutions to problems. In many types of problems, the outcome, if it is to be acceptable, must meet certain conditions. These "side conditions" are frequently expressed in terms of inequalities or the prohibition of negative values.

Multiple Correlation

A correlation in which there is more than one independent variable.

New York Bight

The marine area which extends from Montauk Point, Long Island, New York to Cape May, New Jersey, and from the coastline to the edge of the continental shelf, as defined by the 100 fathom depth contour.

Objective Function

A mathematical statement which specifies what is to be maximized.

Ordinal Rank

Designation of the place (first, second, third, etc.) occupied by an item in an ordered sequence.

Oxygen Sag

The relationship between the supply and the demand for dissolved oxygen in a waterbody produces a dissolved oxygen profile. If the oxygen demand is temporarily greater than the oxygen supply, the profile will display an oxygen sag.

Penalty Function

A mathematical technique used to convert constrained minimization problems to a sequence of unconstrained minimization problems.

Production Function

A technological relationship between the output or production of an output and the inputs and factors of production required to produce it.

Residuals

A product or substance resulting from a technical process or activity.

Sensitivity Analysis

A statistical technique useful in the revision of uncertain data that determines whether a small change in the magnitude of one variable may give rise to a small or large change in another.

Simplex Algorithm

One of a number of techniques used to solve linear programming problems through an iterative process.

Socio-Political Feasibility

The probability of a policy alternative receiving sufficient support to be approved and politically implemented within a given time period.

Variable Metric Descent

A gradient technique for function minimization where the selection of the downhill descent direction is a function of a variable matrix.

APPENDIX

ANNOTATED BIBLIOGRAPHY

This bibliography is in three parts: 1. an alphabetical listing of marine resource reports prepared by or for the Regional Marine Resources Council and the Nassau-Suffolk Regional Planning Board; 2. an alphabetical listing of those reports prepared under the Sea Grant project, *The Development of Methodologies for Planning for the Optimum Use of the Marine Resources of the Coastal Zone;* and 3. Nassau-Suffolk Regional Planning Board publications used for comprehensive planning, listed by date of publication.

I. Regional Marine Resources Council and Nassau-Suffolk Regional Planning Board Marine Resource Reports

Cok, Anthony E., and Sirken, Leslie A., *Investigation of Surface and Subsurface Sedimentary Deposits in Offshore Environments of Southern Long Island,* (Garden City, New York, Adelphi University Institute of Marine Science, 1973).

> Describes methods used and results of research on geomorphology, sedimentology, and stratigraphy in surface and subsurface sediments in the near and offshore regions of southern Long Island — the Ridge and Swale topography. Bibliography 6 items (18 pp).

Davies, D. S., Axelrod, W., and O'Connor, J., *Erosion of the North Shore, Long Island, New York,* (Stony Brook, New York, Marine Sciences Research Center, State University of New York, Technical Report Series No. 18, 1973).

> Description of beaches and bluffs of north shore of Long Island, inventory of natural characteristics and man made structures, character and effects of dynamic beach processes catalogued with recommendations as to steps to take to minimize damage to persons and property. Maps show station locations and erosion and accretion rates. Bibliography 99 items (101 pp).

Gross, M. Grant, et al., *Characteristics and Environmental Quality of Six North Shore Bays, Nassau and Suffolk Counties, New York,*(Stony Brook, New York, Marine Sciences Research Center, State University of New York, Technical Report Series No. 14, 1972).

> Describes physical characteristics and result of surveys of water quality, sediments, and waste deposits of six bays. Develops three environmental quality indicators (present, integrative, and predictive) used to rate the six bays. Recommends further studies for better evaluation of bay environmental quality. Bibliography 109 items (98 pp).

Gross, M. Grant, et al., *Survey of Water Quality and Sediments in Six North Shore Bays, Nassau and Suffolk Counties, Long Island, New York (Appendix to Technical Report No. 14),* (Stony Brook, New York Marine Sciences Research Center, State University of New York, Technical Report Series No. 15, 1972).

> Describes sampling procedures, analytical techniques, data for water quality, and sediment survey, with maps of the six bays showing location of sampling stations. Bibliography 6 items (29 pp).

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O'Connor, Joel, *Dredging and Spoiling on Long Island,* (Stony Brook, New York, Marine Sciences Research Center, State University of New York, Technical Report Series No. 19, 1973).

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Inventories, maps, and classifies the wetlands of Nassau-Suffolk counties and estimates changes in acreage since 1964. Discusses requirements for management

decisions, e.g., acquisition, zoning regulations, and recreational development. Bibliography 58 items (99 pp).

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Regional Marine Resources Council, *Proceedings of the Seminar on Advanced Wastewater Treatment and Disposal,* (Hauppauge, New York, Regional Marine Resources Council in cooperation with U. S. Environmental Protection Agency and U. S. Geological Survey, 1972).

Papers on state-of-the-art wastewater treatment, groundwater management experience, and new projects for treatment and recharge (167 pp).

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Papers on dredging technology, regulatory procedures, and dredging and spoil disposal activities on L.I. research activities, state-of-the-art beach erosion and stabilization. Includes notes on the National Shoreline Study, and Federal beach erosion activities on L.I. (125 pp).

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Bartholomew, F. L. and McGuinness, W. V., Jr., *Coast Stabilization and Protection on Long Island,* (1972).

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Cheney, Philip B., *Functional Step Two, Knowledge Requirements,* (1970).

Categorization of knowledge requirements for development of marine resource planning into those that pertain to location and time specific information in the form of descriptive data, and into those that pertain to the understanding of environment (31 pp).

Cheney, Philip B., *High Priority Research and Data Needs, Interim Functional Step Four,* (1970).

Preliminary list of high priority research and data collection programs considered vital to the solution of L. I. coastal problems and coastal zone management. Bibliography 8 items (14 pp).

Dowd, Richard M., *Dredging on Long Island,* (1972).

Dredging motivation, processes, environmental conditions changed and implications of the changes, and suggested controls for managing dredging. Bibliography 32 items (43 pp).

Ellis, R. H., et al., *Functional Step One, The Classification of Marine Resource Problems of Nassau and Suffolk Counties,* (1969).

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Ellis, R. H., et al., *The Design of a Management Information System for Coastal Resources Planning,* (1972).

A management information system designed with five components, i.e., data storage and retrieval, environmental relationships, analytical design, synthesis and analysis, and executive control. Description and use of matrices explained in relation to L. I. coastal zone management (113 pp).

Green, Ralph F., *Wetlands on Long Island,* (1972).

Wetlands characteristics, natural functions, uses by man, and natural and man-made changes, experience with various techniques for wetlands management, and suggested guidelines for L. I. Bibliography 54 items (80 pp).

McGuinness, W. V., Jr., *State of the Art for Selected Marine Resources Problems on Long Island,* (1972).

Assessment of adequacy and availability of data and knowledge most relevant to planning and policy formulations for four high priority marine resources problems: integrated water supply and wastewater treatment and disposal; coast stabilization and protection dredging and dredge spoil disposal; and wetlands management. Bibliography 175 items (172 pp).

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Examination of natural hydrological systems, man's water supply and wastewater system and its effect on water quantity and quality, now and projected into the future. Development and analysis of alternative solutions regarding water supply and wastewater disposal problems. Bibliography 59 items (180 pp).

McGuinness, W. V., Jr., Pitchal, R., and Northrop, G.M., *Technology Transfer in the Marine Environment of Long Island,* (1973).

Description of the activities of CEM during 1972 and early 1973 in providing the MRC with briefings on analyses and findings regarding the four high priority research areas and assistance in developing planning guidelines (51 pp).

Ortolano, Leonard, *Quality Standards for the Coastal Waters of Long Island, New York,* (1970).

Legal and other basis for water quality "standards," their use in classifying L.I. waters, possibilities for refinement, and recommendations for new sets of standards for marine resource management. Bibliography 15 items (26 pp).

Ortolano, Leonard and Brown, Philip S., Jr., *The Movement and Quality of Coastal Waters: A Review of Models Relevant to Long Island, New York,* (1970).

Descriptions of hydrodynamic, hydraulic, and water quality models, state-of-the-art of such models, and possible application to L. I. coastal waters. Bibliography 48 items (88 pp).

Pitchai, R. and McGuinness, W. V., Jr., *A Proposed Problem-Oriented Marine Research Program for Long Island,* (1972).

Summaries of 77 research projects specifically relating to the solution of four high priority marine resource problems: integrated water supply and wastewater treatment and disposal; coast stabilization and protection; dredging and dredge spoil disposal; and wetlands management, with indicated costs and priorities. Bibliography 15 items (119 pp).

Smith, Frank A., et al., *Fourteen Selected Marine Resource Problems of Long Island, New York: Descriptive Evaluations,* (1970).

Identification and systematic description of 14 outstanding marine resource problems with indication of information needs. Bibliography 191 items (121 pp).

III. Nassau-Suffolk Regional Planning Board Publications

Republic Airfield, 1966.

A study of the feasibility of converting a privately owned airport into a publicly owned general aviation facility.

Special Report — Proposed Bayville — Rye Bridge, 1966.

A study to determine the advantages and disadvantages of a proposed Long Island Sound crossing between Nassau County and Westchester County.

North Shore Transportation Corridor, 1967.

A study of the need to create a major roadway along the North Shore of Nassau and Suffolk Counties which would eliminate the need for widening State and County roads in the area.

Residential Market Analysis, Volume 1, 1967.

An inventory of regional housing stock and surveys of substandard units and the housing of welfare recipients.

Suffolk County Inventory of Existing Bus Systems, 1967.

An inventory of Suffolk County's private bus network and an evaluation of its major deficiencies.

The Economy of Long Island, 1967.

A survey of employment and economic trends in Nassau and Suffolk Counties.

A Look Ahead at Long Island Employement, 1968.

A projection of employment demand in the Long Island area to 1985.

Existing Land Use, 1968.

An inventory of land uses in the bi-county area. This report includes land use summaries for all cities, towns, villages, and school districts along with a projection of total population saturation for these areas if they are developed according to existing zoning.

Residential Market Analysis, Volume 2, 1968.

A summary of housing costs and needs to 1985. The report also includes an analysis of the existing multi-family housing market in the bi-county area.

Housing — Better Homes for Better Communities, 1968.

A summary of housing conditions in the area along with projections of housing needs and ways to meet these needs.

Inventory of Public Lands and Facilities, 1968.

An inventory of recreational lands, school facilities, health facilities, and public buildings in the area.

Projected Employment and Occupational Mix, 1968.

A projection of the types of industries and related jobs that will be necessary to accommodate the population increase anticipated in the region.

Sales Tax Study, 1968.

A report recommending the establishment of a sales tax for both Nassau and Suffolk counties to reduce the dependency on the property tax for financing governmental projects.

Population, 1969.

A summary of population trends for municipalities along with projections to 1985 for major municipalities and school districts.

Soil Interpretations — Inventory and Analysis, 1969.

An inventory of all soils in Suffolk County and recommendations on how these soils can best be used in the future.

Utilities — Inventory and Analysis, 1969.

An inventory of existing water, sewer, electrical, and waste disposal systems with an evaluation of the drainage areas on Long Island.

Transportation Plan, 1970.

An inventory of existing air, water, road, and rail transportation networks on Long Island. An analysis of these networks and a recommended overall transportation plan.

Zoning — Inventory and Analysis, 1970.

An inventory of existing zoning ordinances in each of the 108 municipalities in the bi-county area with an evaluation of the ordinances and recommendations for a model zoning ordinance.

Comprehensive Development Plan — Summary, 1970.

A summary of all elements of the bi-county plan in a version that can be widely distributed to the general public.

Housing Code Enforcement, 1970.

A summary of housing codes and their enforcement with a recommendation for a county-wide system of housing inspections on a regular basis.

The Long Island Economy — Anatomy of Change, 1971.

A survey of changing economic conditions in the bi-county area.

On Planning and its Uses in Government, 1971.

A theoretical report identifying essentials of the planning process, relationships to programming and budgeting practices, and opportunities for cooperation with others through better job specification and organization.

U. S. Census '70, Volume One — Number of Inhabitants, 1971.

An analysis of total population change for all minor civil divisions and places and census tracts in the two counties.

U. S. Census '70, Volume Two — Color and Race, 1972.

A report detailing racial changes in the decade to 1970.

U. S. Census '70, Volume Three — Age, 1972.

An analysis of the age composition of the bi-county population.

U. S. Census '70, Volume Four — Housing, 1972.

An analysis of conditions and changes relating to housing, tenure, vacancies, and type of units in the 1960-1970 decade.

U. S. Census '70, Volume Five — School District Population, 1972.

A report presenting 1970 census data for each school district in Nassau and Suffolk counties.

U. S. Census '70, Volume Six — Income, 1972.

A report indicating the changes in median family income in the last decade, with the location of high income and poverty areas.

U. S. Census '70, Volume Seven – Senior Citizens, 1972.

An analysis of characteristics of the aged population based on detailed information from the 1970 Census.

A Profile of the Nassau-Suffolk Labor Force, 1973.

A report based on the 1970 census that indicates occupational patterns and changes in the last decade. It includes an analysis of place of work and income.

The Demand for Higher Education in the Nassau-Suffolk Region, 1970 – 2000, 1974.

An inventory and analysis of enrollment in higher education with a projection of the facilities needed to accommodate higher education needs for this area by the year 2000.

NOTES – PART I

1. Ritchie, William A., *The Archaeology of New York State,* (Garden City, N.Y., The Natural History Press, 1965), pp. 141, 163-169, 265-271. Overton, Jacqueline, *Indian Life on Long Island,* (Port Washington, N.Y., Ira J. Friedman, Inc., 1963).
2. Langhans, Rufus, *Nesaquake Tales,* (Smithtown, N.Y., The Smithtown Library, 1965), and *Places and Names,* 1961.
3. "Island Fishermen: A Handful of Us Left," *The Long Island Catholic,* (April 23, 1964). Pell, Claiborne, *Challenge of the Seven Seas,* (New York, N.Y., William Morrow & Co., 1966), p. 102.
4. *Yearbook of Fishery Statistics,* Food and Agriculture Organization of the United Nations, (New York, N.Y.), vol. 18.
5. The federal expenditures for oceanographic programs have grown from 8 million dollars in 1953 to over 300 million dollars in one decade. Similarly, private industry has invested almost 3 billion dollars in continental shelf exploration in the same period. See the Report of the Panel on Oceanography, President's Science Advisory Committee, *Effective Use of the Sea,* (Washington, D. C., The White House, June, 1966), pp. 66-75.
6. Suffolk County Department of Planning, *Economic Base,* (Hauppauge, N.Y. The Department, May, 1962). Nassau County Planning Commission, *Selected Population and Employment Data,* (Mineola, N.Y., The Commission, 1965).
7. Suffolk County Department of Planning, *op. cit.* Arthur D. Little, Inc., *An Industrial Development Study of Suffolk County,* (September, 1965).
8. This statement of objectives was ratified by the Nassau-Suffolk Regional Planning Board on September 27, 1965.
9. Nussbaumer, Clarke and Velsey, *Summary of Drainage Report-Suffolk County, N.Y.,* (New York, N.Y., July, 1957). This report discusses the general topography as related to drainage. See also the United States Coast and Geodetic Survey's Quadrangle Maps for Long Island of 1954.
10. Koppelman, Lee E., *Planning for Open Space in Suffolk County,* (Hauppauge, N.Y., Suffolk County Dept. of Planning, May 1964), p. 6.
11. Wiggin, Thomas H., *Report on A Comprehensive Plan for the Development and Distribution of the Available Water Supply of Suffolk County,* Long Island, N.Y., (Suffolk County, New York, Suffolk County Water Authority, January, 1957), p. 24.
12. Mr. Anthony Taormina, of the New York State Department of Conservation, rendered such testimony before the Committee on Oct. 20, 1965.
13. Odum, Eugene P., "The Role of Tidal Marshes in Estuarine Production," *The Conservationist,* (New York State Dept. of Conservation, June-July, 1961), pp. 12-15.
14. Report of the Environmental Pollution Panel – President's Science Advisory Committee, *Restoring the Quality of Our Environment,* (The White House, November, 1965), p. 222.
15. *Effective Use of the Sea, op. cit.,* p. 17.
16. U.S. Fish and Wildlife Services, *Review Draft of Shellfish Resources,* (New York, August 7, 1962).
17. N.Y.S. Dept. of Conservation, *Mt. Sinai Harbor,* p. 7.
18. Mr. David H. Wallace, of the New York State Department of Conservation, in testimony on September 22, 1965. Mr. George Vanderborgh, president, Long Island Shellfish Farmers, in testimony on November, 15, 1965.
19. *Restoring the Quality of Our Environment, op. cit.,* p. 22.
20. This estimate is based on various testimony presented to the Committee and includes the materials removed by the Long Island State Park Commission for its various park programs.
21. Testimony of Mr. Edward Leitiet and Mr. George Murphy of the U.S. Dredging Corp., April 20, 1966.
22. Mr. George Vanderborgh, *loc. cit.*

23. Mr. Anthony Taormina, *loc. cit.*
24. See Suffolk County Appropriations Bill No. 223, March 28, 1966.
25. Dredging Ordinance of the Town of Babylon, November 26, 1957.
26. Mr. David H. Wallace, *loc. cit.*
27. Wheat, Maxwell C., Jr., "Eelgrass — A Controversial Link in the Chain of Life in our Marine Waters," *The Conservationist*, (New York State Dept. of Conservation, February-March, 1962) pp. 28-30.
28. Wilson, Ronald S. and Brenowitz, A. Harry, *A Report on the Ecology of Great South Bay and Adjacent Waters,* (Institute of Marine Science, Adelphi University, Oakdale, N.Y., 1966).
29. *Ibid.,* pp. 24-25.
30. *Effective Use of the Sea, op. cit.,* p. xi.
31. Testimony of Mr. John Flynn, P.E., Principal Sanitary Environment Engineer of the Suffolk County Dept. of Health, Nov. 15, 1965.
32. County of Suffolk, N.Y., *Report on Need and Feasibility for Public Sewerage Disposal Facilities in Western Suffolk,* (Hauppauge and Riverhead, N.Y., January, 1962), Appendix B.
33. Resolution No. 494-1965 of the Board of Supervisors of Suffolk County, New York, Sept. 27, 1965, establishing the Suffolk County Sewer Agency, and for other purposes.
34. *Restoring the Quality of Our Environment, op. cit.,* pp. 223-224.
35. Woods Hole Oceanographic Institute, *Report on a Survey of the Hydrography of Great South Bay made during the summer of 1950 for the Town of Islip, N.Y.,* (Woods Hole, Mass., Jan., 1951).
36. Testimony of Mr. Kinsey of the Nassau County Department of Parks, Mosquito Control Division, April 13, 1966.
37. Woods Hole Oceanographic Institute, *Report on a Survey on the Chemistry and Hydrography of Great South Bay and Moriches Bay made in June, 1957 for the Town of Islip, N.Y.,* (Woods Hole, Mass., Oct., 1957), p. 4.
38. Woods Hole Oceanographic Institute, *Report . . . of 1950 . . .* pp. ii-iii.
39. The basic list was taken from the report, Oceanography in New York, by Dr. John H. Ryther of the Woods Hole Oceanographic Institute. The individual schools were asked to update the information if necessary. Four schools responded.
40. *Ibid.* p. 37.
41. *Nassau County Marine Environment Center — Feasibility and Recommendations,* Museum of Natural History, Division of Recreation and Parks, Department of Public Works, June, 1966, (mimeo).
42. Speech at the meeting of the American Fisheries Society in September, 1963 and quoted in Science, September 4, 1964.
43. Spilhaus, Athlestan F., *et. al.* Science vol. 15, (June, 1966), p. 1359.
44. *Effective Use of the Sea, op. cit.,* p. 80.
45. Statement by Captain Everett Snyder, U.S.N. and Mr. Robert Abel at Heritage Motel, Syosset, N.Y., August 24, 1966.
46. *Nassau County Marine Environment Center — Feasibility and Recommendations,* as cited above, also Gaso, Ralph G. and Purcell, Francis, "Testimony before the House Merchant Marine and Fisheries Subcommittee on Fish and Wildlife Conservation on H.R. 11236," (Town of Hempstead, N.Y., June 21, 1966).
47. The Suffolk County Board of Supervisors has set aside a portion of the park at Cedar Beach Point in the Town of Southold for experimental research on shellfish.
48. Master Plan of the State University of New York at Stony Brook.
49. Testimony of David H. Wallace, N.Y. State Dept. of Conservation, before the Committee Sept. 15, 1966. See also the N.Y. State Capital Construction Budget for F.Y.'66-'67. This project is receiving 75% federal financing under P.L. 88-309.
50. The Land Acquisition Bond Act of 1960, provided for the allocation of 75 million dollars to be spent by local municipalities and the State for the purchase of open-space areas

for conservation and recreation. See Article 16-C Park and Recreation Land Acquisition Act, Section 875-85.

51. New York State Conservation Law as amended, Article V, Part V-A, (1963), "Comprehensive Public Water Supply Studies and Reports."
52. "Harbor Bill Passes," Newsday, September 3, 1966.
53. Testimony of Harry H. Raines and representatives of the Greenport Sea Food Products Co.
54. Pell, Clairborne with Goodwin, Harold Leland, *Challenge of the Seven Seas,* (William Morrow & Co., New York, 1966), pp. 65-67.
55. As cited by Mr. Cornelius Poillon, President, Long Island Fishermen's Assoc. in testimony before the Committee on October 10, 1965.
56. Pell, Clairborne, *op. cit.,* pp. 1-24.
57. *Ibid.,* p. 6. The Committee wishes to acknowledge its appreciation to the publishers, William Morrow & Co., Inc. for their generous cooperation in permitting this quote to be used.
58. "Underwater Farming Long Island's Oldest Industry and Newest Business Frontier" *Long Island Commercial Review,* Special Section (November 21, 1963), also testimony of D. Wallace and G. Vanderborgh, Jr. before the Committee, September 15 and September 22, 1965.
59. *Ibid.*
60. Woods Hole, "Report . . . of June, 1957 . . .", p. 8.
61. Testimony of George Vanderborgh, Jr., President, Long Island Shellfish Farmers, before the Committee, September 15, 1965.
62. Testimony of Mr. Edward Leitiet and Mr. James Murphy representing U.S. Dredging Corp., before the Committee, April 20, 1966.
63. Testimony of the Long Island Duck Farmers Cooperative, Inc. before the Committee, December 15, 1965. The total investment in land, buildings and equipment, including processing plants, total 16.4 million dollars.
64. New York State Water Pollution Control Law of 1949 (now Section 112 of the New York State Public Health Law).
65. Wilson and Brenowitz, *op. cit.,* p. 24.
66. For a history of this pilot plant and the relevant legislation, see "A Study of the Pollution Control Effects in Suffolk County, New York, as it Pertains to the Long Island Duck Industry." (Long Island Duck Farmers Cooperative, Inc., Eastport, New York, 1965, mimeo) pp. 4-13.
67. Estimates were made on the basis of data obtained from the State of New York and from William B. Rick, Planning and Developing Waterfront Property. (Technical Bulletin 49. Urban Land Institute, Washington, D. C.). p. 8.
68. Estimate based on statistics supplied by the New York State Dept. of Licenses and Information supplied by the National Home Builders Institute.
69. Estimate based on testimony of Cornelius Poillon and others.
70. Estimate based on testimony of Joseph Dutra, Herbert Bellringer and others.
71. Taken from material submitted by Richard Schoenfeld from the National Home Builders Institute, Washington, D. C.
72. Richard Schoenfeld, Letter to Lee E. Koppelman, May 13, 1966 and testimony before the Committee, April 27, 1966.
73. Arthur D. Little, Inc. *An Industrial Development Program for Suffolk County,* Report to the Suffolk County Department of Commerce and Industry, p. 70. A full discussion of the locational requirements and advantages for port-oriented operations is contained in Benjamin Chinitz, *Freight and the Metropolis* (Harvard University Press, Cambridge, Mass. 1960).
74. Arthur D. Little, Inc. *op. cit.* pp. C-1 to C-25.