The Narrow River Special Area Management Plan

Coastal Resources Management Council

Adopted December 8, 1986

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STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

COASTAL RESOURCES MANAGEMENT COUNCIL
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ADDENDUM

to

THE NARROW RIVER SPECIAL AREA MANAGEMENT PLAN

* **Section 320.1.A.2.a & b** **(Effective November 28, 1989)**

a) In order to be in conformance with this plan, subdivisions (as defined in Section 320 of the Coastal Resources Management Plan) shall not exceed a density of 1 residential unit per 80,000 square feet. For the purposes of this section, the allowable number of units in conformance with this standard shall be calculated on the basis of available land suitable for development. Land suitable for development shall be defined as the net total acreage of the parcel, lot or tract remaining after exclusion of the areas containing, or on which occur the following protected resources: Coastal features as defined within Chapter 46-23 GLRI and/or the Coastal Resources Management Program Section 210; freshwater wetlands as defined in Chapter 2-1 GLRI, and/or any rules or regulations of the Department of Environmental Management, as promulgated thereunder. The division of a tract, lot or parcel not subject to municipal regulation under the provision of Chapter 45-23-1, for the reasons set forth therein, shall remain subject to the jurisdiction of the requirements of Chapter 46-23, the CRMP and this section.

b) Cluster development is recommended as a means to preserve open space, aesthetic qualities, and agricultural lands, reduce the costs of development, and minimize the environmental impacts of development. For CRMC purposes, the number of units in a cluster shall be calculated on the basis of developable land within the subdivision in accordance with all local ordinances, and as defined in (a) above. Lands included within statutory setbacks from freshwater wetlands as defined in Chapter 2-1 GLRI or any rules and regulations of the Department of Environmental Management, as promulgated thereunder, and lands to be developed as streets and roads shall also be excluded from the calculated acreage of developable land. The density of the cluster development shall not exceed the standard established in (a) above.

Section 320.1.B.3:
Adopted June 21, 1987

3. Areas of Critical Concern. The definition and regulations pertaining to areas of critical concern apply to those properties platted after the adoption date of this plan. Alterations, to coastal features or within 200 feet of a coastal feature on properties platted prior to the adoption of this plan will, where possible, conform to the regulations of this section.

In cases where, due to the size or configuration of a lot that was platted prior to the adoption of this plan it is not possible to provide a 200 foot buffer, then the determination of the boundaries of a buffer zone must balance the property owner's rights to enjoy their property with Council's responsibility to preserve, and where possible, restore ecological systems. Recommended Buffer Zone shall be established according to the environmental values and sensitivities of the site as assessed by the Council's staff engineer and biologist.

Section 320.2 Watershed Controls for Surface Water Runoff (adopted 7-13-93)

Amend Section 320.2.A.2.b to read as follows: (b) Applicants are required to satisfy the stormwater management requirements included in Section 300.6 of the Rhode Island Coastal Resources Management Program and most recent version of the Rhode Island Stormwater Design and Installation Standards.

Delete Section 320.2.B

Delete Section 320.2.C

Delete Section 320.2.D

Delete Section 320.2.E

Renumber Section 320.F to Section 320.2.B

Renumber Section 320.2.G to Section 320.2.C

Section 320.3 Watershed Controls for Septic System Management
(adopted 1-12-93)

Section 320.3.B.1 Extension of Sewer Lines

Continue this program change indefinitely.

Section 420 Management Regulations and Initiatives
(adopted 1-12-93)

Section 420.1.C Controls for Habitat Protection

Filling, removing, or grading (RICRMP, Section 300.2) is prohibited on any wetland in the Narrow River watershed. For the purposes of this section, wetlands shall include coastal wetlands (RICRMP, Section 210.3) and all other wetlands subject to the Rhode Island Freshwater Wetlands Act (RIFWWA)

that are located in the Narrow River watershed. However, the following exceptions may be permitted by the Council:

1) The fifty (50) foot wetland perimeter and river bank wetland areas outside the wetland "edge" (RIFWWA, Section 2-1-20 (d) and (g)) shall not be considered part of the wetland under this section.

2) Filling, removing, or grading of freshwater wetlands within the Narrow River Watershed, excluding areas regulated as coastal wetlands (RICRMP, Section 210.3), may receive relief from this prohibition in instances where filling is required to access otherwise buildable land and when no other reasonable alternatives for access exist and when the applicant has satisfied the variance burdens of proof set forth in Section 140 of the RICRMP. Buildable land shall be defined as a land area which satisfies all federal, state, and municipal requirements for the intended development. To be defined as buildable land, the intended development must also satisfy the requirements in the Narrow River Special Area Management (SAM) Plan and meet all of the Department of Environmental Management's regulations and requirements for Individual Sewage Disposal Systems (ISDS) in "Critical Resource Areas". In cases where the Council approves filling of a freshwater wetland in the Narrow River watershed in order to access otherwise buildable land, the applicant shall be subject to the following requirements: a) The applicant shall be required to mitigate the area of wetland lost on a 1 to 1.5 area basis; b) the wetland that is replaced shall be consistent with that which is filled; c) the mitigation shall take place on-site and in an area which is hydrologically connected to the impacted wetland; d) setback and buffer requirements shall be required for the wetland replacement area; e) enhancement of existing wetland shall not be an acceptable form of mitigation under this section; f) all wetland replacement projects will require the approval of the Rhode Island Department of Environmental Management (RIDEM), Division of Freshwater Wetlands; and g) the applicant shall concurrently submit applications to the RIDEM and to the CRMC so that a concurrent review of the proposed activities can occur.

<u>Section 520.1</u>
Adopted July 25, 1989

1. Section A, Delete "D(3)". Corrected form should read:

   A. Construction in coastal high hazard flood zones (V zones), as defined by federal flood insurance rate maps, shall follow the regulations as listed in Section 300.3 of the CRMP as amended.

2. Section B, Delete "D(4)". Corrected form should read:

   B. Construction in areas of coastal stillwater flood hazards (A zones), as defined by flood insurance rate maps, shall follow the regulations as listed in Section 300.3 of the CRMP as amended.

Bibliography (adopted 7-13-93)

Coastal Resources Management Council, Rhode Island, 1993. Rhode Island Stormwater Design and Installation Standards Manual. Wakefield, RI: Rhode Island Coastal Resources Management Council

/jmm
Amended September 22, 1993

The Narrow River Special Area Management Plan

Adopted December 8, 1986

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for the Coastal Resources Management Council by

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E X E C U T I V E S U M M A R Y

INTRODUCTION

The Narrow River Special Area Management Plan describes the present status of the river, characterizes its watershed, identifies sources of pollution, and recommends specific actions to restore, protect and preserve this highly regarded natural resource. Accomplishing this involved the collation of data regarding the natural history of the watershed, past and current land use and development trends, water quality status, critical wildlife habitats, flood and storm hazards, and future projects. This information is presented in the SAM Plan as "Findings of Fact" sections in the various chapters. Each chapter concludes with the recommended management techniques, "Management Regulations and Initiatives", aimed at addressing the issues raised within the chapter.

The findings presented in this plan clearly demonstrate that the Narrow River has been, and continues to be, threatened by serious water quality problems. If not addressed, the continuing decline in the water quality of the river will result in the degradation of a unique and valuable coastal resource. This would give rise to potential public health problems, and adversely affect the biological resources, recreational opportunities, and the aesthetic beauty of the watershed. Thus, the Plan has put forth management policies, programs, and strategies which are focused on coordination of government agencies and bodies, identification and restoration of sources of pollution, identification and protection of critical wildlife habitats, guidance for new uses of the watershed within the limitations of the environment, and to provide a consistent, ecologically based policy framework for decisions involving the use of the watershed resources.

THE FRAMEWORK OF MANAGEMENT

The watershed of the Narrow River lies within the political boundaries of three towns: Narragansett, South Kingstown, and North Kingstown. Additionally, the use and management of the resources of the area involves the jurisdiction of a number of state agencies.

The SAM Plan provides several mechanisms to coordinate these separate governmental bodies, including:

- Sets forth consistent, ecologically based policy recommendations for the use and protection of the natural resources of the watershed;

- Assigns special responsibilities to the Small Estuaries Subcommittee of the Coastal Resources Management Council;

- Recommends procedures to institute more effective and coordinated review of major development proposals;

- Recommends the creation of an Action Committee, composed of officials from state agencies, municipal governments, and the general public to undertake non-regulatory initiatives.

THE WATERSHED ENVIRONMENT AND IMPACTS TO WATER QUALITY

The Narrow River and its watershed are truely unique estuarine and geologic environments. Past development practices have resulted in serious water quality problems within the estuary today. Measured bacteria levels have consistently exceeded state standards for Type SA waters (the present classification of the Narrow River), periodically restricting the use of the river for shellfishing and invoking concern for public health. It is probable that the excessive bacterial counts are indicative of other pollutants, including pathogens and nutrients. The high rate of Individual Sewage Disposal System (ISDS) failures within the area, and a large number of stormwater drains discharging surface runoff to the river are indicated as likely sources of the contamination problem. The extreme development pressures on the region threaten to aggravate these problems by encouraging levels of development beyond the capacity of the watershed to support.

Recommended management strategies center on:

- Identification and restoration of failed ISDS units, including the prioritization of areas with concentrations of failed units for sewering;

- Guidelines for control of stormwater runoff into the Narrow River;

- Guidelines for control of erosion and sedimentation resulting from construction and upland alterations;

- Identification of the different land uses in the three towns and tailoring mitigative efforts to the specific needs of each.

CRITICAL HABITATS

The Narrow River has often been identified as one of the "gems" of South County. This characterization is derived in part from the combination of diverse habitats which create an aesthetically pleasing

environment. These habitats support many wildlife species, each playing a critical role in the viability of the Narrow River. Unfortunately, encroachment of human activity is threatening to destroy these habitats. Consequently, wildlife species can be lost, threatening the natural processes essential to functioning of this ecosystem.

Recommendations for management include:

- protection of critical areas (i.e., wetlands, estuarine waters) through utilization of buffer zones;

- encouragement of land management practices such as conservation easements, conservancy zoning, and direct acquistion;

- public education and cognizance of unique and critical areas.

FLOOD AND STORM HAZARDS

A steady increase in development has occurred within the flood plain of the Narrow River. This growth, combined with the conversion of summer homes to year-round use, increases the flood and storm vulnerability of the area. Records indicate substantial damages have occurred in the past; should a serious hurricane strike this area today, damages will be much more extensive. There also exists within the watershed, an extensive wetland system which serves to modify flooding effects and help mitigate the level of flooding.

Presently, no post-storm restoration plan exists which considers the potential impacts of flood plain reconstruction to the river. In addition, the CRMC is not formally linked with statewide emergency response procedures for re-permitting development after the disaster. Haphazard redevelopment can have adverse effects on the Narrow River ecosystem.

Management recommendations include:

- protection and preservation of wetlands, which serve in flood abatement;

- development of a post-storm restoration plan;

- coordination of the CRMC and other regulatory agencies involved with disaster response and redevelopment.

IMPACTS OF PLANNED AND FUTURE PROJECTS

Several projects are planned or have already been approved within the watershed limits. Such projects include the extension of Route

138 and the rehabilitation of Route 1A. Other projects are speculative, but have the potential for planning, design, and implementation. These include dredging and bridge reconstruction. Impacts of such major projects on the Narrow River can contribute to the degradation of water quality and threaten or destroy critical habitat areas.

Sea level is a major concern to all coastal domains. Although not a specific project, it is a future modification to the present status of the watershed. The predicted rise in sea level may cause the loss of valuable wetlands, induce intrusion of saltwater into groundwater supplies, and flood low-lying areas.

Management strategies focus on:

- development of a cooperative review for major projects which specifically consider the cumulative and direct impacts on the Narrow River ecosystem;

- recommendation of detailed studies prior to any alterations or modifications within the Narrow River.

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PHOTO CREDITS

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First and foremost to be thanked are the members of the Narrow River Advisory Committee. Their constant flow of ideas and suggestions throughout the numerous meetings, drafts, and nuances of the SAM planning process contributed significantly to the final form of the plan. Members of the Small Estuaries Subcommittee of the CRMC also attended meetings, providing their expertise in dealing with coastal resource management issues.

The CRMC staff, specifically George Seavey, Ken Anderson, Nick Pisani, Linda Steere, and Irene Kenenski also deserve special thanks for their comments, based on many years of working in the front line trenches, handling coastal applications.

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Chapter One. Introduction

110. The Narrow (Pettaquamscutt) River Special Area Management Plan

A. Special Area Management represents a new phase in environmental planning, which has already had some success both on national and local levels. The strategy behind the development of Special Area Management involves recognition of all components involved in a specific ecosystem and the complexity of interactions which have evolved among these components. Subsequently, the disturbance or alteration of just one component of the system can have far-reaching effects, often unexpected and occasionally irreversible.

B. The development of the Special Area Management Plan for the Narrow River watershed, located in the towns of North Kingstown, South Kingstown, and Narragansett (Figure 1-1), resulted from the merger of two ideas. The first idea was the adoption of a Special Area Management Plan for the salt pond region of southern Rhode Island, a precedent setting management strategy for the state, which tailored the legislative and regulatory powers of the Coastal Resources Management Council (CRMC) to the specific problems of the Salt Ponds. The second idea was the urgent need for strong management policies within the the Narrow River watershed, which encompasses several unique water bodies (Figure 1-2). Past building practices and current building pressures within the watershed have led to water quality degradation, human encroachment on critical habitat areas, limited public access, and a decrease in the aesthetic value.

C. In September, 1985, the Narrow River Special Area Management planning effort began, with the aim of detailing specific management strategies for the CRMC through a plan tailored to the watershed which considers all components of the ecosystem. A comprehensive characterization of the existing status of the watershed was documented through collation and summarization of available research reports provided by consulting firms, scientists from the University of Rhode Island, state agencies, student theses and dissertations, and town and community records. From this documentation, past and present problems were evaluated and management strategies and initiatives were developed concerning use and protection of the ecosystem. Specific aspects addressed in the study include water quality, land use, critical habitats, storm hazards, and impacts from future uses.

D. The characterization and evaluation of the river and the subsequent management strategies were combined to create the SAM Plan. The focus of the SAM Plan included several problems that had been unsuccessfully addressed in the past:

1. Degradation in water quality;

2. High rate and density of ISDS failures;

3. Development pressures in the watershed forcing encroachment

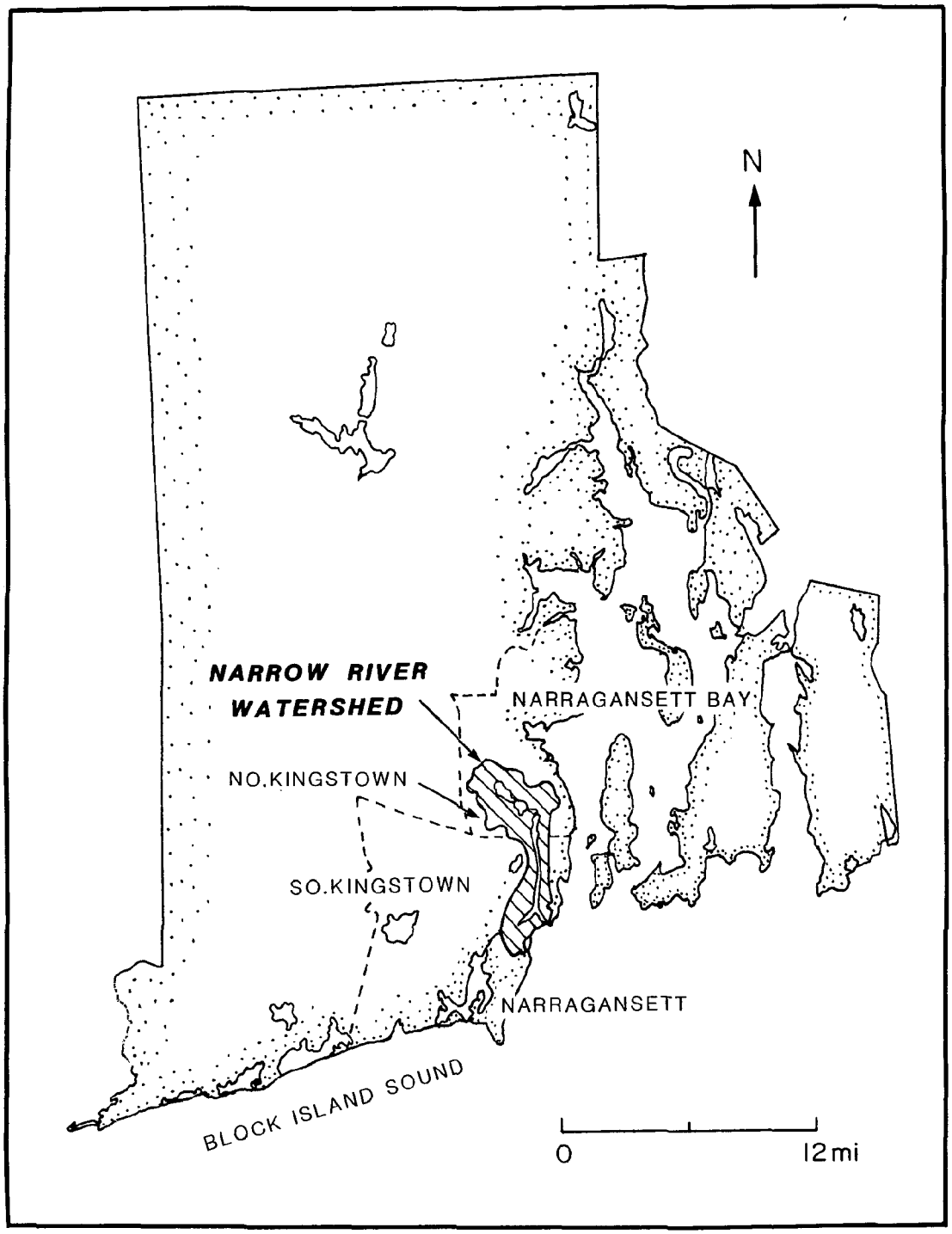


Figure 1-1. Location of the Narrow River watershed in the state of Rhode Island.

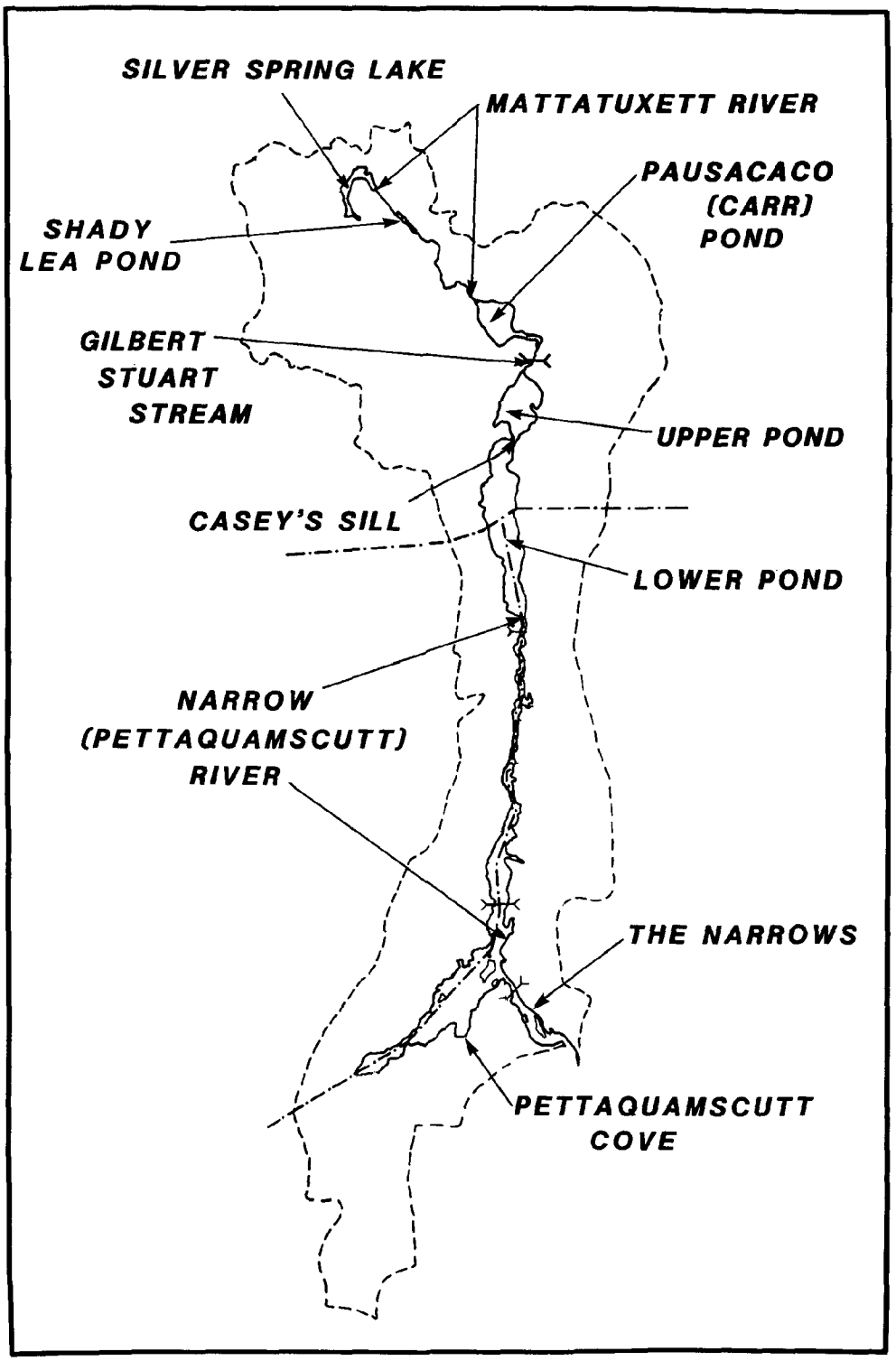


Figure 1-2. Water bodies of the Narrow River System.

into areas unsuitable to build, i.e., wetlands, slopes greater than 10%, soils with very high or very low drainage capacity, and along the shoreline;

4. Potential loss of several rare and uncommon wildlife species and habitat critical for their survival;

5. Loss of aesthetic value.

E. A building moratorium was imposed by the CRMC at the onset of the planning process. The moratorium applied to all applications within an area 200 feet inland of mean high water, or the inland edge of a coastal feature (i.e., wetlands, bluffs, or river bank), and all CRMC permits required by subdivisions of six units or more and facilities requiring a parking area of one acre or more throughout the watershed. All permit applications received after September 24, 1985 were included under the moratorium, which extended through December 31, 1986. Applications submitted for review after this date became subject to the guidelines and regulations set forth in the plan.

F. The moratorium served an important function by preventing a flood of development applications prior to the completion of the SAM Plan. This increased the plan's effective implementation towards the goal of preserving, protecting, and restoring the Narrow River watershed.

120. Past Management Efforts in the Watershed

A. The Narrow River Preservation Association (NRPA), a local environmental group founded in 1970, helped to organize and partially fund the Tri-Town Narrow River Planning Committee, which attempted the first comprehensive planning study of the river. A consulting firm was hired and completed a report entitled: A Plan for the Narrow River Watershed (River Landscapes, 1976). The focus of this plan was to evaluate development trends and potential impacts within the watershed, and recommend techniques to control the location and rate of growth. Two more groups evolved as a result of the recommendations from this plan, the Narrow River Watershed Advisory Council and The Narrow River Land Trust.

B. The Narrow River Watershed Advisory Council was formed in 1981 and was comprised of representatives from each of the three towns whose political boundaries encompassed a portion of the watershed. The mandate of the Advisory Council was to "promote and provide for the perpetuation of the watershed's value to all". The Council, in turn, appointed a Narrow River Watershed Advisory Commission, also composed of representatives from the three towns. The Watershed Commission was directed to "develop and administer a watershed program, to make recommendations on town and regional policies, to formulate a comprehensive plan for the watershed area, and to collect and analyze data

on watershed resources".

C. The Narrow River Land Trust, established in 1983, is private non-profit group able to aquire property and certain property rights in order to preserve lands within the watershed. The Land Trust, which recently received a small parcel of saltmarsh in the central reach of the river, and NRPA continue to work toward their goal of preserving and protecting the watershed.

130. Watershed Uses and Resource Values

A. The Narrow River, because of its unusual and diverse nature, has sustained extensive occupation along uplands and the shoreline for at least 3,000 years. Throughout this time, the area has been utilized successfully for such activities as hunting and gathering, commercial farming, ship building, and more recently, extensive residential use. The earliest record of occupation, established through archaelogical excavations, indicate that Native American Indians inhabited the river edge areas (RIHPC, 1983). In the early 1700's, development of the uplands began with the division of land into large plantations. Produce, fertilized with seaweed from Narragansett Bay, and dairy products from these farms were considered the finest in New England and were shipped to nearby cities from Boston Neck. In the early 1800's shipbuilding became a major industry along the river; many centerboard vessels built here were used extensively for trade with the West Indies (PHS, 1963). The river was used predominantly as a summer resort area during the 1900's. The upgrading of roads and increasing use of automobiles initiated conversion from seasonal housing to the more recent year round use. The Rhode Island Historical Preservation Commission, which has sponsored studies throughout the watershed area, plays an active role in protecting many of these cultural resources by identifying significant sites and working toward their preservation.

B. The Narrow River provides many uses and values that are beneficial to the surrounding communities and to a diverse wildlife population. The river is a vast recreational resource providing a place to swim, fish, shellfish, canoe, motorboat, windsurf, and waterski. Many residents and visitors hike, camp, picnic, and birdwatch along the shores. The river valley is recognized as one of the most scenic areas in Rhode Island, and possesses a variety of unique water and land forms along its entire length.

C. Many species of wildlife utilize the estuary and adjacent wetlands as a primary food source, a rest stop along migratory pathways, and as breeding, nesting, and spawning grounds. Several rare and unusual species have been documented, including several species of marsh grass, osprey, Least Tern, sea cucumber, moonfish, luminescent moss, and a small stand of very diverse ferns.

D. Scientists from the nearby University of Rhode Island use the estuary and bounding habitats frequently for scientific investigations. Topics of the resulting studies range from the geologic evolution of the basin and river valley (Gaines, 1975) to the habits of the marsh dwelling hermit crab (Rebach, 1970). Local schools also utilize the watershed as an educational resource, exploring the ecological importance of the marshes and adjacent estuarine and upland habitats.

140. Goals of the Plan

A. The goals for the Plan were derived from several advisory committee planning sessions and served as a guide for establishing the recommendations included herin.

B. The Narrow River Special Area Mangement Plan goals are as follows:

1. To provide for a balance of compatible uses, consistent with the CRMC responsibility for preserving, protecting, and restoring coastal resources; specifically, to guide the actions of private citizens, municipalities and state agencies in the restoration and maintenance of environmental quality in the Narrow River;

2. To provide a regional plan for the Narrow River that recognizes that the watershed functions as an ecosystem; specifically to protect, restore, and maintain the chemical, physical, and biological integrity of the Narrow River; to encourage the protection of natural systems and the use of them in ways which do not impair their beneficial functioning; to minimize the transport of pollutants to the waters of the estuary; to maintain and protect groundwater resources; to protect and maintain natural salinity levels in estuarine areas; to minimize erosion and sedimentation; to prevent damage to wetlands, and; to protect, restore, and maintain the habitat of fish and wildlife.

3. To create a decision-making process appropriate to the management of the watershed as an ecosystem, specifically insuring consideration of long term cumulative impacts.

Chapter Two.

The Framework of Management

210. FINDINGS OF FACT

210.1 Management Authorities

A. The legislative mandate for ecosystem-based planning and management of Rhode Island's coastal region is set forth in the Coastal Resource's Management Council's (CRMC) enabling legislation and describes the resource management process as follows:

1. Identify all of the state's coastal resources: water, submerged lands, air space, finfish, shellfish, minerals, physiographic features, and so forth;

2. Evaluate these resources in terms of their quantity, quality, capability for use, and other key characteristics;

3. Describe the current and potential uses of each resource;

4. Determine the current and potential problems of each resource;

5. Formulate plans and programs for the management of each resource, identify permitted uses, locations, protection measures, and so forth;

6. Carry out these resource management programs through implementing authority and coordination of state, federal, local, and private activities;

7. Formulate standards where these do not exist, and reevaluate existing standards;

An initial series of resource management activities shall be initiated through this basic process, then each phase shall continuously be recycled and used to modify the Council's resource managment programs and keep them current (GLRI 48-23-1).

B. While the CRMC has direct and comprehensive authority over the Narrow River and its shoreline, its direct inland regulatory authorities are limited. The municipalities possess the primary authority for the watershed that forms the terrestrial portion of the estuarine ecosystem. The authorities and responsibilities of the CRMC, municipal governments, the Department of Environmental Management, the Marine Fisheries Council, and the Department of Transportation are probably sufficient to effectively manage the Narrow River ecosystem. The challenge lies in coordinating the individual actions of these authorities towards the implementation of a consistent management policy. The Narrow River Special Area Management Plan provides a

policy framework around which to build the needed coordination among the various authorities, private organizations, and individuals. During its development, the municipalities involved, state and federal agencies, and citizens of the watershed actively participated in the formulation of the policy decisions embodied in the Plan. Its effective implementation can only be assured by sincere adherence to the agreed upon objectives. Each of the involved parties, the citizens and town councils of the municipalities, the developers, the state agencies, and the CRMC have unique and individual roles to play within the implementation of the Plan. Each also bears a unique responsibility for its success.

210.2 The Need for Growth Management in the Region

A. The manner in which continuing residential development is regulated and managed in the Narrow River watershed is the critical factor in preventing degradation of the coastal ecosystem due to impacts from improper or insensitive development practices (see Chapter III). The major factors that determine how and when further development will proceed are municipal zoning and subdivision regulations, state regulatory programs, and the application of acquisition, conservation, and municipal tax policies to undeveloped lands. Nearly 68% of the watershed is presently undeveloped, with the greatest proportion of such lands in the towns of North Kingstown and South Kingstown.

B. The manner in which open lands are developed or preserved will be a principal determinant of the future water quality in the Narrow River. These lands also hold the region's future as either a unique environment of exceptional quality, or another suburb where such character is reduced and destroyed. The Narrow River watershed is located in one of the fastest growing areas of the state, and has experienced steady growth over the past 40 years (see Chapter III). The development pressures place powerful economic incentives on the conversion of present open space to residential use. The preservation of the environmental quality of the watershed, and the prevention of public health hazards require that growth within the watershed be managed in a coordinated, planned manner, cognizant of the natural constraints within the watershed.

C. The SAM Plan is built from an ecosystem-based examination of the resources, their capabilities for use, the problems, and the existing institutions of the watershed. Its policies and regulations are designed specifically to insure the preservation of the vital elements of the ecosystem, to guide future development within the limitations of the land, and to resolve existing problems.

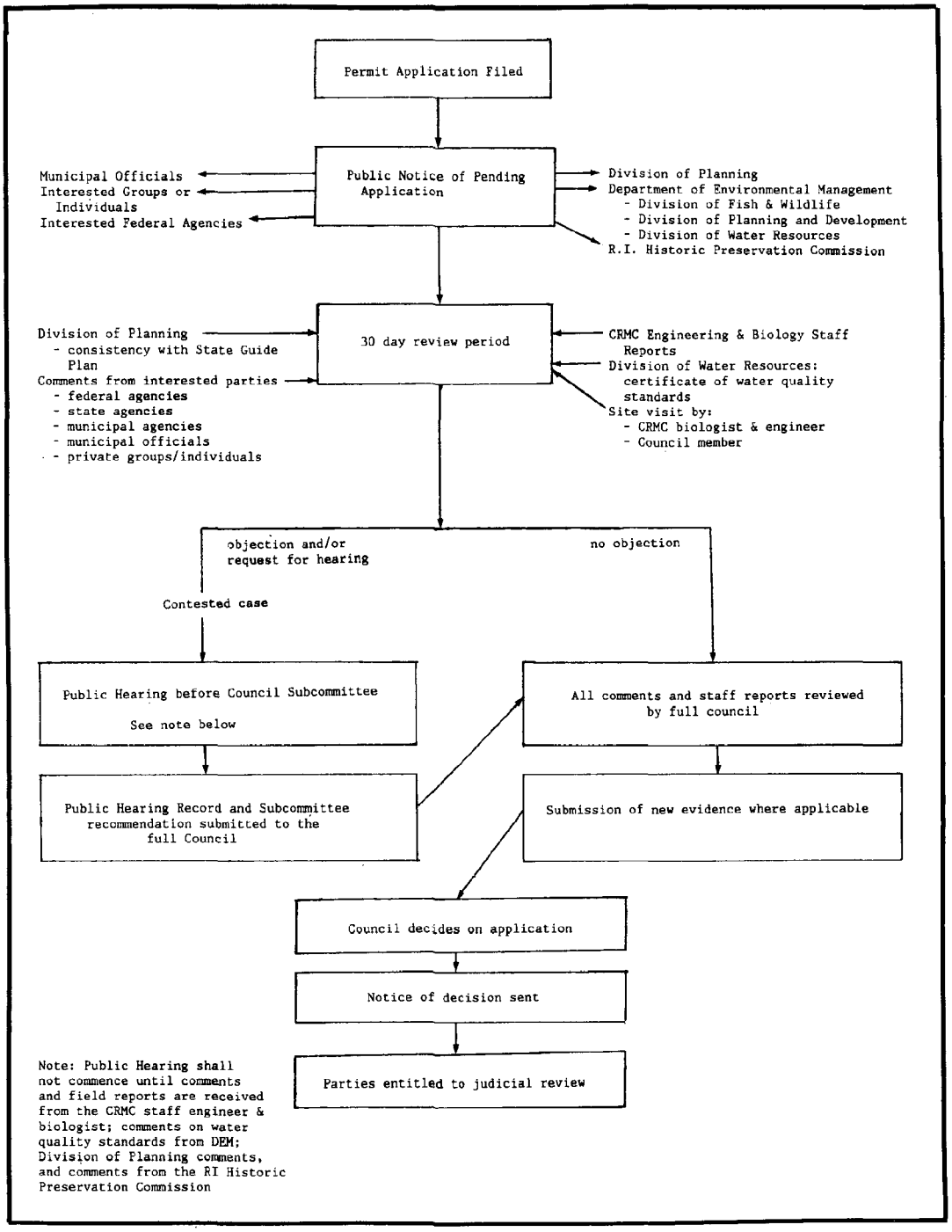
210.3 Problems with the Present Permitting Process

A. Agencies of state and local government which are engaged in the review process grant permits in a sequential, usually isolated manner. This reduces the integration of the diverse concerns of individual agencies. While the decisions reached in this manner may be legally valid, they forego the opportunity to increase their effectiveness. Sequential decision making is also inefficient, and often frustrating for an individual desiring to undertake a project that requires permits from several agencies.

B. A person wishing to develop a parcel within the region is often required to obtain approvals for the building or subdivision (from several town commissions), approval for on-site sewage disposal systems (from DEM's ISDS Section), a Water Quality Certificate and wetlands permit (from DEM's Division of Water Resources), and after all other permits have been obtained, a CRMC assent (Table 2-1). If variances or special exceptions have to be obtained anywhere along the line, the applicant's flexibility to respond to the concerns of other authorities become constrained. An applicant who has received some of the necessary approvals may be forced to renegotiate if an agency finds the constraints imposed by other permits unacceptable. The process takes months or even years and may involve several lengthy hearings before various permitting bodies. The process is expensive since engineers, surveyors, planners, and/or lawyers must be paid to guide the plan through the process. Expensive plans must sometimes be revised as the various permits are negotiated.

C. Municipal government is frequently frustrated because, as the agency with the primary responsibility over land development and often with the greatest concern for the potential impacts of the development, it is the first in line and must act without the benefits of the expert reviews of state agency staffs. Conversely, the ability of the state agencies to work with the developer to mitigate potential impacts and prepare an optimal plan is severely constrained once the applicant has received municipal approvals. The CRMC, which has the broadest powers to consider environmental impacts, is often the most constrained, since its procedures make it the last agency to grant a permit and quite frequently, the last agency to be consulted (Olsen and Lee, 1984).

Table 2-1. CRMC Permit Application Procedure



220. MANAGEMENT REGULATIONS AND INITIATIVES

220.1 Management Objectives

A. A primary objective of this Plan is to reinforce and supplement the new mechanisms which were introduced in the CRMC Salt Ponds Special Area Management Plan, to provide guidance to decision making by the various authorities within the watershed, and to improve coordination of the regulatory permitting process. This shall be accomplished through the following:

1. Assigning special responsibilities to the CRMC Small Estuaries Subcommittee;

2. A cooperative permit review procedure for major activities involving a process of consultations with involved agencies early in the planning process, and

3. The creation of an Action Committee responsible for coordinating further planning, education programs and other nonregulatory initiatives.

B. The cooperative permit-ting procedure will not alter existing authorities or change the legal basis or sequence by which permits are issued. Agencies will continue to be constrained by their specific legislative authority to act upon limited aspects of a proposal, and applicants must continue to meet the requirements and criteria of each permitting agency. The purpose of the cooperative procedure is:

1. To reduce time and expense incurred by the applicant during the permitting process;

2. To evaluate major development proposals on the basis of shared expertise from each permitting agency;

3. To identify and evaluate major impacts on the ecosystem at the beginning of the permitting process;

4. To reduce possible conflicts with regulatory program requirements by making the applicant aware of what is to be expected prior to entering the permitting process.

220.2 CRMC Small Estuaries Subcommittee

A. The CRMC Small Estuaries Subcommittee shall serve as the coordinating body of planning and regulatory activities in the Narrow River watershed. It shall promote the CRMC legislative mandate which states that "preservation and restoration of ecological systems shall

be the primary guiding principle upon which environmental alteration of coastal resources will be measured, judged and regulated" (GLRI 46-23-1).

B. The CRMC Small Estuaries Subcommittee shall:

1. Where possible, review all applications for contested Category B Assents and Special Exceptions within the Narrow River watershed and prepare recommendations on these permitting decisions for full CRMC consideration and action.

2. Coordinate actions with local, state, regional, and federal agencies and private interests; the Subcommittee shall act jointly with the Action Committee when implementing nonregulatory management initiatives contained in this plan (GLRI 46-23-6Af).

3. Make recommendations to the full Council, which shall serve as an arbitration board "in any matter of dispute involving the resources of the Narrow River and the interests of two or more municipal or state agencies" (GLRI 46-23-6Ce). The Subcommittee recommendations shall be referred to the full Council for a binding decision.

4. Encourage research on management issues in the Narrow River watershed and advise the Governor, the General Assembly, and the public on coastal matters (GLRI 46-23-6c).

220.3 Cooperative Permit Review Procedures

A. The towns located within the Narrow River watershed shall be invited by the CRMC to designate an appropriate official to serve as the Permit Coordinator for the Cooperative Review process. Parties proposing an activity listed in Section 220.4 below shall notify the Permit Coordinator before a formal application is filed for any municipal or state permit.

B. The Permit Coordinator shall meet with the applicant to identify:

1. The permits and regulations that are likely to be involved;

2. Characteristics of the proposal which are likely to pose environmental issues, impacts, or conflicts with existing regulatory policies and plans.

C. Upon the recommendation of the Permit Coordinator, the applicant shall submit the following information:

1. A locus map of the site and a general description of the project;

2. A soils map of the property (suggested scale 1 inch = 100 feet) with an accompanying analysis of the best use potential of the soils present; the soils map and use potential prepared by the U.S. Soil Conservation Service should serve as the basis for this analysis;

3. A map of identical scale (i.e., soils map) showing the principal vegetation types or any significant features identified by the Natural Heritage Program of the DEM and the RI Historic Preservation Commission on the property;

4. A topographic map of identical scale (i.e., soils map) showing surface drainage patterns and information on the depth to groundwater and the estimated direction and volume of groundwater flows;

5. A map, or aerial photographs, of identical scale (i.e., soils map) showing a delineation of coastal and freshwater wetland boundaries on the project site, and a delineation of the extent of the 100 year floodplain as shown on the most recent Federal Emergency Management Agency Flood Insurance Rate Maps (FIRMs);

6. A preliminary schematic map showing the proposed development, including, as appropriate, buildings, roadways, parking areas, drainage systems, sewage treatment and disposal facilities and undisturbed lands. Some of the above maps may be deemed unnecessary by the Permit Coordinator when activities other than subdivisions are considered.

D. The town Permit Coordinator shall forward a request for review of the proposed project to all agencies that may be required to issue permits for the proposed alterations, or any other participating or interested agency (Section 220.5), with copies of the required information.

E. The submitted information shall be reviewed by the participating agencies for conformance or potential conflicts with the regulatory requirements and policies, or significant environmental impacts, within their respective areas of jurisdiction. Any and all comments pertaining to these issues, or any other which the particular agency deems relevant, shall be submitted to the Permit Coordinator.

F. Upon completetion of all review and comment, if no objections or concerns are raised by any of the participating agencies, the applicant may apply for the necessary permits. The Permit Coordinator shall provide the applicant with copies of all comments received from

participating agencies and organizations, including a list of necessary permits and the permit application sequence. Comments and recommendations resulting from this review process are for the purpose of educating the applicant as to the permit process, and in no way represent formal or conditional permit approval.

G. If any participating agency raises any objection to, or concern with the proposed project, or requests a cooperative review conference as a result of their review, the Permit Coordinator shall schedule a pre-application conference between the applicant and all participating agencies. The purpose of the conference shall be to:

1. Identify and discuss the major design alternatives or modifications which may resolve the raised objections, or concerns;

2. Discuss the likely impacts of such alternatives, or modifications on the affected site and ecosystem;

3. Insure that recommendations for any such alternative or modification will not create conflict with any other agencies' permit requirements, basis for review, or review recommendations;

220.4 Major Activities Requiring Notification of the Permit Coordinator

A. The following activities require notification of the permit coordinator:

1. New subdivisions of 6 units or more.

2. Facilities requiring or creating more than 10,000 square feet of total impervious surface.

3. Construction or extension of municipal, private, or industrial sewage facilities or systems, conduits, or interceptors.

4. All roadway construction and upgrading projects, or activities requiring a DOT Permit for Physical Alteration.

5. Water distribution systems and supply line extensions.

6. Construction or extension of public or privately owned sanitary landfills.

7. Mineral extraction (to be defined by area).

8. Processing, transfer, or storage of hazardous materials as

defined by DEM.

9. Electrical generating facilities of more than 10 megawatts capacity.

10. All residential and commercial in-ground petroleum storage tanks; all petroleum processing and transfer facilities of more than 2,400 barrels capacity.

11. Proposed stormwater and/or drainage projects.

B. Any participating agency (Section 220.5) may request a cooperative review of any proposal within the Narrow River watershed that poses substantive environmental issues.

220.5 Agencies Participating in the Cooperative Permit Review

A. The following agencies of local, state, and federal government shall be notified by the Permit Coordinator of all proposals listed in 220.4 above:

1. The DEM Office of Environmental Coordination, which in turn will notify applicable departments within this agency.

2. The planning board, zoning board of review, conservation commission, town manager, town planner, and building inspector of the municipality within which the alteration is proposed.

3. The Department of Administration, Division of Planning.

4. The Historic Preservation Commission.

5. Soil Conservation Service.

6. The Department of Transportation

7. The Coastal Resources Management Council

B. Agencies (or divisions or boards) from whom a permit is necessary will attend pre-application conferences. The participation of all interested agencies will be encouraged.

220.6 The Action Committee

A. The Chair of the CRMC Subcommittee shall chair the Action Committee, which has primary responsibility for acting upon the nonregula-

tory initiatives contained in this Plan.

B. Membership of the Action Committee is as follows:

- All members of the CRMC Small Estuaries Subcommittee

- 5 members from each municipality appointed by their respective Town Councils; the towns are encouraged to appoint representatives from the Planning Board, Town Council, Conservation Commission, and the general public.

- A representative of the Department of Environmental Management.

- A representative of the Division of Planning.

- A representative of the Historical Preservation Commission.

C. The Action Committee shall support the CRMC and the Small Estuaries Subcommittee toward its goal of restoring the Narrow River to SA quality and shall identify its work priorities for each year. Candidate priorities for the first year are as follows:

1. To design, in cooperation with the DEM, an effective program to implement the recommendations of the ISDS Task Force on the maintenance of on-site sewage disposal (ISDS) and upgrading of substandard and failing ISDS in the region.

2. To develop a cooperative program involving all three towns for the retrofitting and upgrading of direct discharges of stormwater runoff.

3. To design and implement a public education program on the initiatives that individual homeowners can take toward maintaining and protecting water quality in the region. The primary focus of the program will be ISDS maintenance and fertilizer applications. Educational programs shall be carried out at the community level.

4. To develop strategies for the preservation of remaining open space and measures that will reduce the cumulative environmental impact of further small lot residential development in the region.

5. To work toward increasing cooperation and coordination among the involved local municipalities in matters of mutual concern within the Narrow River watershed.

Chapter Three.

The Watershed Environment and Impacts to Water Quality

310. FINDINGS OF FACT

310.1 Introduction

A. There have been many reports and studies released over the years relating water quality to the influence of human activity surrounding the Narrow River. Most of these studies suggest that bacterial contamination is a primary pollutant, and can be attributed to the close proximity of high density older communities to the river. The primary threat from high bacterial counts are not from the coliforms themselves, but from diseases that may be associated with their presence. As the bacterial count climbs, so does the probabilty that a potential health hazard exists. This infringes upon the uses and values of the river as a natural resource.

B. The river basin configuration has many constraints that have the potential to intensify bacteria levels, principally, relatively steep slopes which drain into a constricted poorly-flushed river. With the expected increase in development along the river, the bacterial problem will not disappear. Instead, other pollutants associated with high intensity land uses will begin to appear. As an area becomes more developed, the percentage of impervious surfaces increases with a corresponding increase in the amount of surface water runoff. Surface water runoff is the pathway by which substances such as road tars and oils, trace metals, sediments and petroleum products enter receiving waters (Hoffman and Quinn, 1983). Thus, while high bacteria counts present the most immediate threat to use of the river for shellfishing and swimming, increased pollutant loadings can alter the habitat characteristics resulting in long term degradation of ecological, recreational, and aesthetic qualities.

310.2 Natural Features Affecting Water Quality

A. Topography

1. The path the Narrow River follows was carved into the bedrock many millions of years ago. During the most recent glacial transgression, 18,000 years ago, glaciers deepened the river valley, steepening the flanking walls. As they retreated, a thin veneer of sand and gravel (outwash) was deposited, blanketing the valley (Figure 3-1). The steepened walls of the watershed, bounding the river to the east and west, pose one of the more severe constraints to watershed uses. The western slopes range in steepness from 20-40% (CRMC, 1986). There are several hills in the northwest region which drain directly into the upper reaches, with greater than 15% slopes. Normal development procedures are considered inadequate when slopes greater than 10% are encountered (SCS, 1981).

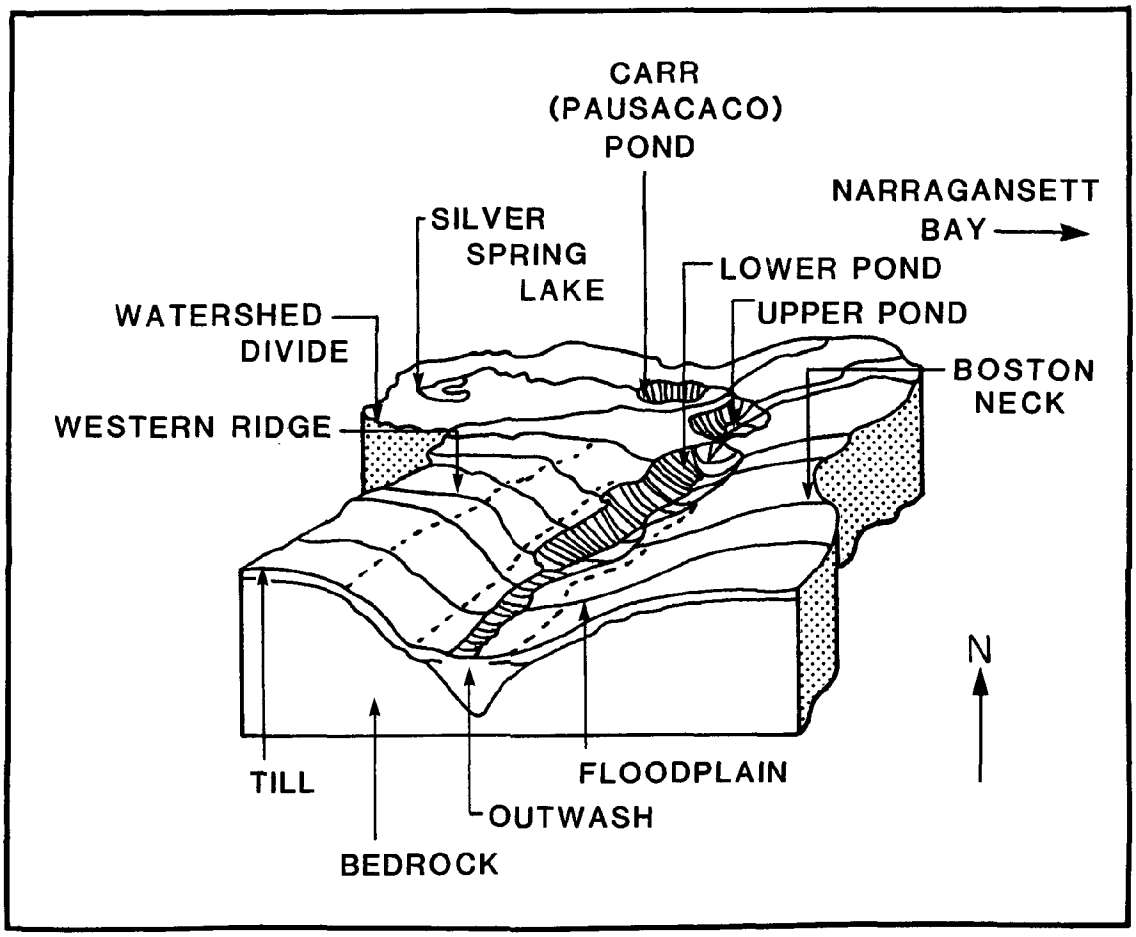


Figure 3-1. A perspective view of the topography and surficial geology of the Narrow River watershed (River Landscapes, 1976)

2. As one proceeds southward through the watershed, the land becomes flat and is near sea level. The veneer of sand and gravel also thins, and the bedrock can be seen outcropping in various locations (i.e., Gooseberry Island, southwest shore of the Cove). Because the bedrock is close to the surface and the soil layer is thin, the depth to water table is usually less than three feet, posing severe limitations on development activities.

B. Physical Oceanography

1. The Narrow River is not truly a river. It is more accurately described as a composite of a tidal inlet and backbay, an estuary, a fjord-like pond, and a river. This combination gives the Narrow River it's unique quality and character, but also hinders the natural capabilities the river system has for handling stresses such as increased pollutant loadings.

2. The river is shallow (averaging 3-5 feet) except in the northern two basins where depths plunge to an average of 50 feet (Map 12). Flow is sluggish throughout most of the Narrow River, excluding areas under the bridges and in the Narrows where currents accelerate due to the restricted width of the river. Because the river is so narrow and poorly flushed, the ability of the river to cleanse itself of anthropogenic contaminants is severley reduced. This allows the accumulation of pollutants, suspended in the water column and absorbed onto bottom sediments, in excess of what is considered safe not only to the natural ecosystem, but to human uses of the water as well.

3. Natural freshwater flow measured in two studies (Wright, et al. 1949; Durbin, et al. 1979) during the spring season, from Gilbert Stuart Stream averaged 10,017.5 gallons per minute. Base flow taken by the United States Geological Survey (1961-1963) averaged 1,443 gallons per minute in the summer. From these few measurements it is apparent that flow from the headwaters covers a considerable range and that the base flow (from groundwater) is small. Consequently, the headwaters are very sensitive to inputs from melting snows, ground thawing, rainfall and subsequent runoff, thus, the quality and quantity of runoff is of considerable concern.

C. Anoxic Basins

1. The two northern basins, Upper Pond and Lower Pond, were formed at the end of the latest glacial period by melting ice blocks. The basins are an interesting feature in that they are so unlike the rest of the Narrow River. The basins are approximately fifteen times deeper than the lower reaches and the headwaters region, and because of this great depth, have a separate and distinct character.

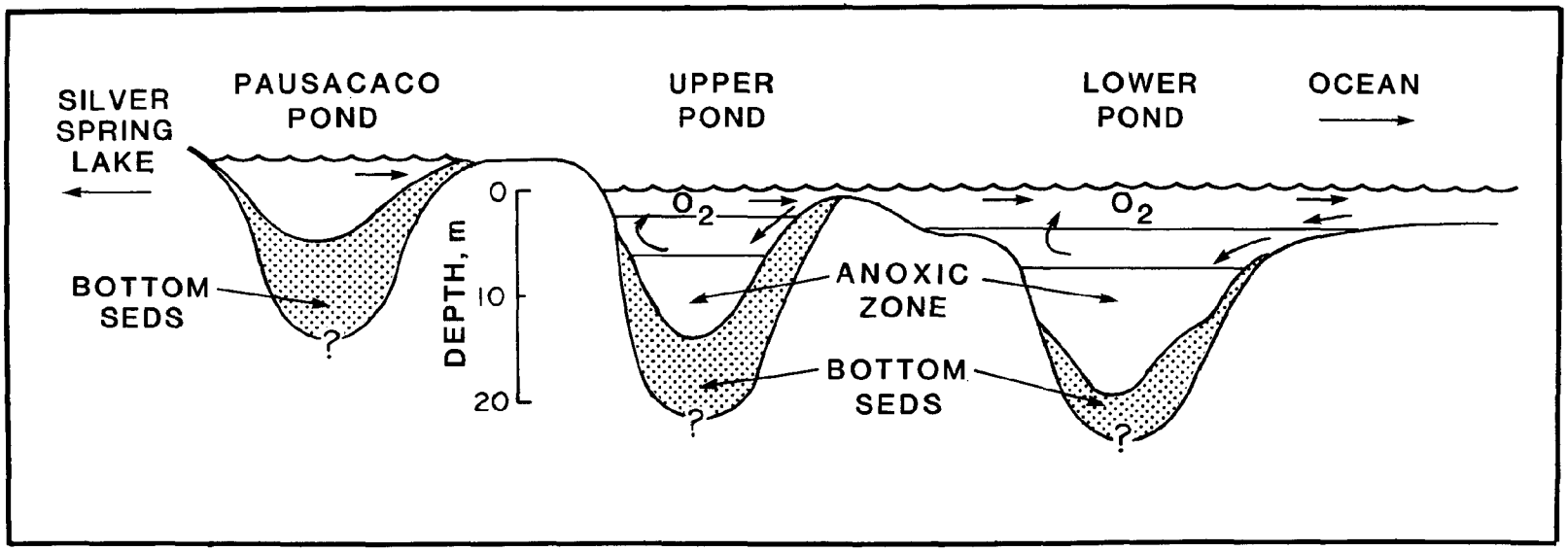


Figure 3-2. Longitudinal cross-section of the two northern basins and Carr (Pausacaco) Pond showing the dynamics of the water regime and stratification feature.

2. The basins are characterized by a stratification feature induced by the sinking of heavier brackish waters on flood tide, below the bouyant fresh upper layers as illustrated in Figure 3-2 (Gaines, 1975). Due to the depth and reduction in sunlight, the temperature of the lower layers may drop by several degrees, further enhancing stratification. An important consequence of this stratification of the water is a reduction in the mixing between layers, with the lower layers becoming very sluggish and stagnant. Occasionally the bottom waters are renewed with fresher water during a process known commonly as "overturn". When ambient conditions are right, the bottom waters are displaced to the surface, releasing accumulated nutrients and gases, most notably hydrogen sulfide. This sudden flux of nutrients has been known to cause eutrophic conditions and fish kills (Horton, 1958a). The residence time for the bottom waters of the Upper Pond has been estimated to be approximately 3 to 5 years (Gaines, 1975).

3. These basins, because of the extremely poor flushing in the lower layers, act as huge catch basins for any substances introduced from the headwaters or transported by surface water runoff or groundwater flow. Further, these substances can be expected to remain in the basins for long periods of time, increasing the amount of time the substances interact with the ecosystem. The natural cyclic turnover of the bottom waters has been known to produce adverse effects; if the system becomes more highly eutrophied or polluted, the effects of a turnover may be considerably intensified (DEM, 1986).

310.3 Land Use within the Watershed

A. Current Land Use

1. Land use within the watershed has been and continues to be devoted primarily to residential use. Although the trend in development has increased steadily over the past 40 years within the three towns, the most obvious change has been an accelerated growth rate, most readily observed in the town of Narragansett (Figure 3-3). The trend in growth in Narragansett exceeds that of North Kingstown and South Kingstown by a margin greater than the two towns combined (Howard-Strobel et al, 1986).

2. The development of residential land use, though seemingly benign, has proceeded in a piecemeal fashion, especially within the lower portion of the watershed and has resulted in a situation where the highest density communities are located in close proximity to the river. Mapping of the distribution reveals 1/2 to 1/8 acre lots in South Kingstown and Narragansett along the most narrow reach of the river (Map 2). In North Kingstown, the high

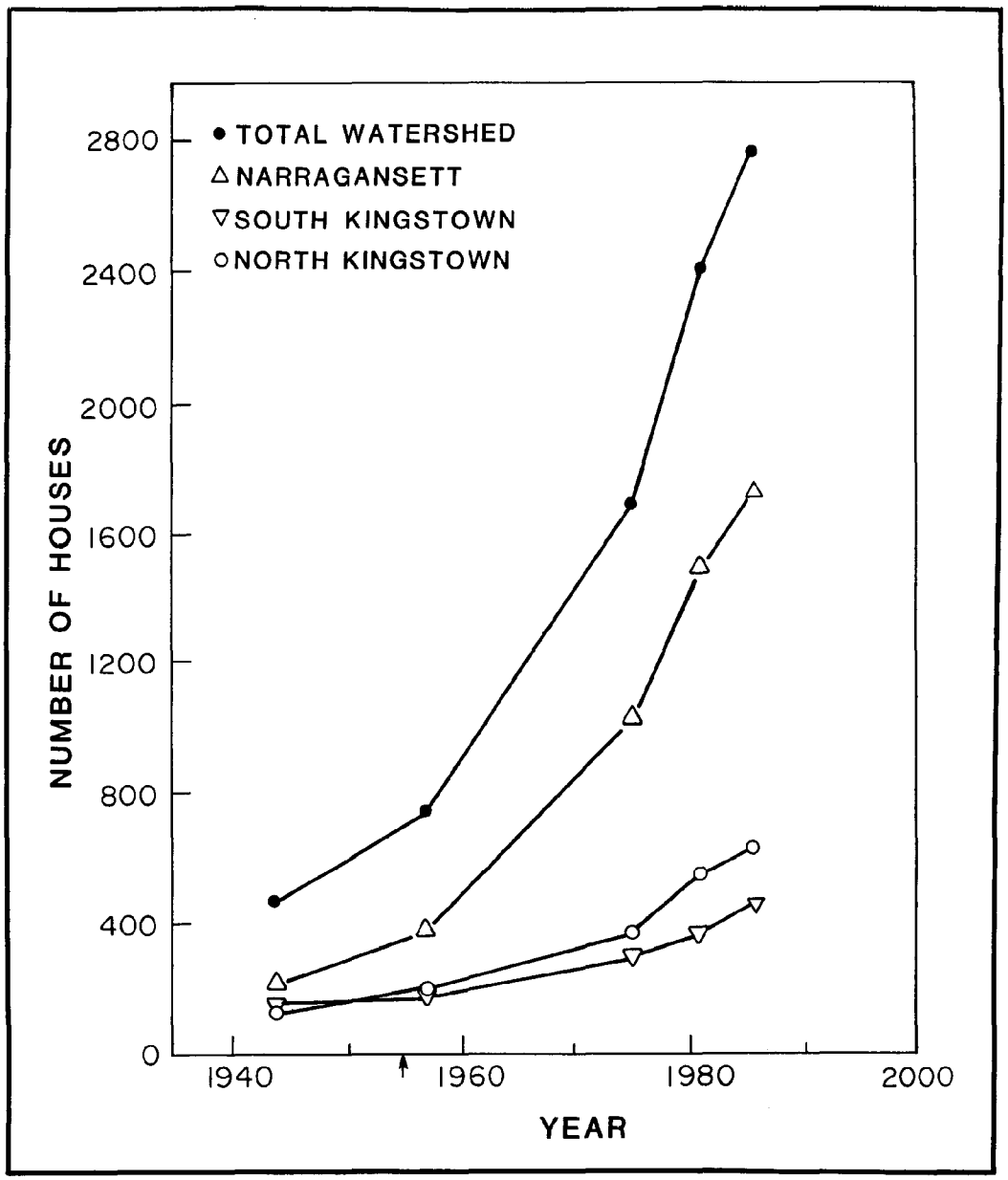


Figure 3-3. The growth rate trend in the Narrow River watershed from 1944 to 1985.

density development occurs near Siver Spring Lake in the headwater region. The close proximity of this high density housing to the river increases the significance of degradational impacts from human activities (EPA, 1983).

3. Approximately 30% of the land area within the watershed is developed (Figure 3-4). The percentage of developed land area in Figure 3-4 refers to lots with existing residences and residential supporting facilities (schools, churches, etc.), access roads, and vacant lots within otherwise developed areas (scattered dwelling units in undeveloped areas were assigned one acre of developed land). Undeveloped lands account for almost seventy percent of the watershed (Figure 3-4) and refer to open and wooded land not supporting residences. These lands include rural roads, large tracts of land amenable to further subdivision, and "grandfathered" lands not amenable to further subdivision. Most of the undeveloped lands are located in the north-northwest region. North Kingstown's undeveloped land area in the watershed is just over 80%, South Kistown has 70%, and 46% is undeveloped in Narragansett (Figure 3-5 and Map 2). Much of the land is undeveloped because of constraints imposed by the natural features (high water table, steep slopes, wetlands, etc.), or is devoted to conservation purposes (land dedications, conservation easements, and lands zoned for open space or conservation).

4. Present engineering technologies and the installation of public utilities bypass many of the natural constraints. Based on the exisiting land use and present zoning ordinances for each town, the potential for an almost fivefold increase in residential development exists (Table 3-1). This increase presumes most of the natural constraints are averted (excluding wetlands) and includes a number of "grandfathered" substandard lots. Because many of the undeveloped parcels are large, the future uses (i.e., conservation, acquisition, or development) are important factors that affect the river and should be managed for long-term benefits.

B. Roads and Highways

1. Roads and highways are an important land use when considering impacts from surface water runoff. These paved areas, as well as driveways, roofs, etc., considered impervious material by the Soil Conservation Service (1981), allow almost all precipitation to run off without percolating into soil substrate. This limits the natural filtering process provided by soils which act to reduce contaminants such as road tars and oils, trace metals, sediments, and petroleum fuels. In excess, these substances are harmful to the natural estuarine environment (Hoffman and Quinn, 1985).

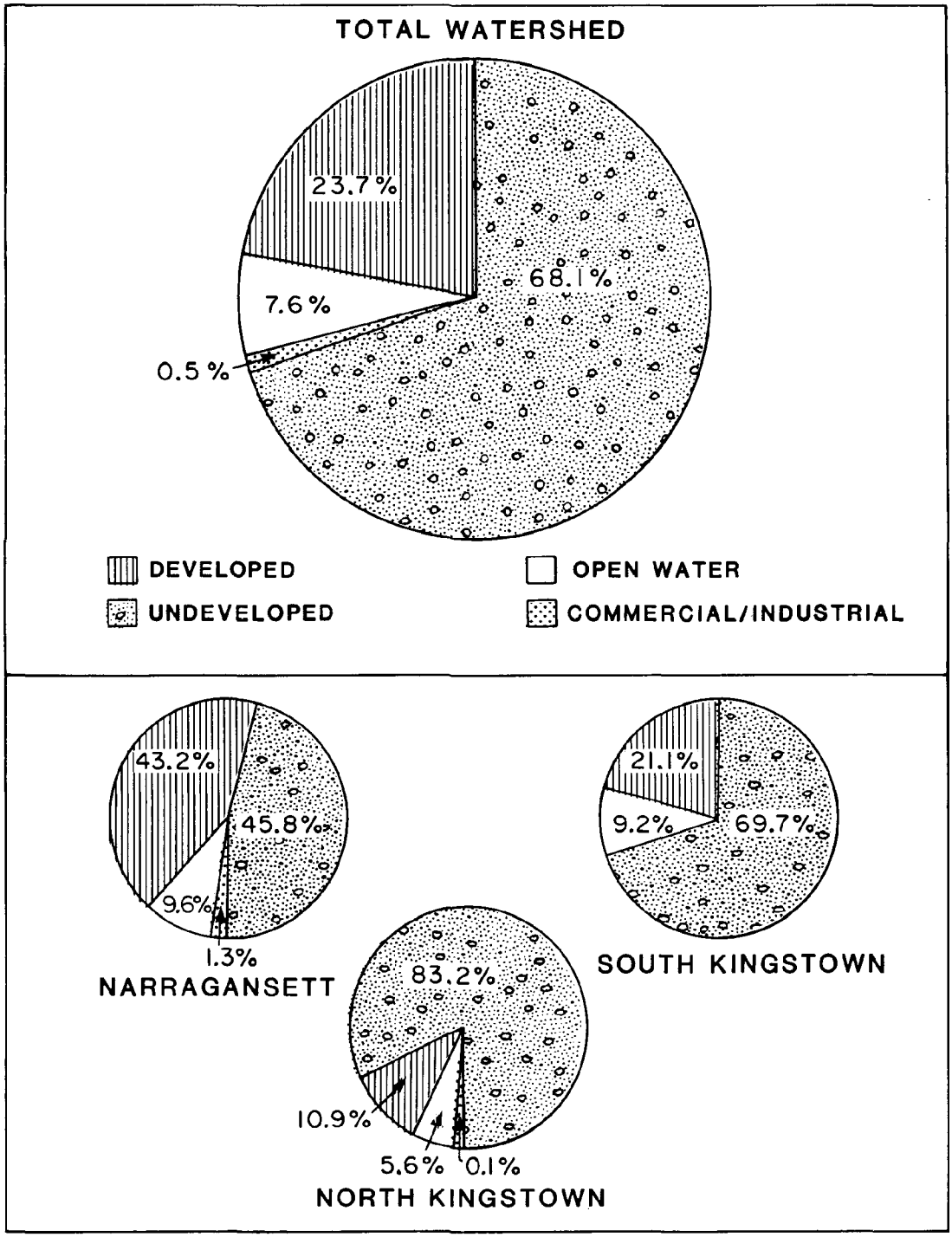


Figure 3-4. Land use distribution within the Narrow River watershed (based on data from 1985-86 aerial photos and municipal tax maps).

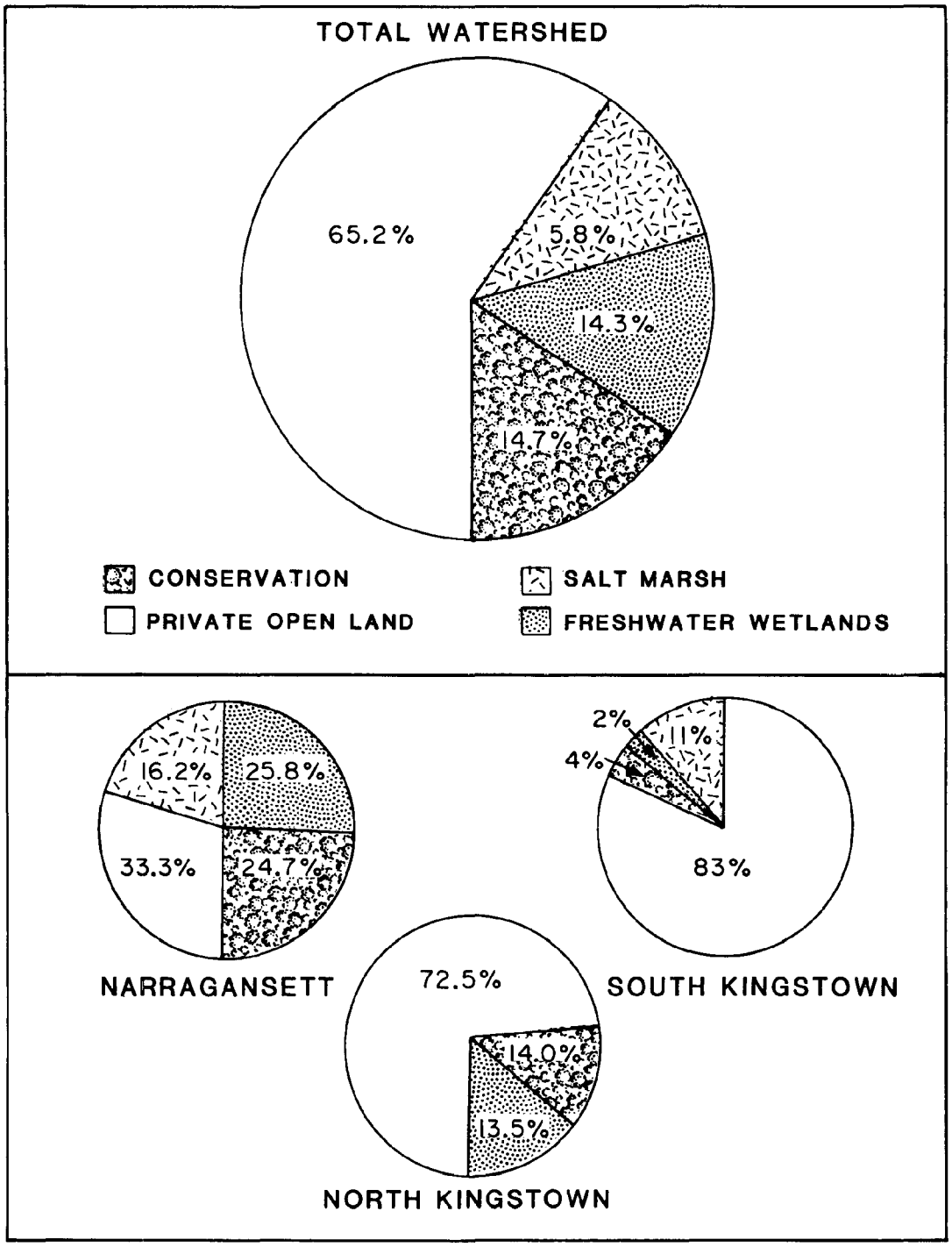


Figure 3-5. Distribution of the open lands within the Narrow River watershed (based on data from 1985 aerial photos, National Wetlands Inventory of 1979, and 1985-6 municipal tax maps).

Table 3-1. Existing and Potential Development

	Existing Houses*	At Saturation**	Increase Factor
North Kingstown	545	858	1.6
Narragansett	1495	2547	1.7
South Kingstown	438	2,050	4.7

*Data calculated from 1985 aerial photos
**Estimates exclude wetlands

2. There are three major highways traversing the watershed, Routes 1, 1A, and 138 (Figure 3-6). Route 138 runs east-west through North Kingstown, serving as a major link from mainland Rhode Island to the island of Conanicut (Jamestown) and the East Bay region. Routes 1 and 1A run north-south along the two ridges bounding the Narrow River. There are four east-west connectors between Routes 1 and 1A, all crossing the Narrow River. In order to link the two highways, these connectors descend into the river valley, meeting at the four bridges: Sprague, Middlebridge, Bridgetown, and Gilbert Stuart. Unless proper drainage control is in place, this smooth sloping conduit facilitates the transport of surface water runoff. This is currently a problem in portions of the watershed (Collins, 1986).

C. Public Utilities

1. Public sewer lines are a key factor in determining the destiny of certain lands. The installation of sewer lines encourages building and bypasses natural constraints that would otherwise inhibit development (River Landscapes, 1976; Olsen and Lee, 1984). However, where ISDS appear to be failing at a high rate, the installation of sewer lines may be beneficial to the sanitary conditions of the neighborhood and to the water quality of nearby receiving waters. In the town of Narragansett, aside from a few of the northern most neighborhoods, public sewer lines service the entire area. Neither North Kingstown nor South Kingstown are presently utilizing public sewer lines within the watershed.

2. Public water lines also play a role similar to that of sewer lines in determining the fate of certain lands. The addition of water pumped in from outside the watershed increases the net amount of freshwater input to the river which can severely alter the natural dynamics of the estuary. Narragansett is almost entirely served by public water lines. South Kingstown has

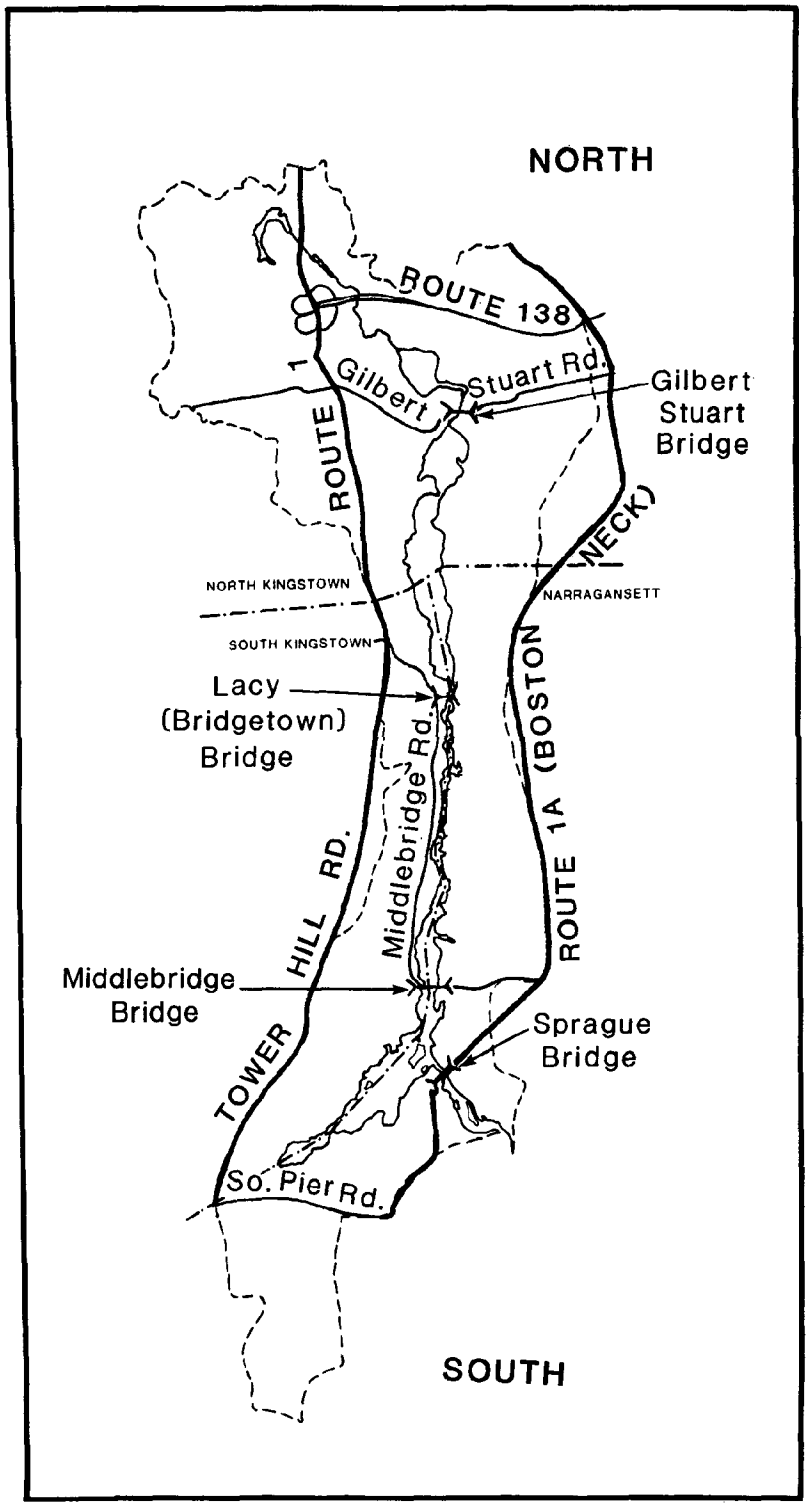


Figure 3-6. Location of major roadways in the watershed.

public water lines servicing the Middlebridge neighborhood, adjacent to the central reach of the river. Several water lines feed into a few neighborhoods of the watershed in North Kingstown.

3. For those areas not serviced by water lines, the potential for groundwater contamination becomes a major concern. Pollutants that may enter wells include bacterial coliforms, insecticides, fertilizers, road salts, graywater (dishwasher, washing machine, sink, and shower discharges), and petroleum products. Of particular concern to well owners living near an estuary or other salt water body is the threat of contamination from a salt water intrusion. This is known to occur if an aquifer is overpumped, causing excessive drawdown. In the Narrow River watershed, continuing development increases the potential for problems associated with salt water intrusion. Surface water runoff, carrying many of the same pollutants and posing the same threats as groundwater, can also enter older, cracked, or improperly sealed wells.

D. Special Resources

1. Cultural resources are an important attribute of the Narrow River and include a number of historical and archeological sites listed, or eligible for listing, in the State Register and the National Register of Historic Places. Significant historical resources within the watershed, located on approximately 457 acres, include most notably the Gilbert Stuart Birthplace (a National Historic Landmark), the Jireh Bull Blockhouse site, the original Governor Sprague Bridge, the McSparran site, and the Silas Casey Farm (the oldest working farm in the U.S.). These sites, many dating to Colonial times, contribute significantly not only to the historical aspects, but also to the aesthetic qualities of the watershed.

2. Surveys sponsored by the Rhode Island Historical Preservation Commission have identified numerous sites and sensitive areas which contain, or may contain, prehistoric Native American artifacts. Most of these are in close proximity to the river, indicating that earlier cultures also utilized the Narrow River's wealth of natural resources. These sites date back more than 3000 years and contain important data that can contribute to research topics and issues identified for the Rhode Island coastal zone (RIHPC, 1986).

3. Unfortunately, many of the historical and archaeological sites have been altered or destroyed. These cultural resources are the most vital link to earlier life within the Narrow River and should be recognized as such, not only by those agencies who govern their use, but also by other involved regulatory bodies, as well as local residents. These fragile and nonrenewable re-

sources provide a unique and educational quality to the resource value of the river and thus, deserve consideration for protective measures. Educational programs, sponsored through concerned local groups and perhaps more importantly, in the local schools, can help to stimulate interest and assure long term appreciation and protection for these fragile resources.

E. Development Trends

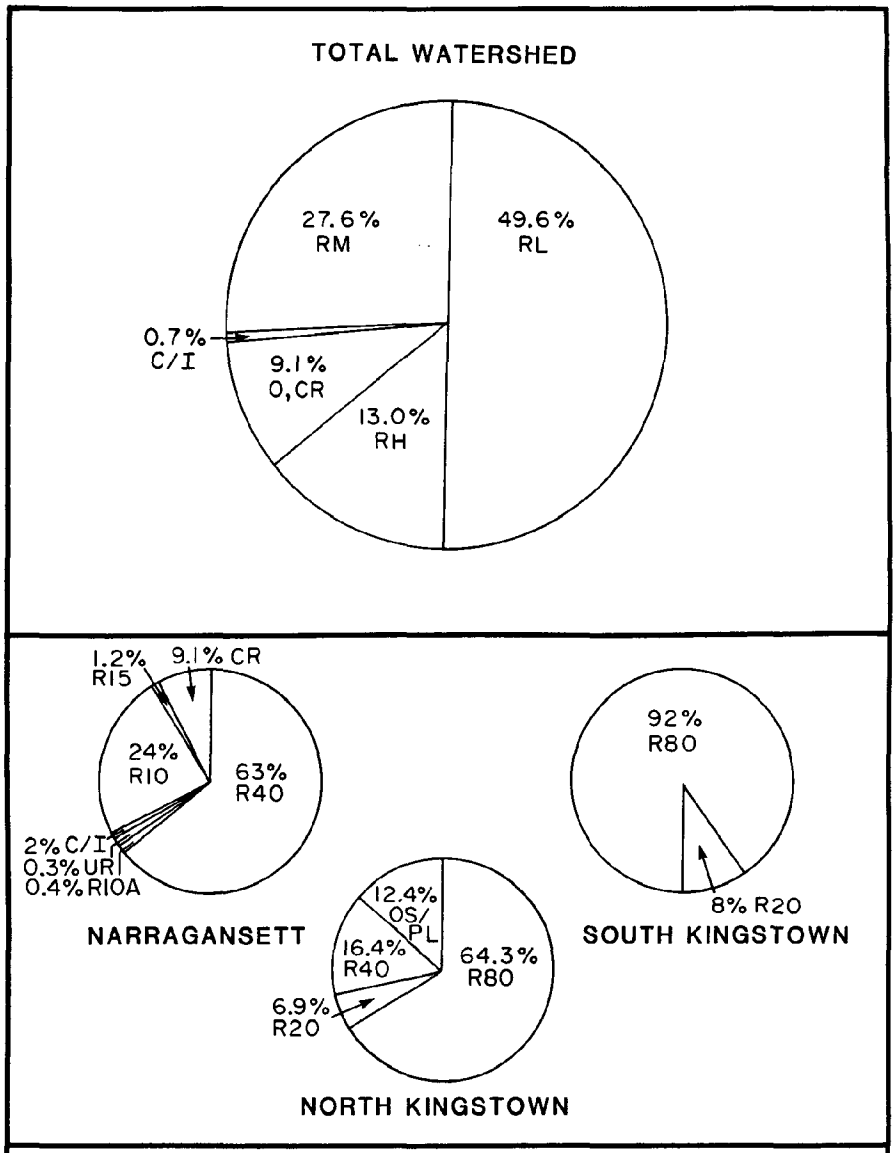
1. Growth along the Narrow River has been dramatic in the past forty years, as can be seen by the greater than fivefold increase in the number of dwelling units throughout the watershed (Figure 3-3). Narragansett has experienced the bulk of this growth with a sevenfold increase. Although the other two towns seem moderate when compared to Narragansett, South Kingstown has doubled its growth rate and North Kingstown has increased by more than fourfold (Howard-Strobel, et al, 1986).

2. Zoning is the principal determinant of the type and density of use of land, usually laid out in districts to insure the separation of various activities. All three towns within the watershed have established zoning districts, with residential uses being the primary zone designation. The densities allowed vary greatly over the range of the watershed, from one residence per 10,000 square feet to one per 80,000 square feet (Figure 3-7). Narragansett generally has the highest densities, both in zoning and existing land uses. The less developed areas of North Kingstown and South Kingstown have substantial acreage devoted to low density (Map 11).

F. Public Access Sites

1. Public access along the river includes several existing sites. There are three state owned boat launching ramps, two in the headwaters region near Silver Spring Lake in North Kingstown, and one on the west side of the river in South Kingstown. Two popular fishing sites include Lacey Bridge and Middlebridge Bridge (Figure 3-6). A bridge at the site of the Gilbert Stuart Birthplace also offers access for fishing and boating, within the Gilbert Stuart Stream. Two scenic overlook areas within Narragansett provide access to the river at the Narrows, where boats may enter the river from Narragansett Bay.

2. There are numerous private access areas throughout the estuary, most located in the constricted middle reach of the river. These areas are frequented by the public for boat launching and other recreational uses. Public access points include individual docks from adjacent river properties, numerous community association beaches, and the Mettatuxet Yacht Club on the east shore. While the docks for the most part serve the individual, the



Residential Zones			Additional Zones	
	R10	- 10,000 sq ft/du*		
RH (High)	R10A	- 10,000 sq ft/du	C/I	- Commercial/Industrial
	R15	- 15,000 sq ft/du	O	- Open Space
	R20	- 20,000 sq ft/du	CR	- Conservation
			UR	- Urban Redevelopment
RM (Moderate)	R40	- 40,000 sq ft/du	OS/PL	- Open Space/ Planning
RL (Low)	R80	- 80,000 sq ft/du		

* dwelling unit

Figure 3-7. Zoning distribution within the watershed, 1986.

beaches and Yacht Club are owned and used by the local communities. A small "fee for use" marina is also located adjacent to Middlebridge Bridge in Narragansett.

3. As growth in the towns surrounding the river proceeds, the need for new and/or larger facilities will become a more important factor. The Coastal Zone Management Act, as amended in 1976, encourages planning for public access along shoreline areas.

310.4 Water Quality Status

A. Present Classification

1. The Rhode Island Department of Environmental Management currently classifies the Narrow River as follows: from the Narrows to the landward limit of the saltwater influence at the top of Upper Pond, Type SA waters; from Gilbert Stuart Stream to Pausacaco Pond, Type A waters; and from the start of the Mattatuxett River to Silver Spring Lake and Pendar Pond are Type B waters (R.I. Statewide Planning, 1979).

2. Type SA waters are defined as suitable for all salt water uses, including shellfish harvesting for direct human consumption; Type A waters are suitable for water supply and all other water uses; and Type B waters are suitable for bathing and other recreational uses. This classification scheme represents water quality goals and not necessarily the present condition of the water body.

B. Bacterial Contamination

1. State officials classify an estuary out of compliance for Type SA waters when bacteria levels fail to meet both parts of the State of Rhode Island water quality standard as follows:

(a) "total coliforms not to exceed a median MPN (Most Probable Number) of 70/100 ml and not more that 10% of the samples shall exceed an MPN of 330 of a 3-tube decimal dilution."

(b) "fecal coliforms not to exceed a median MPN of 15/100 ml and not more than 10% of the samples exceeding 50/100 ml."

2. Water quality trend data collected by the R.I. Department of Environmental Management (DEM) show that the Narrow River has consistently exceeded state standards for total coliform counts since 1959 (Howard-Strobel et al, 1986). A tabulation of the DEM

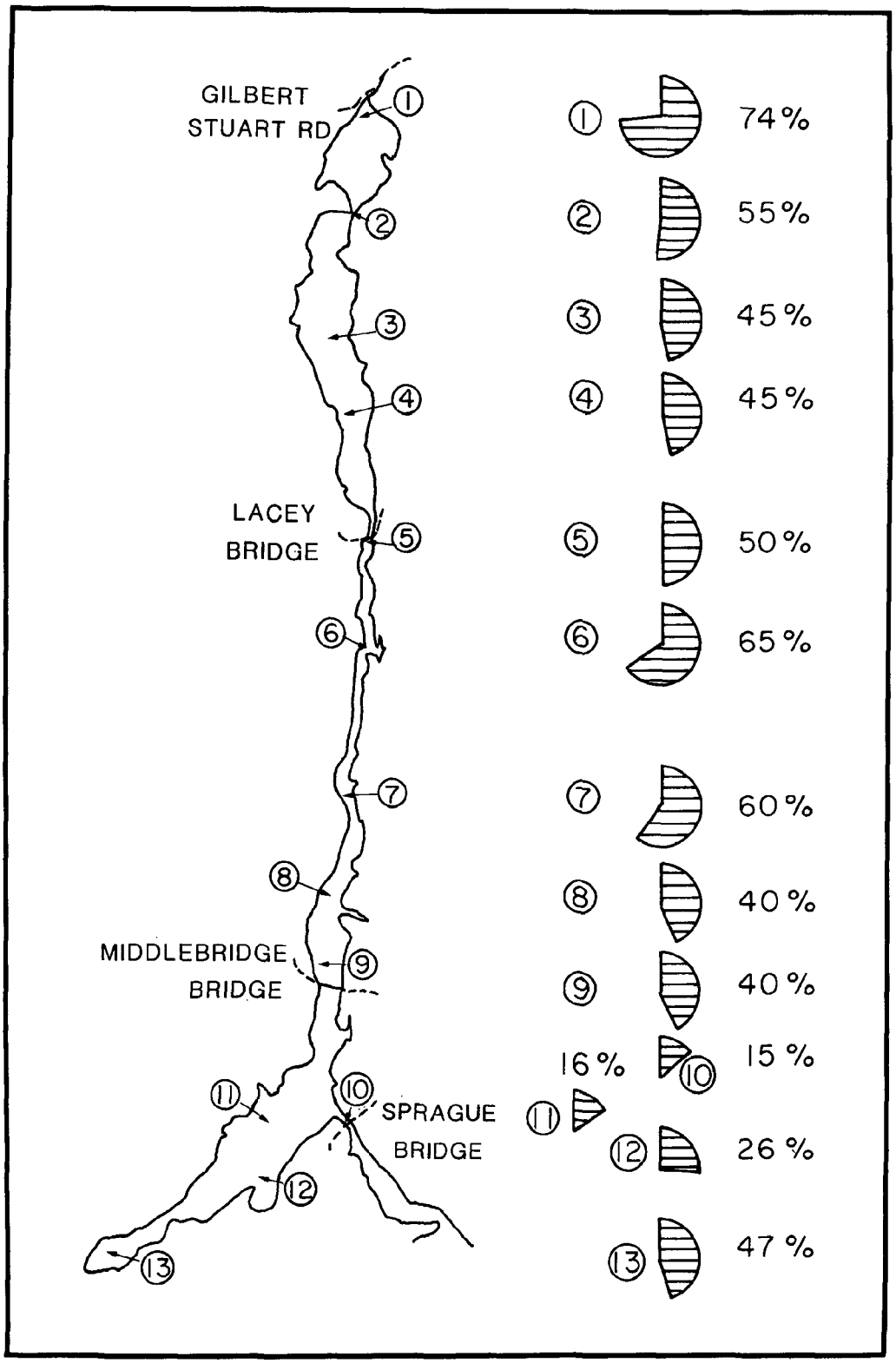


Figure 3-8a. Percentage of samples, collected by the RI DEM, exceeding state limits for <u>total</u> coliform levels from 1980 to 1985.

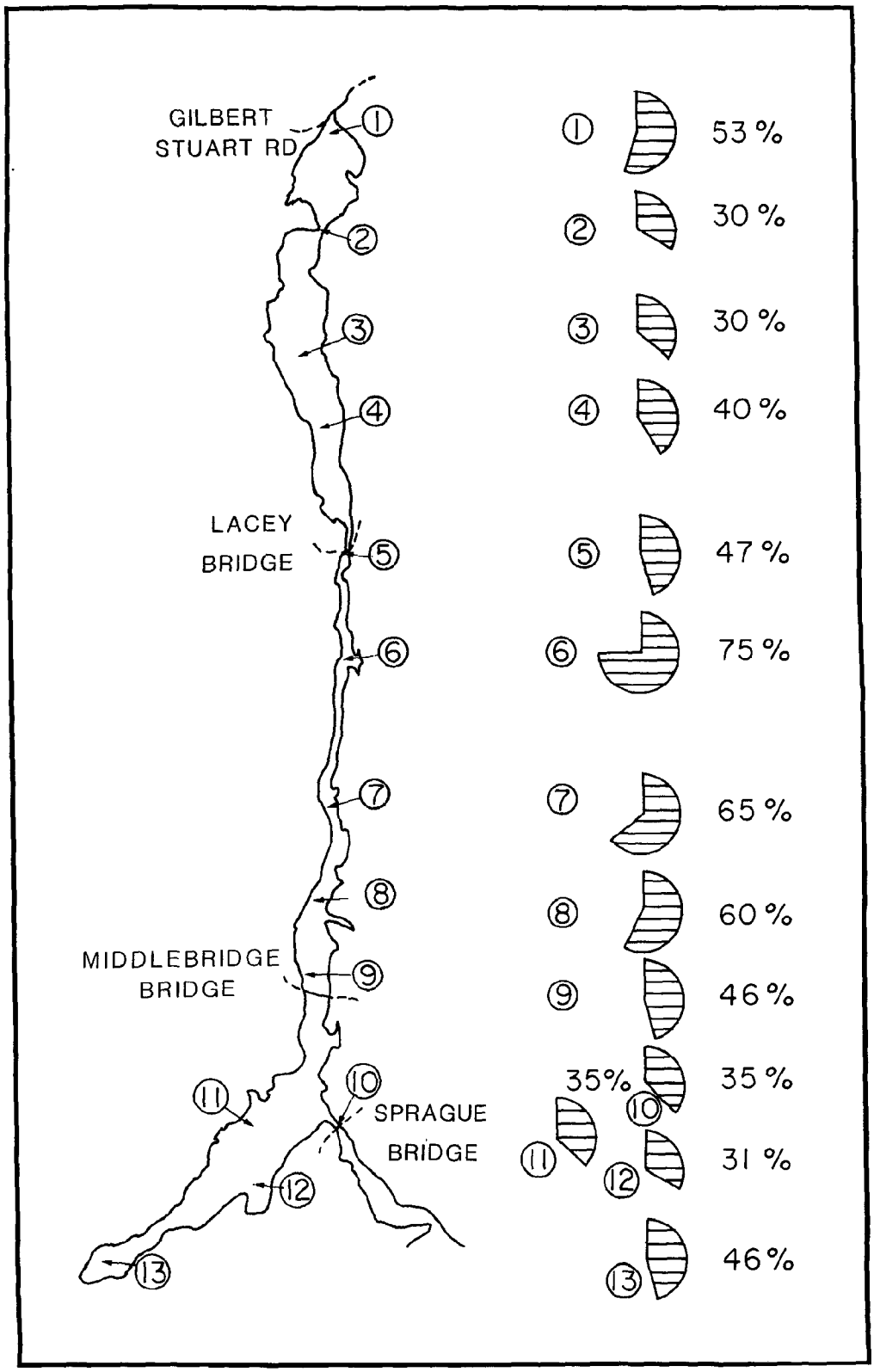


Figure 3-8b. Percentage of samples, collected by RI DEM, exceeding state limits for fecal coliform levels from 1980 to 1985.

data shows that of the 121 samples taken from the river over the past 21 years, 50 (41%) were out of compliance (> 70 MPN total coliforms). Since 1980, 24 out of 48 samples taken, or 50%, were out of compliance (> 70 MPN total coliforms).

3. Figures 3-8a and 3-8b, are graphic representations of the data collected by DEM since 1980. The pie diagrams along the length of the river represent the percentage of the total number of samples for a particular station that was out of compliance for total (Figure 3-8a) coliforms and fecal (Figure 3-8b) coliforms. "Hot spots" of consistently high counts (>50% of samples exceed state limits) are readily observed from this presentation. These include Station 1 (Gilbert Stuart Stream), Station 2 (mid-channel at Casey's Sill), Station 5 (mid-channel at Lacey Bridge), Station 6 (mid-channel at Wampum Rd.), Station 7 (near Mettatuxett Yacht Club) and Station 8 (mid-channel south of Torrey Rd.).

4. The history of high bacteria levels has been further substantiated by detailed and intensive analysis performed by microbiologists from the University of Rhode Island. Data collected at Lacey and Middlebridge bridges in the summer of 1972 exhibited counts of total coliforms ranging from 73 to 436 MPN/100 ml (Hanisack, 1972). Figure 3-9 plots the results of a study performed two years later in the summer of 1974 (Respaz and Hargraves, 1974). The investigators concluded the study with a recommendation that the river be reclassified as Type SB waters (Type SB water are suitable for bathing and other recreational purposes) due to the high levels of bacterial contamination observed. Sieberth (1983) noted high coliform counts in 1978 and 1979 while doing a study for the Narrow River Preservation Association. The results (Figure 3-10) led to the closing of the Narrow River to shellfishing in August, 1979. The river was reopened the following Spring, 1980. Recently, Hargraves (1986) obtained samples above and below Middlebridge Bridge after late July storms and found fecal coliform (mFc) levels of 2799/100ml and 2863/100ml, respectively.

5. Sources of bacterial contamination that exist within the watershed include storm drains, failed septic systems, and fecal material from domestic animals and wildlife. Storm drains were investigated by R.I. DEM in April, 1980 and June, 1982 (Figure 3-11). Of the 33 storm drains along the Narrow River, 22 were selected for sampling. The results are tabulated in Table 3-2. The significance of storm drains as a source of bacterial coliforms is quite obvious, as state standards are exceeded 3 to 3,400 times by total coliforms and up to 3,000 times for fecal coliform counts.

6. Failing individual sewage disposal systems (ISDS) are a well

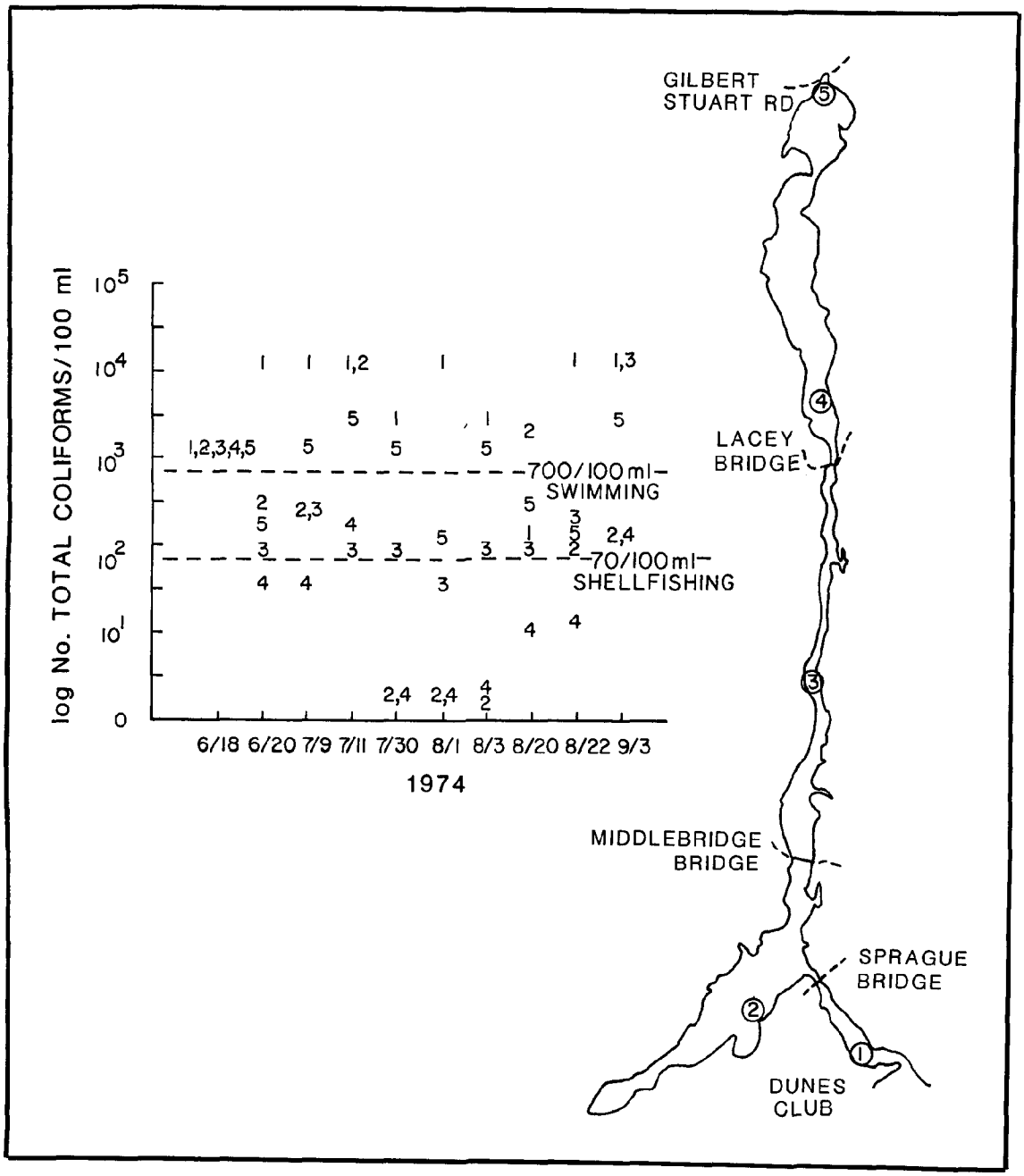


Figure 3-9. Total coliform levels measured during the summer months in 1974, along the Narrow River. Numbers plotted in the graph refer to the station numbers along the river. The two dashed lines in the graph represent the uppermost level for each standard: shellfishing and swimming (data from Repasz and Hargraves, 1974).

Table 3-2. DEM Storm Drain Survey (Total Coliform/Fecal Coliform ratio in MPN/100 mls).

Station	April 29, 1980	May 21, 1980	June 25, 1982
1	2,900/640	---	23,000/2,300
2	9,300/930	240,000/43,000	2,300/ 23
3	---	15,000/2,300	---
4	---	43,000/15,000	---
5	4,300/43	23,000/9,300	230/ 23
6	---	---	---
7	---	150,000/23,000	---
8	---	---	---
9	---	23,000/1,500	---
10	4,300/290	23,000/9,300	---
11	23,000/930	43,000/23,000	230/ 23
12	43,000/430	43,000/23,000	23,000/ 23
13	23,000/2,300	43,000/7,500	---
14	430/43	23,000/4,300	23,000/230
15	4,300/4,300	240,000/21,000	---
16	930/93	---	---
17	930/4**	---	23,000/930
18	230/ 3**	---	---
19	15,000/230	75,000/75,000	---
20	930/4**	---	---
21	2,300/9**	93,000/9,300	---
22	2,300/230	75,000/4,300	230,000/230,000

**Only samples that do not exceed fecal standards for Class SA waters.

known source of bacterial coliforms. The average life span of an ISDS is estimated at 10 to 15 years (Canter and Knox, 1985). Aside from faulty installation, cracks, or leaks and general misuse and abuse, which tend to shorten the life, the ultimate fate of ISDS are failures due to clogging of the soil with organic material (Canter and Knox, 1985). When the soils clog, the effluent from a system cannot filter through the soil substrate and may pool at or near the surface. This appears to be a common occurrence in the watershed as supported by the results of several surveys, including R.I. Projects for the Environment (RIPE, 1980) which performed an extensive survey of neighborhoods in Narragansett and documented numerous failures (Table 3-3 and Figure 3-12), Collins (1986), on failures in the Mettatuxett neighborhood, and the Providence Journal (1986) reporting on a failure from an apartment complex. Consequently, during or after a rainstorm, the effluent, already near the surface, surges upward with the water table and flows downslope with minimal infiltration (Dickerman, 1986). This is the case in the Narrow River, as can be evidenced by the high per-centage of samples out of compliance within three days of a rainstorm; over the past 21 years, 82% of samples have exceeded total coliform standards. This mode of contamination has been found to be a significant source of bacterial input to nearby waters in other regions as well (Nixon et al. 1982; Carlile et al. 1977; Sculf et al. 1977).

7. Domestic animals and wildlife as a source of bacterial contamination have not been investigated in the Narrow River watershed. The R.I. DEM (1986) suggests that such sources could be significant. If this is the case, quantification of the relative contribution of this type of input needs to be documented. Wildlife biologists have studied the Narrow River and found that waterfowl use the estuary primarily as a migratory transit stop in the late fall and winter, and are not permanent residents (Enser, 1986). Expected coliform counts should be elevated during this time period, however, the seasonal time series of counts show that winter is a period of relatively depressed coliform levels (R.I. DEM, 1972). Further, as development in the watershed has continued, the numbers and observations of wildlife have decreased.

C. Nutrient Loading

1. Nutrients in the estuarine environment, specifically nitrogen and phosphorus, are similar in function to fertilizers used on land. They promote the growth and development of plants, the basis of the food chain. When excessive amounts of nutrients enter the estuary, increased algal growth occurs creating surface scum on the water and decreasing the amount of oxygen available to fish and shellfish. This, in turn, increases the hydrogen sulfide level (toxic to most organisms at high levels), decreases

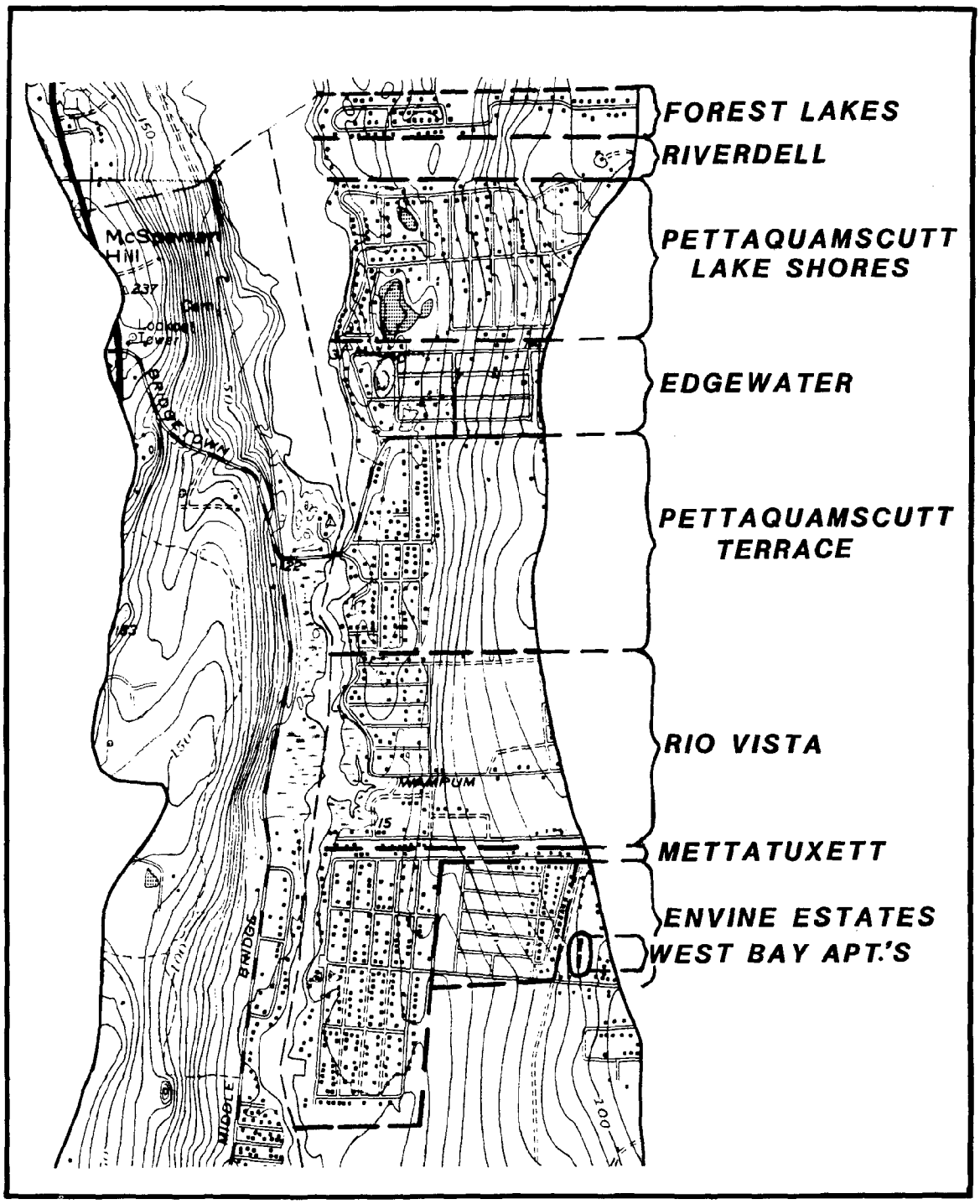


Figure 3-12. Location of neighborhoods surveyed by RIPE, Inc., 1981.

Table 3-3. Summary of RIPE, Inc. Survey, 1980.

Neighborhood	Age of Homes (yrs)			Age of Septic (yrs)			% Homes With A Pump Program	No. Homes That Use Chemical and Average Frequency	Septic System				
	0-11	12-20	20-30	0-11	12-10	20-30			ST	ST/L	ST/L/D	CESS	Other
Mettatuxet	25	31	11	31	32	8	51	14 @ 1/8 months	--	54	11	2	-
Rio Vista	28	5	--	38	5	-	42	21 @ 1/5 months	--	41	4	-	-
Pettaquamscutt Terrace	18	12	12	18	12	12	48	14 @ 1/11 months	--	26	7	7	2
Edgewater	16	7	--	16	7	--	52	5 @ 1/4 months	--	19	4	-	-
Petaquamscutt Lake Terrace	19	5	21	19	5	21	39	22 @ 1/9 months	4	28	11	1	4
Forest Lakes	31	3	--	31	3	--	47	6 @ 1/3 months	-	30	4	-	-
TOTALS	137	63	44	153	64	41	46	82 @ avg. of 1/7 months	4	198	41	10	6

ST = Septic Tank, L = Leachfield, D = Drywell, Cess = Cesspool

water clarity, and may change surface sediment texture to a black organic ooze. This condition is quite often referred to as eutrophication, meaning well-nourished, and implies the natural or artificial addition of nutrients to bodies of water and their effects.

2. The sources, types, and amount of nutrients entering a water body are heavily influenced by population density and land uses (EPA, 1983). Land use in the Narrow River watershed is primarily residential; in residential areas nitrogen inputs originate from ISDS and lawn and garden fertilizers (Koppelman, 1978; Canter and Knox, 1978). The increased growth rate and high potential for failing ISDS in the watershed suggests that the level of nutrients in the estuary may be approaching undesirable levels.

3. The signs of nutrient enrichment have been observed in the Narrow River as early as 1972. Hargraves (1972) noted increases in the growth of sea grass (Zostera sp.), sea lettuce (Ulva sp.), and Nannochloris sp., a microscopic green plant, all related to increases in nutrient levels. During this study, peak levels were recorded at 34 ug-at/l (microgram atoms per liter) for nitrogen as ammonia (NH_3) and 50 ug-at/l for nitrogen as nitrate (NO_3). Nitrogen as ammonia is an indicator of sewage contamination.

4. Nutrients enter a water body through groundwater or surface water runoff. Groundwater was found to be the major pathway for nutrients in the nearby Salt Ponds region of the southern Rhode Island coast (Olsen and Lee, 1984) and may be a pathway for this watershed. A potentially harmful level of nitrate has been recorded in at least one well in the Tower Hill area (Narrow River Preservation Association, 1970). Surface water contributions are more difficult to evaluate. However, Hanisack (1973) did note high levels of nitrates due to increases in surface water runoff, as did Hargraves (1972) after measuring high levels in storm drains after a rain event.

5. The nutrient data described above only covers a very short time period. More recent information is needed to determine the overall trends of nutrient loading within the watershed. Surface water runoff, already identified as a major source of contamination, and the past history of polluted wells suggest an eminently undesirable situation for which controls or mitigations post facto may be useless (NAS, 1969).

D. Soil Erosion

1. Sedimentation resulting from erosion of river banks and surrounding slopes is a major contributor to water quality degradation. Sediment suspension reduces water clarity and light penet-

ration, ultimately affecting the growth and development of larval fish, shellfish, and aquatic vegetation, suffocating bottom dwelling organisms, and eventually disrupting the entire food web.

2. The steepness of a slope and the texture of the surficial soils are key factors in determining the erosion potential of an area. Parental soil material in the watershed is either glacial till or outwash (Map 5). Till is consolidated and poorly sorted, covering the upper flanks of the bounding slopes. Outwash, unconsolidated and relatively well-sorted, is found in the low lying areas abutting the river. The erosion potential, as it relates to slope has been mapped for the watershed (Map 7). Those areas most seriously constrained are located primarily on the western side of the river (Figure 3-1) where slopes reach up to 40% (CRMC, 1986), and in some cases climb precipitously away from the waters edge. The soil characteristics of surficial till, combined with the steep slopes, create a potential problem area requiring adequate safeguards and management.

3. Localized erosion spots occur where the vegetation has been cut back along the river in areas of low slope. When vegetation is cleared from areas of severe slopes, the erosion potential, as well as the rate, volume, and quality of surface water runoff, is dramatically increased. The use of ISDS is not recommended on such slopes because of the likelihood of sewage effluent leaching out of the hillside further downslope or collecting in pools near downslope communities. As yet, most lands with poor soils and steep slopes remain undeveloped because of the existence of these constraints. As building pressures continue, these lands become increasingly "workable". Due to the magnitude of the severe constraints occurring in these areas, and the seriousness of the potential impacts on water quality involved in their alteration, considerable care and attention must be maintained as to their ultimate use.

E. Other Contaminants

1. Other pollutants which threaten water quality include trace metals, petroleum hydrocarbons, pesticides and herbicides, and various chemicals. Little monitoring has been performed related to these pollutants. One study noted PAH's (polycyclic aromatic hydrocarbons) in the sediments of Lower Pond (Gschuend and Hites, 1981). PAH's are indicative of naturally or anthropogenically derived byproducts of combustion (i.e., car exhaust, smoke stacks, and wood burning).

2. Potential sources of pollutants of this nature exist in the southern portion of the watershed: gas pumps and underground tanks at Middlebridge and near South Pier Road, an autobody painting and refinishing shop near South Pier Road, and a staple

manufacturing plant in the northern portion of the watershed on Shady Lea Pond. These potential pollution hazards should be investigated as to the composition, quantity and location of any discharge pipes or storage tanks and drums.

310.5 Buffer Zones

A. Introduction

1. Buffer zones are land areas that are retained in their natural and undisturbed condition in order to a) protect the feature of concern from degradational environmental impacts of upland activity, and b) prevent incompatible development and alteration of lands with severe constraints. The feature of concern may be the edge of a wetland, a steep bluff or bank, the shoreline edge of an estuary and its tributaries, or a habitat critical to the survival of a specific wildlife community. Additionally, the feature of concern may poses a cultural or aesthetic character that may require protection, i.e., an area of historical and archeological significance, or a region with exceptionally high scenic quality.

2. Disturbing forest and open space lands for development purposes has an immediate and direct impact on the functioning of natural systems. The loss of vegetation and the creation of impervious surfaces are directly related to increases in the volume and rate of stormwater runoff. The removal of trees and their supporting root systems, the grading and filling of home sites, and the introduction of additional volumes of water through ISDS facilitates slope destabilization and the subsequent processes of erosion. Impervious surfaces impede absorption of rainfall through the soils, which act to recharge the groundwater, reducing aquifer capacity and limiting the natural flow to rivers and streams during dry periods. Pollutants and toxic substances such as road salts are carried from these impervious surfaces and can be desposited in surface water bodies and groundwater. Addtionally, the intrusion of human activity and the alteration of natural habitats can adversely affect exisiting widlife.

B. Buffer Functions

1. Maintaining undisturbed buffer zones, aids in the mitigation of human activities by protecting and utilizing natural processes and elements of the watershed. A natural densely vegetated zone impedes and slows the rate at which water flows over the land, allowing percolation into the soils (Karr and Schlosser, 1977). Buffers have been shown to reduce the volume of runoff in some instances by 28 percent (Wong and McCuen, 1981). A number of

factors effect the efficiency of volume reduction, primarily: slope, soils, type and density of vegetation, water table, and width of the buffer.

2. A vegetated buffer zone can decrease the sediment load carried by surface water runoff. Initially, the vegetative cover above ground absorbs the energy of falling rain, preventing the dislodging of sediments from the ground (Palfrey and Bradley, 1981). Secondly, slowing the rate of runoff and allowing the percolation of runoff through the soils enables rudimentary filtering to take place. Trees are particularly helpful, as their roots help to penetrate the ground and aerate the soils (Palfrey and Bradley, 1981). The reduction in the rate of flow also allows heavier sediment particles to settle out, decreasing the amount of sediments entering the waterway. Maryland's Coastal Zone Management Program has determined that the use of buffers may decrease sediment transport loads by 90 percent (Wong and McCuen, 1981). The efficiency of the buffer is contingent on the slopes, soils, type and density of vegetation, water table and width of the buffer. However, slopes which exceed 10 percent may not allow for any significant detention of runoff or sediment removal, despite a heavily vegetated buffer zone (Rodgers et al. 1976).

3. Vegetated buffer zones can also aid in the removal of nutrients such as phosphorous and nitrogen from surface water flow. A portion of the nutrients are absorbed onto sediment particles and removed from runoff by filtration through the soils (Karr and Schlosser, 1977; Palfrey and Bradley, 1981). Unfortunately, a much larger proportion of the nutrients are carried in solution and are not easily removed. Findings on the efficiency of removal of soluable nutrients by vegetative buffers vary from 4% to 80% depending on vegetation, soil type, volume of runoff, concentration of nutrients, and slope (Karr and Schlosser, 1977).

4. An undisturbed vegetated buffer zone allows for habitation by a diverse wildlife population. Without a buffer, encroachment by humans on the habitat of faculitative species (those which require a specific habitat) forces the population to abandon the site. This has already been experienced in the Narrow River watershed with the loss of the Least Tern (see Chapter IV). Loss of any one population can have a dramatic effect on species that may have been dependent on the lost group, either as a food source or for population control.

5. The presence of a buffer around the various habitats of the watershed permits the natural migration of species that are opportunistic. For example, deer and blue heron utilize the uplands along the Narrow River for nesting, and migrate to the wetlands for feeding (Golet, 1986). The loss of upland consumers

can disturb the natural balance of the wetlands, in turn, upsetting the balance of the entire ecosystem. When rare or endangered species are present, a buffer can contribute to their continued existence by reducing the potential of human intervention and contact. Rare and endangered species are fragile and can be easily lost due to activities such as inadvertent collection of plant species, or establishment of footpaths through nesting grounds (Clark, 1977).

C. Buffer Zones and the Narrow River

1. Within the Narrow River watershed, establishment of a buffer zone would help protect lands considered environmentally sensitive, as well as furthering the potential for restoring water quality. As development activity encroaches upon the river, the potential for adverse impacts to the Narrow River increases. The soil characteristics adjacent to the river pose severe constraints to development (SCS, 1981). These constraints are defined as "indicating one or more soil properties or site features that are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required". For example, the salt marshes of the southern Cove are bounded by soils having a very slow infiltration rate, permanent high water table, and consequently a high surface runoff potential. These factors, in close proximity to the high quality wildlife habitat and shellfish grounds of the Cove, require that certain uses such as ISDS and impervious surfaces be restricted from those areas.

2. Land on the west side of the river is dominated by steep slopes, up to 40%, which descend to the rivers edge. Clearing of vegetation and grading of the slope can increase surface water runoff considerably and initiate erosive processes such as debris slumps, slides, and flows (Sidle, et al., 1985). The combination of these slopes and the high infiltration rate of the soils raises the concern that ISDS effluent would quickly find its way into the poorly flushed, sensitive areas of the estuary. Further, the accumulation of excess water due to septic leachfields and intense storm events can also saturate and weaken the soils, causing eventual mass movements (Sidle, et al., 1985). Another result of upland alterations has been observed along the Narrow River on the eastern flanks where slopes average 15 percent. Here, residential development has increased the amount of water available for overland transport and percolation through to groundwater reserves. During wet periods, pools of water collect near the homes at the base of the slope (Lee, 1986).

3. Underlying the upper reaches, extending from Upper Pond to Silver Spring Lake and Pendar Pond, is a vital groundwater aquifer and recharge zone (Figure 3-13). These are essential for the

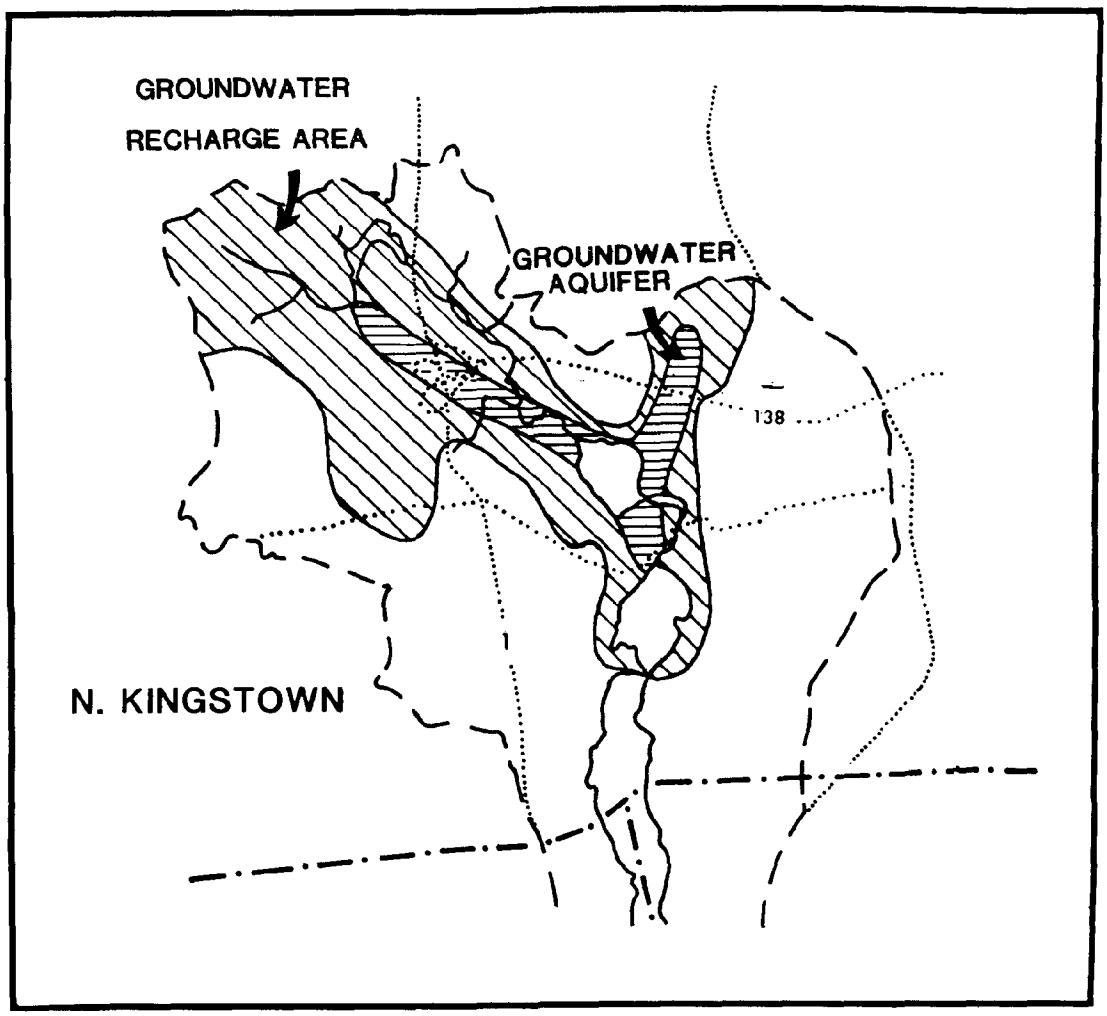


Figure 3-13. Location of aquifer and groundwater recharge zone.

continued availability of water for public and private use. Pollutants that may enter these upper reaches can leach into the groundwater aquifer, contaminating the water supply. Likewise, contaminants from the aquifer can leach into the upper water bodies and eventually be transported down the estuary (Wilson, 1977). Increasing the percentage of impervious surfaces which overlie the aquifer recharge zone can also reduce the potential for a continuous water supply in the future.

310.6 Summary

A. The Narrow River has a serious and persistent bacterial contamination problem. This has resulted from a relatively simple and predictable interaction between the natural features of the watershed and past and present land use distributions. High and medium density residential communities (1/8 to 1 acre) abut the river on both sides of the most narrow reach. These residential communities dispose of their waste by utilizing individual sewage disposal systems (ISDS). Not only are ISDS not recommended for such high densities, but neglect has led to numerous failures resulting in soils clogged with organic matter. When this happens, the untreated sewage waste is unable to filter or percolate through the soils and pools near the surface. During rain events, the proximity to the surface facilitates rapid transport downslope to the river. Once in the river, the waste accumulates due to poor flushing and eventually exceeds accepted levels, thus degrading water quality and creating a potential health hazard.

B. A decline in water quality invokes serious questions as to the perceived present and future use of the estuary by surrounding communities. Development is continuing in close proximity to the river as ever increasing numbers of homeowners desire the Narrow River's premier attractions - aesthetic quality and recreational uses. Concurrent with development is the potential for more pollutants to reach undesirable levels. The unique combination of natural features which give the Narrow River it's high aesthetic quality and unique resource value, imposes significant constraints on the continued uses of the watershed.

C. Buffer zones provide an undisturbed zone around critical areas and serve many functions which help to mitigate the impacts from upland human activities (i.e., construction, lawn fertilization, etc.). Specific functions include slowing the rate of runoff, acting as a filter to improve the quality of surface water runoff, preserving the aesthetic value of the watershed, reducing adverse effects of human encroachment on wildlife and critical habitats, and protecting areas that are unsuitable for development purposes.

320. MANAGEMENT REGULATIONS AND INITIATIVES

Based on Section 310, Findings of Fact, and the primary objective of restoring the Narrow River water quality to the DEM SA classification standard, the following regulations and initiatives are deemed necessary.

320.1 Land Classification for Watershed Protection

A. Self-sustaining Lands

1. Definition. These lands are undeveloped or developed at a density of not more than 1 residential unit per 2 acres, or have been developed with sufficient consideration and management of environmental impacts. The geographic location of these areas is such that minimal impacts may be expected to the estuary if proper development safeguards are employed.

2. Management Policies and Regulations.

(a) In order to be in conformance with this plan, the division of a lot, tract, or parcel of land into two or more lots, tracts, parcels or other divisions of land for sale, lease, conveyance, or for development, simultaneously or at separate times, shall not exceed a density of 1 residential unit per 2 acres.

(b) Cluster development is recommended as a means to preserve open space and aesthetic qualities, and to reduce the cost and environmental impacts of development. For CRMC purposes the number of units in a cluster shall be calculated on the basis of land suitable for development within the project boundaries in accordance with all DEM regulations and local ordinances. This determination excludes lands with severe limitations to development including, but not limited to, coastal and freshwater wetlands, unsuitable soils, lands included within setbacks and buffers from lakes, streambeds, and wetlands, and lands to be used for streets and roads. The overall density of the project shall not exceed the density allowable by the primary zoning district, as modified in Section (a) above.

(c) Sewers are prohibited.

(d) Because these lands are served by onsite sewage disposal systems, a contributing source of bacterial contamination to the Narrow River (Section 310), regular maintenance and/or the upgrading of ISDS are a high priority (see Section 320.3).

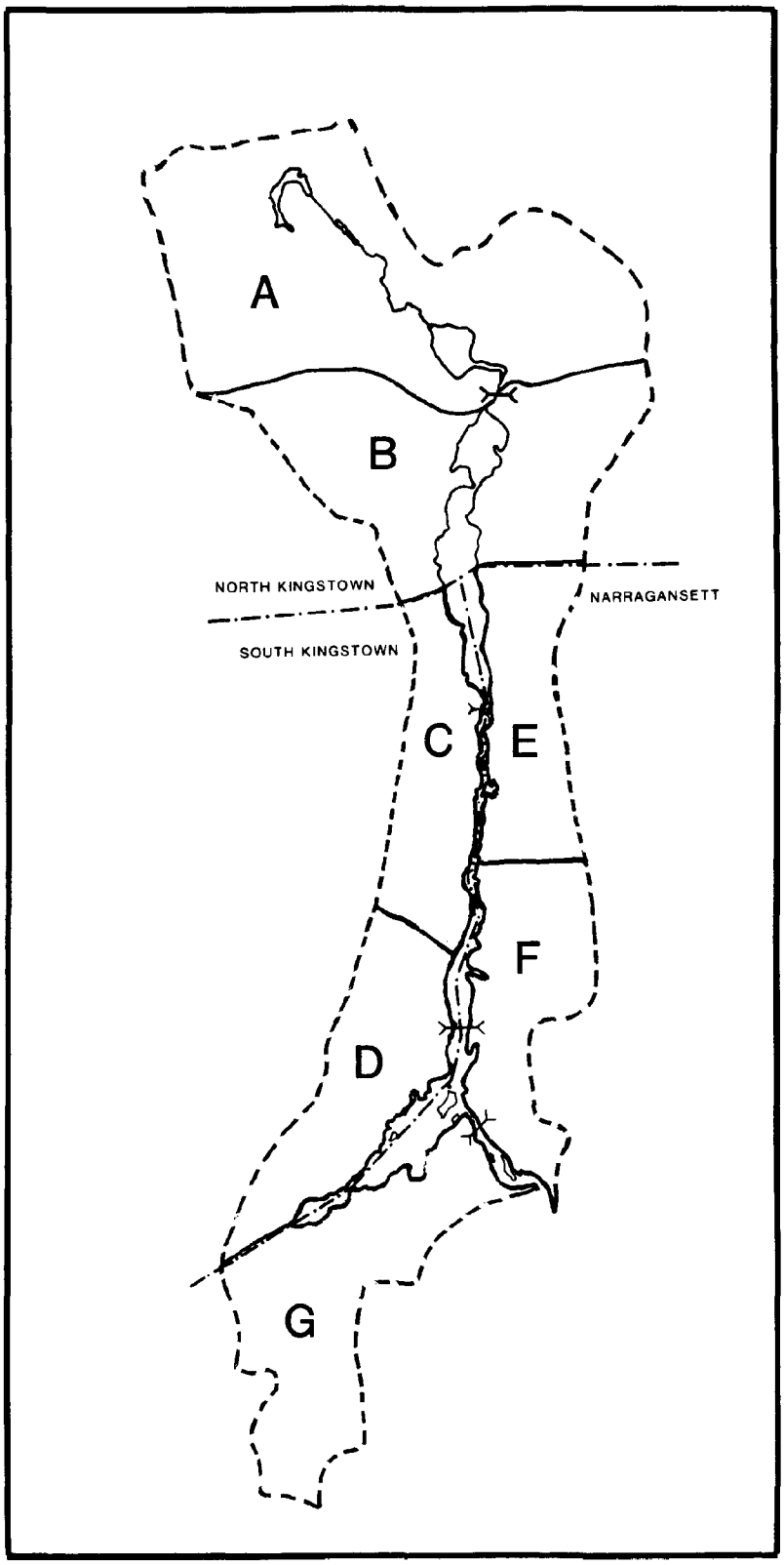


Figure 3-14. Key location map to land use classification maps.

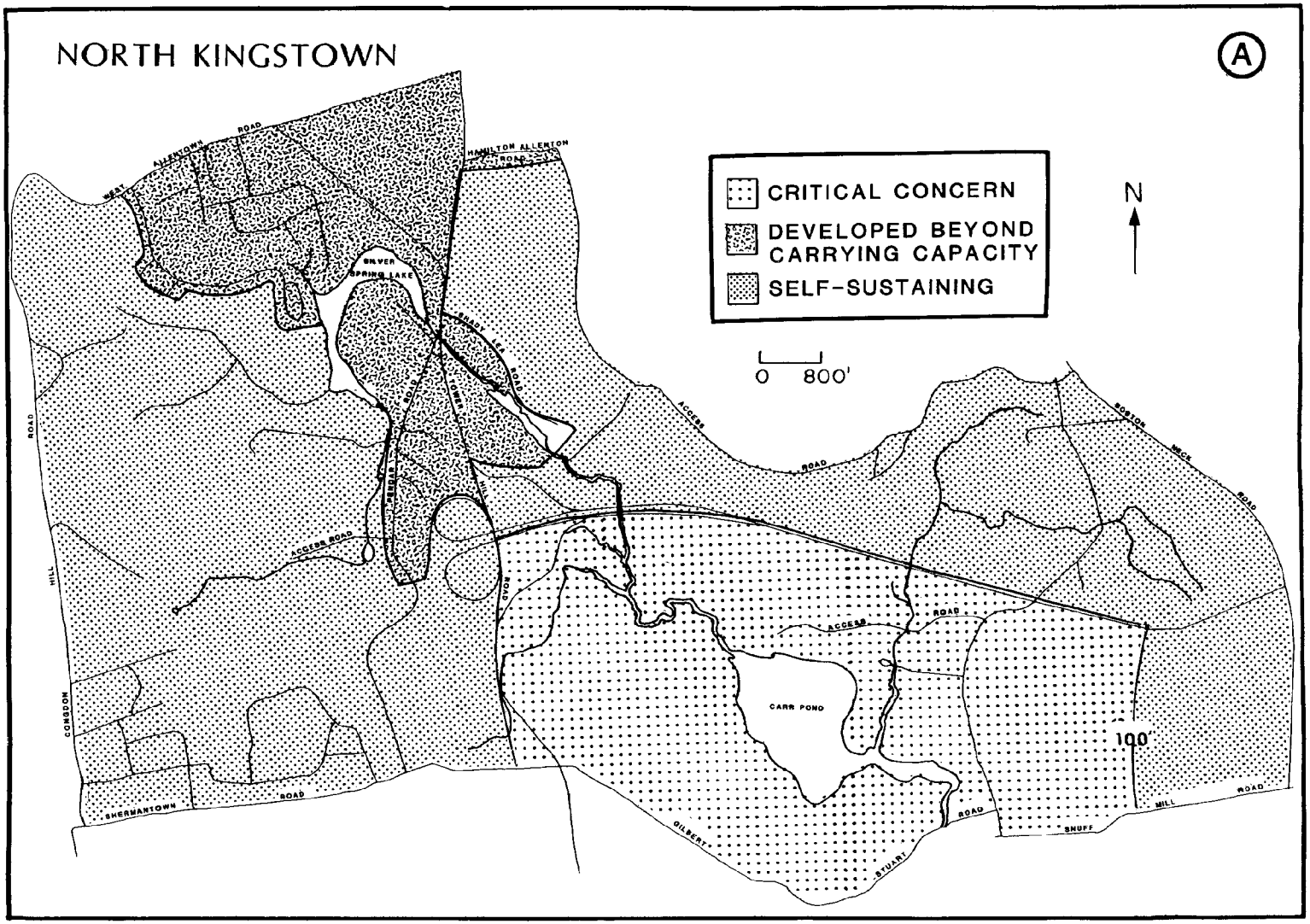


Figure 3-15. Land use classification for North Kingstown, Map A.

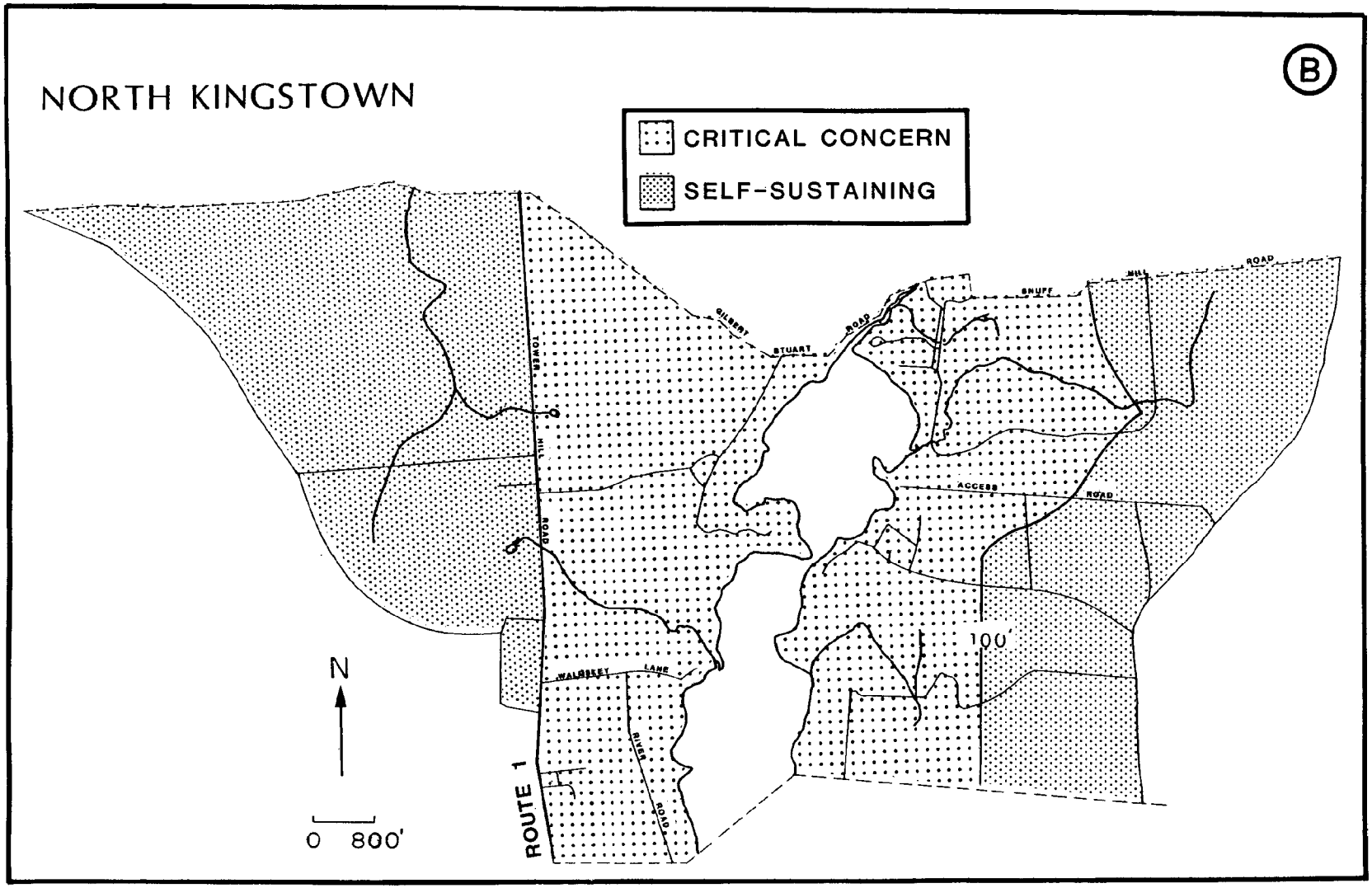


Figure 3-16. Land use classification for North Kingstown, Map B.

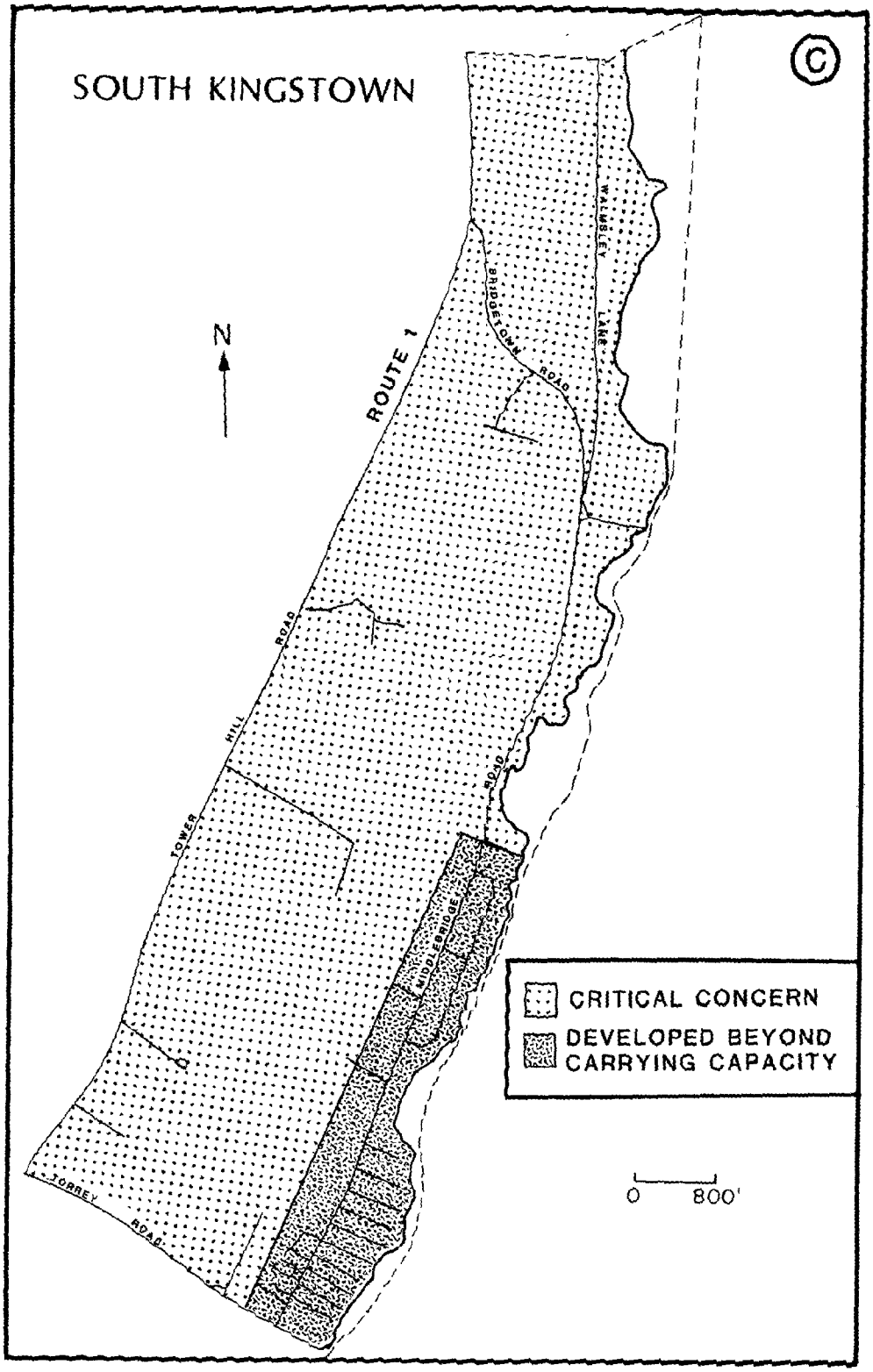


Figure 3-17. Land use classification for South Kingstown, Map C.

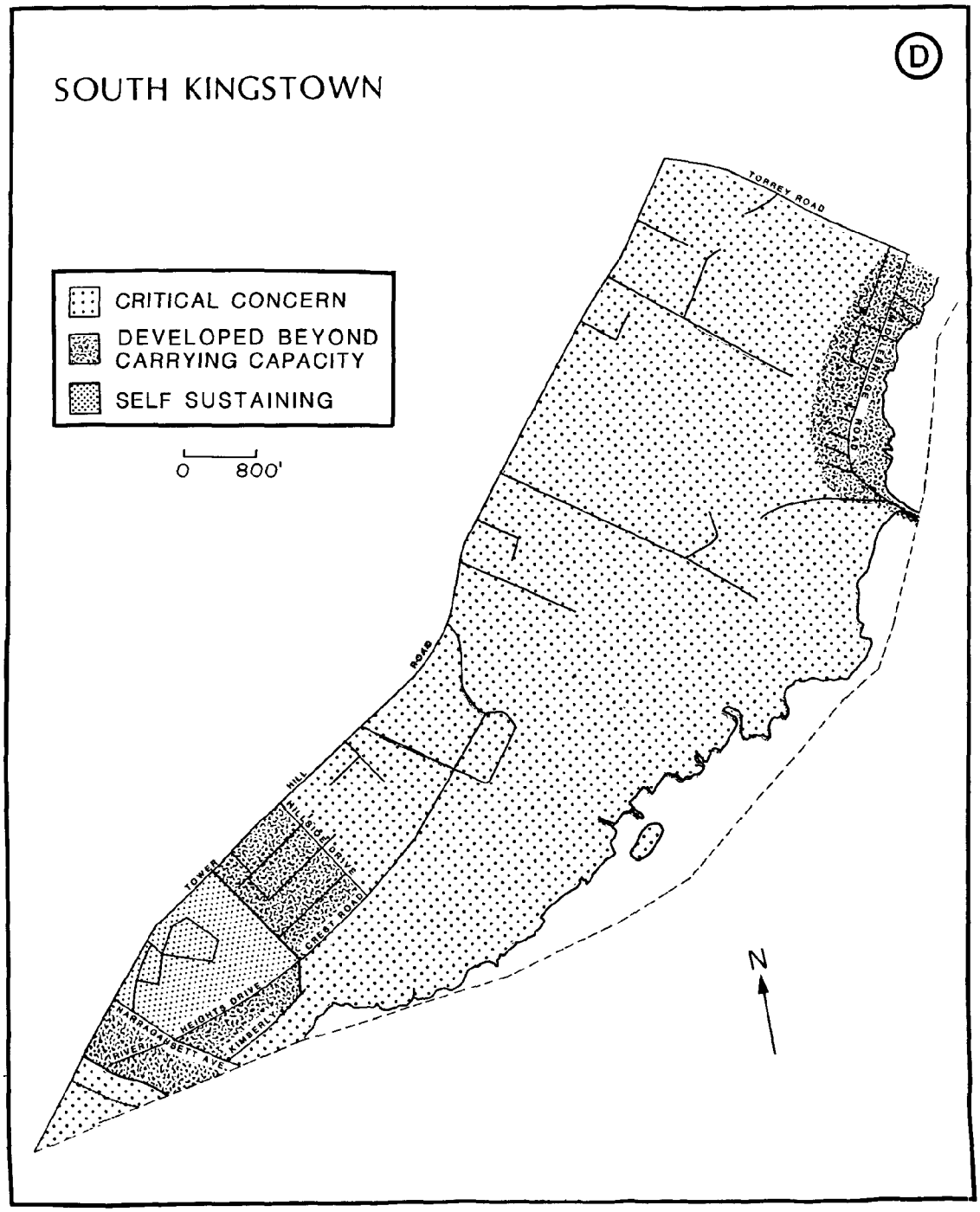


Figure 3-18. Land use classification for South Kingstown, Map D.

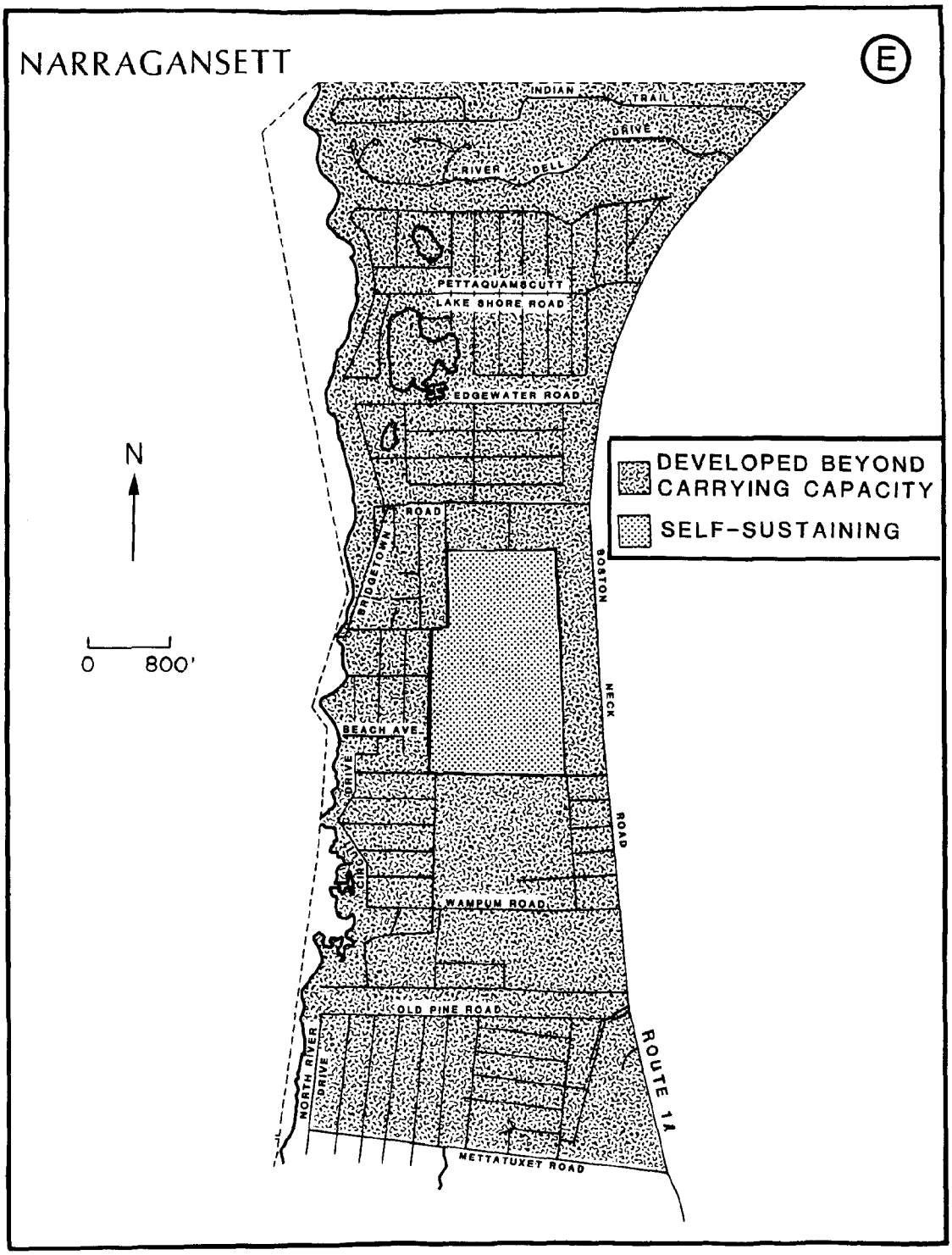


Figure 3-19. Land use classification for Narragansett, Map E.

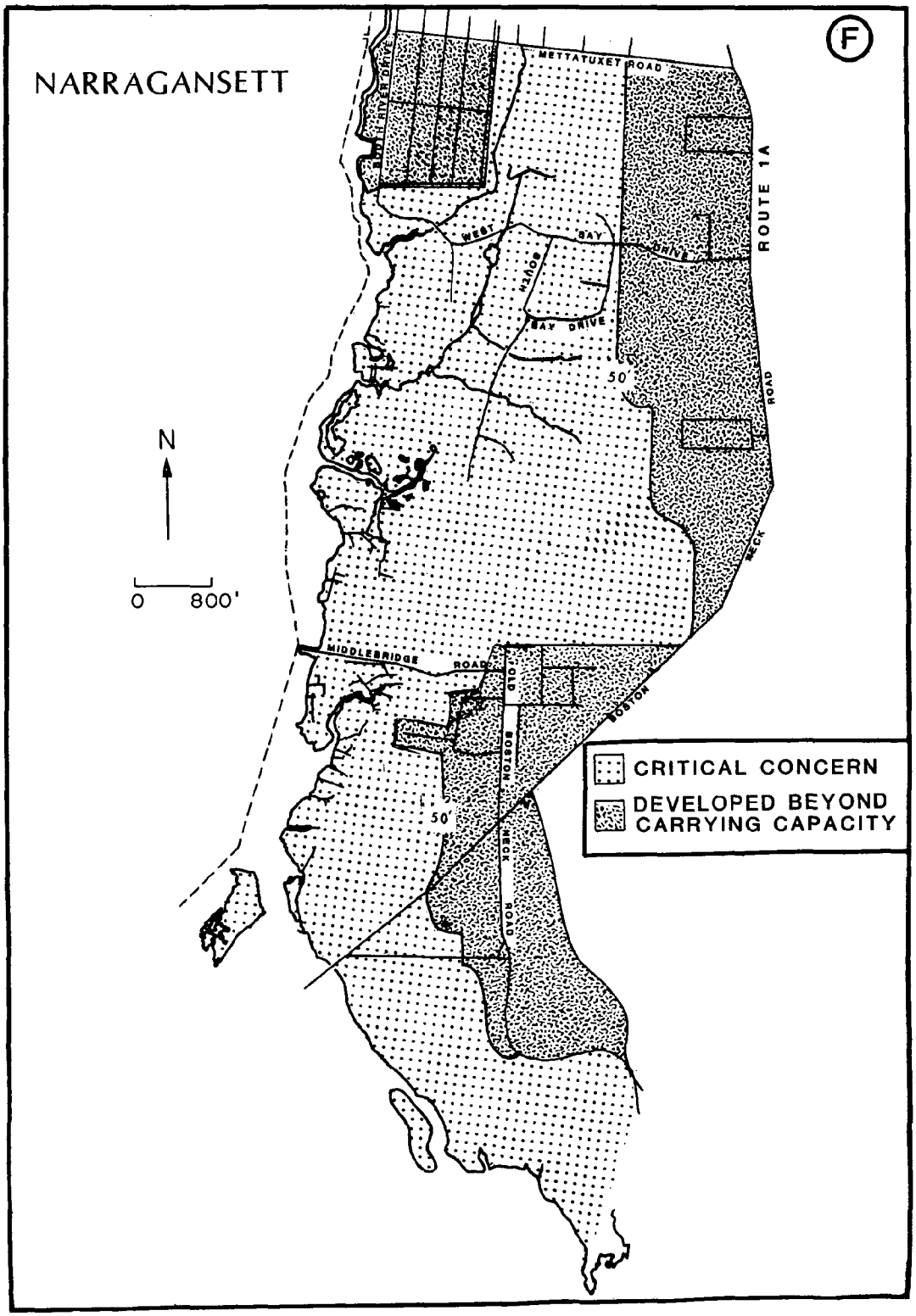


Figure 3-20. Land use classification for Narragansett, Map F.

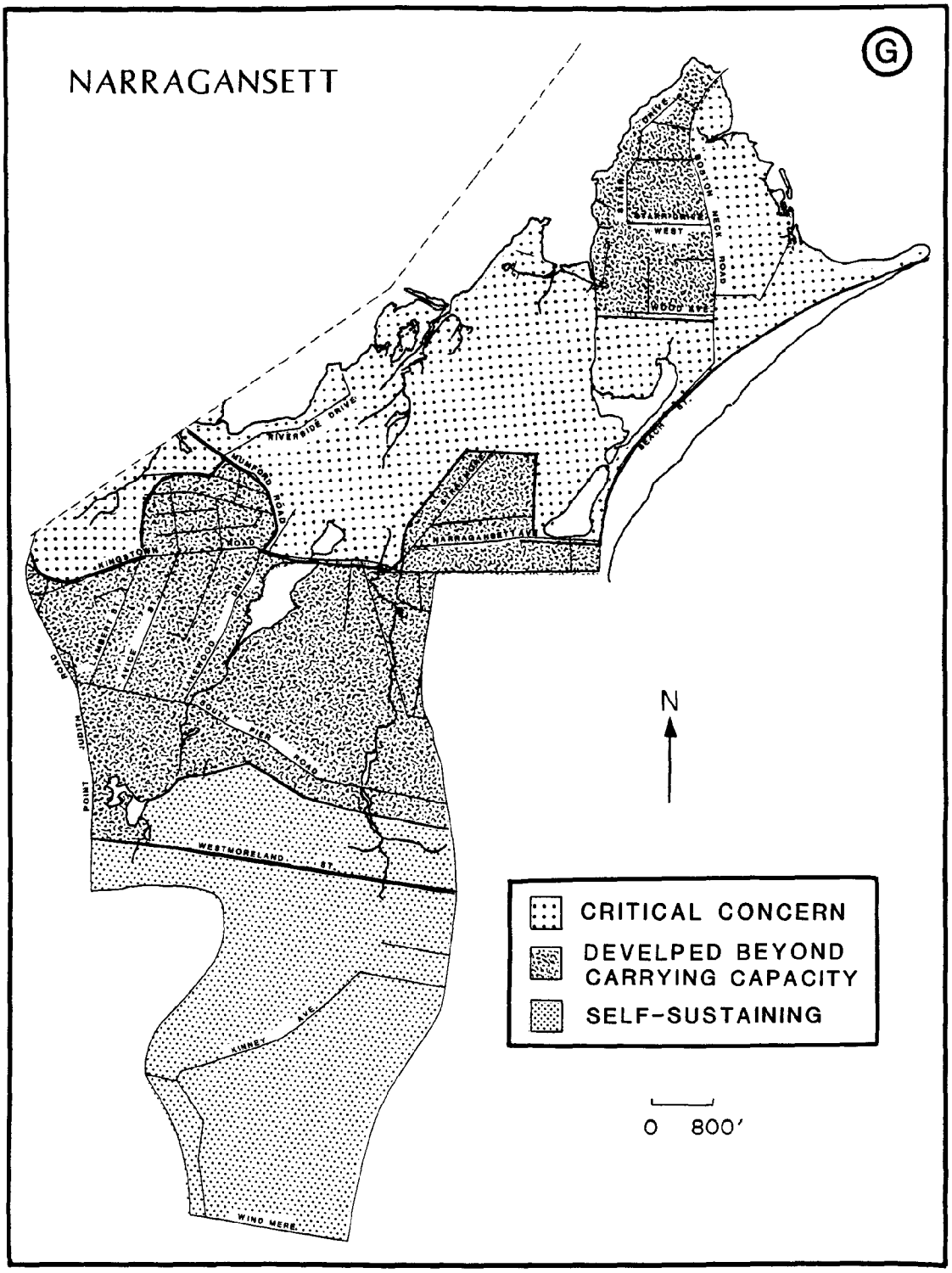


Figure 3-21. Land use classification for Narragansett, Map G.

(e) Where lands in this category abut a perrenial stream (commonly noted as blue line streams on U.S.G.S topographic maps) flowing into, or a tributary of, the Narrow River, a minimum 100 foot buffer of undisturbed vegetation shall be maintained. The use of such streams or tributaries as stormwater conveyances, or as receiving waters of direct discharges of runoff is prohibited.

B. Lands of Critical Concern

1. Definition. These lands are undeveloped or developed at a density of not more than 1 residential unit per 2 acres and a) are characterized by natural features and properties that pose severe constraints for development, and b) are located relative to the Narrow River such that insensitive development in these areas possess the greatest threat to the water quality and viability of the estuary.

2. Management Policies and Regulations

(a) Policies and regulations (a) through (e) above apply.

(f) In those areas within this classification, there are certain activities and alterations inland of shoreline features and their contiguous areas which may require a CRMC assent. These are activities and alterations having a reasonable probability of conflicting with the goals of this Plan, and having the potential to damage the environment of the Narrow River. These activities shall be reviewed by the CRMC for their consistency with the requirements and policies of this Plan and include the following:

i) Alterations to coastal cliffs, bluffs, and banks

ii) Filling, removing, and grading

iii) Residential, commercial, industrial and public recreational structures

iv) Sewage treatment and disposal

v) Public roadways, bridges, parking lots

(g) These areas are priorities for additional measures to minimize environmental impacts from development through acquisition, conservation easements, tax relief, and aquifer protection ordinances.

(h) A buffer area of undisturbed vegetation shall be provided in these areas. The buffer area shall have a minimum

width of 200 feet, measured from the most inland edge of the coastal feature of concern, or contiguous wetland. A mechanism for ensuring maintenance of the buffer shall be required as a condition of the CRMC assent.

(i) New individual or community docks are prohibited.

3. The definition and regulations pertaining to areas of critical concern apply to those properties platted after the adoption date of this plan. Alterations, to coastal features or within 200 feet of a coastal feature on properties platted prior to the adoption of this plan will, where possible, conform to the regulations of this section.

In cases where, due to the size or configuration of a lot that was platted prior to the adoption of this plan it is not possible to provide a 200 foot buffer, then the determination of the boundaries of a buffer zone must balance the property owner's rights to enjoy their property with Council's responsibility to preserve, and where possible, restore ecological systems. Recommended Buffer Zone shall be established according to the environmental values and sensitivities of the site as assessed by the Council's staff engineer and biologist.

C. Lands Developed Beyond Carrying Capacity

1. Definition. These lands are developed or zoned at densities less than 2 acres, frequently at one residential unit per 1/2 to 1/8 acre or less. These densities have exceeded the natural ability of the soils and other environmental factors to attenuate the effects of development. The consequences of such intense development have been a major source of contamination to the estuary. Most of the ISDS in these areas predate state-enforced siting and design standards, and are approaching, or have exceeded, their life span.

2. Management Policies and Regulations

(a) Densely developed lands within the towns of Narragansett and South Kingstown are in close proximity to existing sewer lines; in these areas extension of sewer service is a priority. The following locations are prioritized for sewer service based on community density levels, frequency of reported ISDS failures, and high bacterial coliform levels in the adjacent estuarine waters.

1. Envine Estates (Mettatuxett)
2. Middlebridge
3. Rio Vista Neighborhood
4. Pettaquamscutt Terrace
5. Pettaquamscutt Lake Shores*
6. Forest Lakes*

* These neighborhoods are located north of Bridgetown Road where municipal sewer lines are not as readily available. This, and other factors, make ISDS maintenance and restoration a more appropriate approach to addressing existing problems in these areas, prior to extension of sewer lines (see Section 320.3).

(b) The sewage waste is directed to the Westmoreland Treatment Facility in Narragansett which is nearing capacity. If the facility's capacity is reached before the above prioritized neighborhoods are sewered, the goal of restoring water quality in the near future is seriously curtailed and raises questions as to the feasibilty of acheiving this goal. Because of the immeninency of further water quality degradation, the above priorities must be addressed before any private or municipal sewer extensions or installations will be permitted in areas that do not, as yet, pose a water quality threat, i.e., self-sustaining lands and undeveloped lands in areas of critical concern.

(c) Vegetative buffer zones along the perimeter of the Narrow River and contigous wetlands shall be negotiated by the CRMC in accordance with Section 150 of the CRMP. The reestablishment and restoration of wetlands shall be a priority.

(d) Undeveloped areas previously platted at extremely high densities are priority areas for amendments to zoning ordinances and other actions to provide for reduced density, i.e., a minimum 2 acre lot size.

(e) Lots of less than 2 acres which are in contiguous ownership should be combined before application for development permits are considered.

320.2 Watershed Controls for Surface Water Runoff

A. Stormwater Management

1. Definition. Stormwater Management refers to a) for quantitative control, a system of vegetative and structural measures that control the increased volume and rate of surface runoff caused by man-made changes to the land, and b) for qualitative control, a system of vegetative, structural, and other measures that reduce or eliminate pollutants that might otherwise be carried off by surface runoff.

2. Management Policies and Regulations

(a) It shall be the policy of the CRMC to require proper stormwater management within the Narrow River watershed for the following activities:

i) New residential developments of six units or more;

ii) Facilities or activities requiring or creating 20,000 square feet or more of total impermeable surface area, or resulting in twenty percent or more (20 %) of the project area being rendered impervious;

iii) All roadway construction and upgrading projects;

iv) Any activity within the watershed involving any maintenance, alteration, use or improvement to an existing stormwater management structure changing or affecting the quality, rate, volume, or location of surface water discharge;

(b) Applicants shall follows the guidelines set forth in Section 320.2B below and submit the following information to the CRMC for review in the early stages of planning such facilities or activities. Certain informational requirements may not be applicable to the proposed activity, in such a case the relevant sections may be waived.

B. Guidelines for the Stormwater Management Plan

1. It is the responsibility of the applicant to submit a Stormwater Management Plan containing sufficient information for the CRMC to evaluate the environmental characteristics of the affected areas, the potential and predicted impacts of the proposed activity on the Narrow River and its tributaries, and the effectiveness and acceptability of those measures proposed by the applicant for reducing adverse impacts. The Stormwater Management Plan shall contain maps, charts, graphs, tables, photographs, narrative descriptions and explanations, and citations to supporting references, as appropriate to communicate the information required by this section.

2. The existing environmental and hydrologic conditions of the site and of receiving waters and wetlands shall be described in detail, including the following:

(a) The direction, flow rate, and volume of surface runoff under existing conditions and to the extent practicable, predevelopment conditions; the required information shall be based on the 1 year, 10 year, and 100 year storms for the 24 hour duration, and the duration which coincides with the time of concentration of the watershed;

(b) The location of areas of the site where stormwater collects or percolates into the ground;

(c) A description of all surface watercourses, waterbodies, and wetlands on or entering a site, or adjacent to the site, or into which stormwater flows. Information regarding their water quality and the current water quality classification given them by the Department of Environmental Management shall be included;

(d) Depth to seasonal groundwater levels, approximate direction and rate of flow, seasonal fluctuations;

(e) Location of 100 year flood zones;

(f) Principal vegetation types;

(g) Topography described in full contour detail, at 2 foot intervals, with areas of steep slopes (over 10%) highlighted;

(h) Soils, with an accompanying analysis of the best use potential of the soils and the hydrologic group classification; the soils map and use potentials analysis prepared by the US Soil Conservation Service should be used as the basis for this analysis.

3. Proposed alterations of the site shall be described in detail, including:

(a) Changes in topography, described in full contour details at 2 foot intervals;

(b) Areas where vegetation will be cleared or otherwise altered;

(c) Areas that will be covered with an impervious surface and a description of the surfacing material;

(d) The proposed development layout including:

i) The site arrangement, including the location of structures, roadways, parking areas, sewage disposal facilities, and undisturbed lands.

ii) All drainage systems to be provided, including the location and desgn of roadway and individual lot subdrains; full drainage calculations shall be included, with 1 or 2 year, 10 year, and 100 year storms used as the basis of design.

4. Predicted impacts of the proposed development on existing conditions shall be described in detail, including:

(a) Changes in water quality;

(b) Changes in groundwater levels;

(c) Changes in the incidence and duration of flooding on the site and upstream and downstream from it;

(d) Adverse impacts on wetlands;

(e) Impacts on vegetation;

5. All components of the drainage system and any measures for the detention, retention, or infiltration of water, or for the protection of water quality shall be described in detail, including:

(a) The channel, direction, volume, and rate of the flow (CFS), and quality of stormwater that will be conveyed from the site, with a comparison to existing conditions, and to the extent practicable, predevelopment conditions;

(b) Detention and retention areas and devices, including:

i) Plans for the discharge of contained waters; including the time to draw down from full condition, description of outlet structures;

ii) Maintenance plans; including maintenance schedule, an outline of responsible parties and all pertinent agreements to be executed to insure proper maintenance;

iii) An evaluation of the pollutant removal efficiency of such devices under the existing conditions;

(c) Areas of the site to be used or reserved for percolation including the depth to seasonal groundwater table, and prediction of the impact on groundwater quality;

(d) Areas to be utilized in overland flow, the hydrologic soil type of such areas, vegetation present, and the soil susceptibility to erosion;

(e) Any other information which the developer or the CRMC believes is reasonably necessary for an evaluation of the development.

C. Performance Standards

Stormwater Management Plans submitted must demonstrate that the proposed development or activity has been planned and designed and will be constructed and maintained to meet each of the following standards:

1. Ensure that after development, runoff from the site or activity approximates the rate of flow, volume, and timing of runoff that would have occurred following the same rainfall conditions under existing conditions and, to the extent practicable, pre-development conditions;

2. Maintain the natural hydrodynamic characteristics of the watershed;

3. Protect or improve the quality of surface and ground waters;

4. Protect groundwater levels;

5. Protect the beneficial functioning of wetlands as areas for the natural storage of flood waters, the chemical reduction and assimilation of pollutants, and wildlife and fisheries habitat;

6. Prevent increased flooding and damage that results from improper location, construction, and design of structures;

7. Prevent or reverse salt water intrusion;

8. Protect the natural fluctuating levels of salinity in estuarine areas;

9. Minimize alteration to flora and fauna and adverse impacts to fish and wildlife habitat;

10. Otherwise further the objectives of the SAMP.

D. Design Standards

To ensure attainment of the objectives of Section 320.2 and that performance standards will be met, the design, construction and maintenance of stormwater systems will be consistent with the following standards:

1. Discharging runoff directly into the Narrow River and its tributaries, or enlarging the volume, rate, or further degrading the quality of existing discharges is prohibited. Instead, runoff shall be routed through vegetated swales and other structural and nonstructural systems designed to increase time of concentration, decrease velocity, increase infiltration, allow suspended solids to settle, and remove pollutants; such systems will utilize overland flow and reinfiltration as priority techniques for the treatment of runoff;

2. Retention and detention ponds, and methods of overland flow may be used to retain, detain, and treat the increased and accelerated runoff which the development generates;

3. Water shall be released from detention ponds at a rate

and in a manner approximating the natural flow which would have occurred before development, incorporating the following standards;

(a) Peakflow discharges from 1 year, 2 year, and 100 year storms will not be increased by the development or activity;

(b) Ponds shall not be placed where their use poses concerns of groundwater contamination through the recharging of pollutants from surface runoff;

(c) Detention ponds shall have a minimum containment time of 36 hours, a minimum sump depth of 3 feet, and whenever possible utilize permeable sides and/or bottoms so as to minimize outflow;

(d) Outflow from structural devices shall have flow proceed to natural vegetated areas or vegetated swales when discharging in proximity to watercourses, wetlands, and the estuary; such areas utilized for sheet flow should have hydrologic and vegetative characteristics adequate to insure that stormwater reaching the watercourse, wetland, or estuary does so in a manner approximating predevelopment or existing conditions.

4. Natural watercourses shall not be dredged, cleared of vegetation, deepened, widened, straightened, stabilized, or otherwise altered. Water shall be retained or detained before it enters any natural watercourse in order to preserve the natural hydrodynamics of the watercourse and to prevent siltation or other pollution;

5. Intermittent watercourses such as swales, should be vegetated;

6. The first 1 inch of runoff from impervious surfaces, such as rooftops and paved surfaces shall be treated and reinfiltrated on the site of the development;

7. Runoff from parking lots and roads shall be treated to remove oil and sediment;

8. The use of drainage facilities and vegetated buffer zones as open space and conservation areas shall be encouraged.

E. Information Sources

The basic design criteria, methodologies, and construction specifications, shall be those of the United States Soil Conservation

Service, generally found in the most current edition of the following publications or subsequent revisions:

1. "Urban Hydrology for Small Watersheds:" Technical Release No. 55, January 1975.

2. "Soil Conservation Service Engineering Field Manual", latest edition, as applicable.

3. "Soil Conservation Service Standard and Specification for Ponds", Specification No. 378, July 1981.

4. "Rhode Island Erosion and Sediment Control Handbook", 1980, or its most recent addition.

5. "Methodology for Analysis of Detention Basis for Control of Urban Runoff Quality", EPA Publication, September, 1986.

F. Remedial Stormwater Management Activities

1. Definition. Remedial stormwater management activities are those actions taken to address a situation where no stormwater management, as defined in Section 320.2A, presently exists and there is a clear threat to water quality which the proposed activity addresses.

2. In such situations, a Special Exception may be granted, under the requirements of Section 130 of the CRMP, to a new or expanded discharge of stormwater runoff. In considering such an action the CRMC shall give strict consideration to paragraphs A(2) and A(3), of that Section; that all reasonable steps shall be taken to minimize the environmental impacts and or/use conflicts, and that there is no reasonable alternative means of, or location for serving the compelling public purpose cited.

G. Comprehensive Stormwater Management Plan

The CRMC, the DEM, and the towns should undertake a cooperative program to upgrade existing direct discharges which do not employ, or possess substandard, stormwater management techniques and are discharging into the Narrow River and its tributaries and wetlands. This effort should integrate standards and design techniques such as those presently being evaluated for the Scituate Resevoir by the DEM. Additionally, there is a need to conduct further study on the impacts and mitigation of stormwater inputs to the Narrow River. Investigations could include the following:

1. Analysis of stormwater composition beyond that of just bacteria levels;

2. Quantification of the total volume of runoff which enters the river;

3. Development of technical and mitigative techniques for particular environmental characteristics;

4. Response of groundwater resources to stormwater inputs;

5. Experimental plantings of various hydrophilic/deep rooted vegetation.

320.3 Watershed Controls for Septic System Management

A. Regional Wastewater Management Plan

1. The concurrent pressures from existing ISDS failure concentrations and increasing residential development have reached a critical point within the Narrow River watershed. There exists a need within the watershed, particularly in South Kingstown and Narragansett, to formulate a comprehensive wastewater management plan which will schedule and outline the actions necessary to address the wastewater treatment and disposal problems within the watershed.

2. The plan should be undertaken on a cooperative basis by the municipalities, the DEM, the Department of Health, and the CRMC and should address, at a minimum, the following items:

(a) the future reserve and expansion capacity of South Kingstown's Westmoreland Treatment Plant;

(b) the identification and scheduling of areas that require sewer service with priority consideration given to areas with concentrations of failed ISDS;

(c) a watershed wide ISDS maintenance program including regular mandatory pumping;

(d) the identification and phased replacement of individual failed units;

(e) the application of the Sewerage and Water Supply Failure Fund monies towards these programs;

(f) the development of programs to educate local residents about the use and maintenance of ISDS systems. Coordination with Save The Bay workshops on this topic may be useful.

B. Extension of sewer lines

1. Until such time that the Comprehensive Wastewater Management Plan is devised and agreed upon it shall be the policy of the CRMC that the extension of sewer lines to those areas classified as Lands Developed Beyond Carrying Capacity will take priority over the construction or extension of private, municipal, or industrial sewage facilities or systems, conduits or interceptors to other areas of the watershed.

2. The extension of sewer lines shall follow the priorities outlined in Section 320.1 (C).

C. Septic System Maintenance

1. Until such time as the areas prioritized for extension of sewer lines are serviced by these lines, and in all those areas not prioritized for sewer service but within lands classified as Lands Developed Beyond Carrying Capacity, the towns should undertake a program to support regular maintenance of ISDS within the watershed. The septic maintenance program should include, as a minimum, the following:

(a) ISDS should be pumped every 3 years as recommended by the Rhode Island Division of Planning (1979);

(b) Funds for a maintenance program should be investigated and may be appropriated through:

i) The Sewerage and Water Supply Failure Fund
ii) Municipal bond issues;

(c) Septic tank pumpers should be responsible for reporting to the office designated by each town those septic tanks not able to be pumped, or requiring pumping more than 3 times in one year;

(d) As a incentive to eliminate chronic ISDS problems and to protect future homeowners, information pertaining to failed ISDS or violations of state ISDS regulations should be recorded on property deeds until such time as they are corrected.

2. Through the use of regular maintenance, or pumping, the life span of an ISDS, its effectiveness in treating waste, and protection for groundwater, can be increased. Homeowners should be educated on how their wastes are being treated, the importance of regular pumping, and what preventative measures can be applied to alleviate future problems. Suggested measures include:

(a) water conservation practices;

(b) discouragement of garbage disposals;

(c) avoidance of disposal of greases and oils into household drains;

(d) proper disposal of chemical wastes (paints, thinners, alcohol, acids, drain cleaners, etc.);

(e) separate drainfield for washing machine discharges;

(f) prohibition of the use of chemical ISDS "rejuvenators";

(g) planning for alternate site in the event of primary site failure;

(h) resting part of the leachfield system periodically through design or installation of alternate beds.

320.4 Watershed Controls for Erosion and Sedimentation

A. Definition. Erosion and sediment control refers to the prevention, control, and management of soil loss due to wind and water, caused by alterations to vegetation and soil surfaces within the Narrow River watershed.

B. Management Policies and Regulations

It shall be the policy of the CRMC to prevent adverse environmental impacts to the Narrow River watershed due to erosion, soil loss, and sedimentation, including secondary and cumulative as well as direct impacts. The following standards and procedures shall be required in those cases where the CRMC determines that additional measures are warranted in order to protect the environment of the Narrow River:

1. An Erosion and Sedimentation Control Plan shall be submitted and shall include the following;

(a) A site plan showing the grades, elevations, and contours of the land prior to disturbance and the proposed grades, elevations, and contours to be created;

(b) Location and description of existing natural and man-made features on the property where the work is to be performed, on land of adjacent owners within 100 feet of the property, or which may be adversely affected by the proposed operations;

(c) A soil survey or soils engineering report including data regarding the nature, distribution, and strength of existing soils; conclusions and recommendations covering the adequacy of the site to be developed; the soil investigation and subsequent report should be completed and presented by a professional engineer registered in the State of Rhode Island;

(d) Location and description of proposed changes on the site;

(e) A schedule of the sequence of installation or application of planned erosion controls, both temporary and permanent, as related to the progress of the project, including an account of the total soil surface area which will be disturbed during each stage, and estimated starting and completion dates; measures for soil erosion and sediment control must meet or exceed standards and regulations set forth by the USDA Soil Conservation District. Such standards may be found in the Rhode Island Erosion and Sediment Control Handbook (SCS, 1980);

(f) A slope stabilization and revegetation plan which shall include a complete description of the existing vegetation, the vegetation to be removed and the method of disposal, the vegetation to be planted, and slope stabilization measures which are to be installed including the environmental effects of such operations on slope stability, soil erosion, and water quality.

2. Development shall be accomplished so as to minimize adverse effects upon the natural or existing topography and soil conditions and to minimize the potential for erosion and shall include the following:

(a) Development shall be oriented to the site so that cutting and stripping of vegetation and grading are kept to an absolute minimum. In those areas classified as Lands of Critical Concern such activities shall be restricted to the square footage of the buildings, parking areas, stormwater controls and other essential development related structures, plus an additional ten percent (10%) area of the lot in which construction equipment can operate.

(b) Temporary seeding, mulching, or other suitable stabilization methods shall be used to protect exposed areas during construction and where feasible, natural vegetation shall be retained and protected. Soil and other materials shall not be temporarily or permanently stored in locations that would

cause suffocation of tree root systems.

(c) Land shall be developed in increments of workable size which can be completed during a single construction season. Erosion and sediment controls shall be coordinated with the sequence of grading, development, and construction operations. Control measures shall be put into effect prior to the commencement of each increment of the process. When necessary, temporary seeding or mulching shall be used to protect exposed areas until the next construction season.

320.5 Lands Requiring Special Considerations

A. Definition. There are several areas within the watershed which require special mitigative measures due to their unique characteristics. The importance of measures to mitigate environmental threats either to these lands, or from them to the estuary, cannot be overlooked.

B. Management Policies and Regulations

1. Historical and Archaeological Sites

(a) Those sites identified by the Rhode Island Historical Preservation Commission as having historical or archaeological significance shall be priorities for acquisition and preservation programs such as open space easements and land dedications.

(b) Where possible, these sites should be incorporated into the buffer zone by extending the boundary of the buffer where necessary. The towns are encouraged to make provisions in their respective zoning ordinances for the rezoning of these significant sites for conservation purposes.

2. Undeveloped Small Parcel Lands

Many tracts of land were platted prior to 1968 and are composed of small lots, inconsistent with current zoning ordinances. Where several of these lots are in contiguous ownership, and have not received approval for development, replatting at the lowest allowed density should be considered. This will aid in reducing cumulative environmental impacts associated with high density developments.

320.6 Petroleum Tanks and Oil Spills

A. Petroleum Storage Tanks

1. Definition. In-ground petroleum storage tanks include containers for gasoline, heating oil, diesel fuel, or other petroleum compounds for commercial, industrial, or household use.

2. Management Policies and Regulations

(a) Burial of new domestic fuel oil storage tanks are prohibited in the Narrow River watershed.

(b) All persons proposing to replace or repair buried fuel oil tanks, or install storage tanks for gasoline, petroleum products, or any other substance defined as hazardous by DEM shall apply for a CRMC permit. Applicants are required to demonstrate that the design and construction of the tanks will have no environmental impact and that the tanks are amenable to monitoring for potential leakages.

(c) In the event a leakage is discovered, the tank shall be replaced according to DEM regulations for underground storage of facilities for petroleum products (R.I. DEM, 1984).

B. Oil Spill Contingency

Oil spills shall be treated as outlined in the Rhode Island Oil Spill Contingency Guide (R.I. DEM, 1980). It is further recommended, in the event of a nearshore spill that poses a threat to the river, that efforts should be focused on impeding oil flow into the Narrows and subsequently into the lower reaches of the estuary. An oil boom should be placed as close to the seaward mouth of the estuary as permitted by the currents. If oil should enter the lower reaches, attempts should be made to deflect the oil away from the sensitive salt marshes surrounding the cove through the use of strategic boom deployment. Diversion should be upstream, where fringing marshes are not as expansive, and where the close confines of the river may facilitate clean-up activities.

320.7 Community Participation

A. Community Education

1. Educating the community as to sources of pollution, mechanisms by which pollutants enter the Narrow River, and the degrading effect on water quality can enlighten and encourage participation in clean-up activities. Such clean-up activities may entail individual mitigation efforts, i.e., minimizing chemical fertilizer applications, cisterns for catch-ing rainwater, roof gutters, maintaining septic systems, and water conservation techniques.

2. Various methods for community education may include distribution of pamphlets, seminars and/or workshops, radio or televison advertisements, video tapes, and local newspaper columns.

B. Monitoring

A citizen's water quality monitoring program, i.e., "Riverwatchers", similar to that initiated by the Salt Ponds SAM Plan (Olsen and Lee, 1984), "The Pond Watchers", is a necessary initiative in the Narrow River watershed as it provides a means for supplementing state efforts. Participation by surrounding communities increases enthusiasm and public awareness facilitating the restoration, preservation, and protection goals of the plan.

320.8 Future Research

The CRMC recognizes that further research is needed to help protect the river. As funding becomes available, the research needs listed below are recommended:

A. Initial research programs should be directed toward monitoring river water quality once implementation of the plan begins. The monitoring will measure the effectiveness and efficiency of the restorative management strategies. Such research will provide information as to whether the management techniques shoud be maintained or improved.

B. Development of a quantitative hydrodynamic model of the estuary should be pursued. Such models enable the prediction of the transport and fate of a variety of pollutants and allow for the enactment of "what if" scenarios for different levels of pollutant inputs.

C. Detailed analysis of bottom sediment distribution, composition, and transport dynamics should also be encouraged. These studies provide insight as to processes affecting shellfish and other bottom dwelling organisms. Sediment transport studies are also used in determining locations of erosion and/or deposition.

D. Groundwater data is scarce in the watershed. Focus should be placed on determining the status of groundwater in the watershed in terms of quality and quantity. Flow patterns have not yet been delineated but should be for purposes of determining contaminant transport and pathways.

E. Little is known about the freshwater system in the northern region of the watershed. Water quality testing should be initiated in Pausacaco (Carr) Pond, the Mattatuxet River, and in Silver Spring Lake. Transport studies, hydrodynamical and sedimentological, would

be extremely beneficial.

F. At the present time technical guidelines for storm water management do not exist on state and town levels. There is an overwhelming need for the application of such techniques in the Narrow River watershed, among other areas within the state. The CRMC, the DEM, the SCS, and municipal agencies should undertake a cooperative program to assess the existing status of stormwater management in other states and the applicability of such concepts for the development of guidelines for Rhode Island.

Chapter Four.
Critical Habitat

410. FINDINGS OF FACT

410.1 Introduction

A. A complex series of interrelationships have evolved among the different habitats that coexist within the Narrow River watershed. These habitats include the wetlands, the estuarine waters, and the terrestrial uplands. The interrelations among these three habitats form the basis for a highly productive and diverse wildlife population, establishing the watershed region as a valuable natural resource.

B. The greater the productivity, the more viable the ecosytem, hence, the greater the resource value to the surrounding communities. Specifically, this means unpolluted waters, abundant and diverse fish and wildlife populations, and a high aesthetic quality. Unfortunately, these characteristics attract more human development activities, which can serve to adversely affect the interactions which take place among and within the different habitats.

410.2 The Wetlands Habitat

A. Description

1. Wetlands interact with both the aquatic and terrestrial environments, resulting in a habitat of extremely high productivity (Figure 4-1). During tidal ebb and flood, nutrients and waste material are exchanged between the salt marsh and adjacent estuarine waters. This constant exchange and renewal of nutrients has made the salt marsh the most productive of all wetlands (Odum, 1961). The wetlands display features and species characteristic of both bounding habitats, yet has its own unique characteristics and species, differentiating it from any other habitat (Daiber, 1986). In Rhode Island coastal wetlands include salt marshes and freshwater or brackish wetlands contiguous to salt marshes (Olsen and Seavey, 1983).

2. The abundance and diversity of vegetation is critical in maintaining the high productivity associated with the wetlands. Detrital material (decaying organic matter) derived from the vegetation forms the basis of ecosystem metabolism in the wetland environment, and, via tidal flow, supplements and enhances the productivity of the adjacent estuary. The vegetation also aids in trapping natural sediment and nutrient loads derived from runoff over land and from material suspended in the water column. Thus, the marsh is serving as a rudimentary filter, maintaining the natural quality of the open water habitat. With rising sea level, the filtering and accretion of sediments facilitates growth of the marsh, ensuring continued productivity.

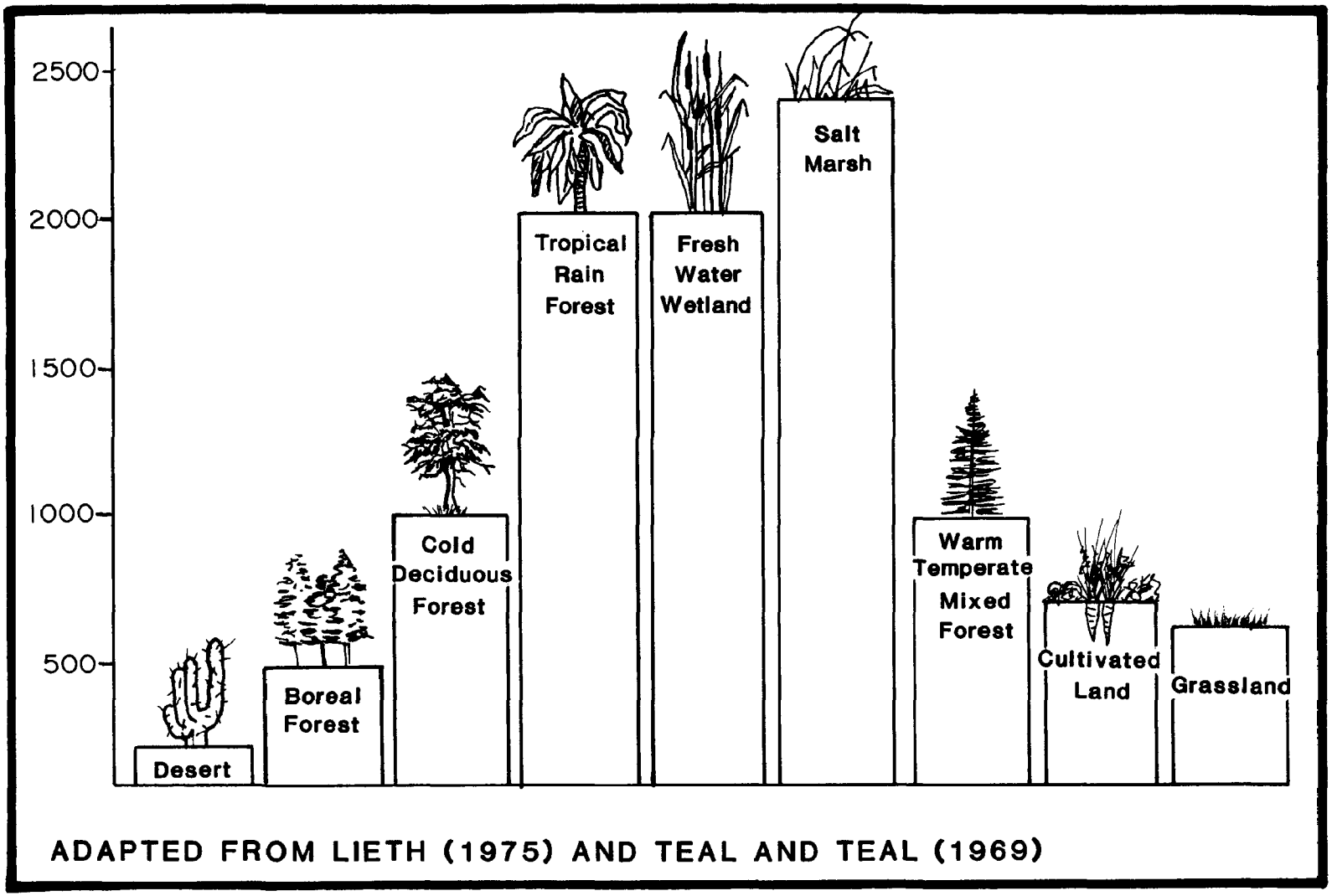
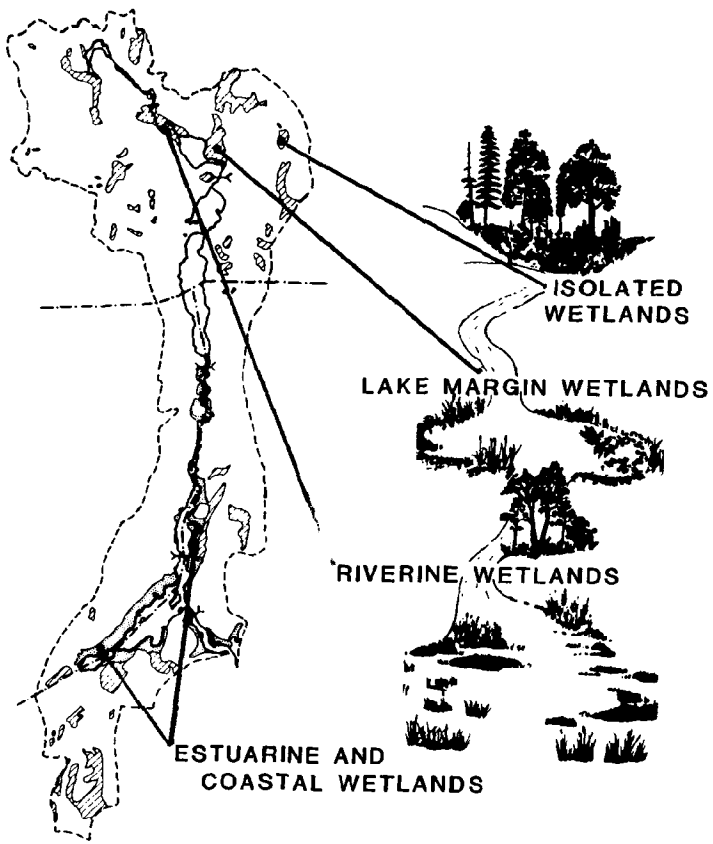


Figure 4-1. Net primary productivity of selected ecosytems, in grams carbon/year (From Tiner, 1985).



VALUES	HAZARDS
Isolated Wetlands	
(Permanently high ground water levels due to discharge and drainage) o waterfowl feeding and nesting habitat o habitat for both upland and wetland species of wildlife o floodwater retention area o sediment and nutrient retention area o area of special scenic beauty	o flooding and drainage problems for roads and buildings due, in some instances, to widely fluctuating surface and ground water elevations o serious limitations for on-site waste disposal o limited structure bearing capacity of soils for roads and buildings due to high content of organic materials
Lake Margin Wetlands	
o see values for "isolated wetlands" above o removal of sediment and nutrients from inflowing waters o fish spawning areas	o see hazards for "isolated wetlands" above
Riverine Wetlands	
o see values for "isolated wetlands" above o sediment control, stabilization of river banks o flood conveyance area	o see hazards for "isolated wetlands" above o flood conveyance area subject to deep inundation o sometimes erosion areas
Estuarine and Coastal Wetlands	
o see values for "isolated wetlands" above o fish and shellfish habitat and spawning areas o nutrient source for marine fisheries o protection from erosion and storm surges	o see hazards for "isolated wetlands" above o often severe flood hazard due to tidal action, riverine flooding, storm surges, and wave action o sometimes severe erosion area in major flood due to wave action

Figure 4-2. Values and hazards associated with the various wetlands found within the Narrow River watershed (From Kusler and Harwood, 1977).

3. Other functions of wetlands are summarized by Shisler, et al. (1975) and include: shoreline stabilization, abatement of storm surge due to attenuation/frictional effects, storage of flood waters, reducing hurricane/storm impacts, nursery and spawning grounds for estuarine and marine species, and resting, nesting, and feeding sites for waterfowl. In the Narrow River watershed, and other estuarine-marsh ecosystems, such wetland functions enhance the value of the resource to the surrounding communities (Darnell, 1979). Figure 4-2 summarizes several of these values and associated hazards that arise when natural functions of the wetlands are ignored.

4. Within the Narrow River watershed 20% of the undeveloped open lands are defined as wetlands. Of these wetlands, 30% are classified as salt marsh and 70% as freshwater marshes (Figure 4-3). Map 4 shows the areal extent of these freswater and salt marshes. Most of the salt marshes are located in the southern embayment, Pettaquamscutt Cove. The Cove is almost completely surrounded by broad expanses of salt marsh with several marsh islands present in the shallow waters. Smaller salt marsh patches and fringing marshes extend up the river, on both sides, as far north as Bridgetown Bridge.

5. Freshwater wetlands contiguous to the salt marshes which bound the Cove, account for almost half of the freshwater systems within the watershed. The remaining freshwater wetlands can be found along the Mattatuxet River and Gilbert Stuart Stream in the headwaters region, and in an extensive trellis network of small streams and wetlands which effectively reach every corner of the watershed. These wetlands are important because the freshwater discharged to the system enhances mixing, which is the basis for high productivity levels.

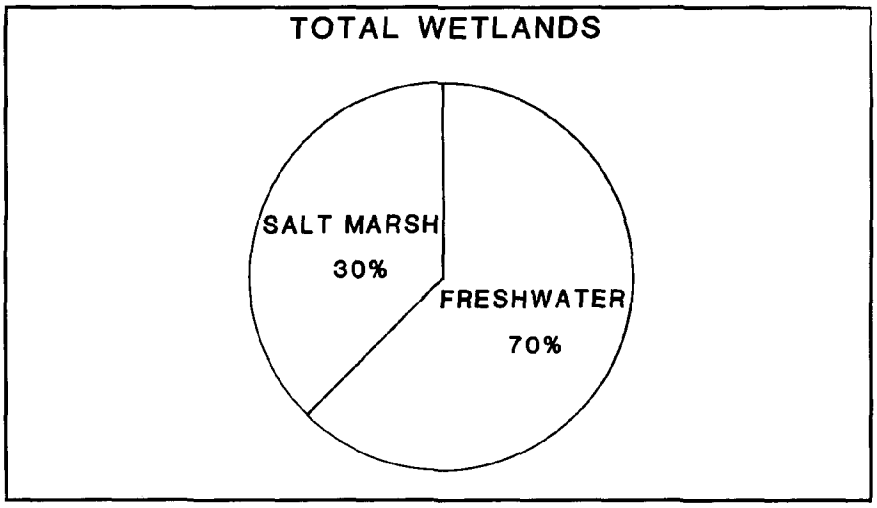


Figure 4-3. Percent compostion of wetlands in the Narrow River watershed.

B. Vegetation

1. Recent aerial photographs have been used to classify the salt marshes surrounding the cove as estuarine intertidal (Kenenski, 1986), characterized by erect, rooted, herbaceous hydrophytes (USFWS, 1979). Plant species typical of this assemblage are listed in Table 4-1. The cordgrasses are a major source of detritus to the marine food web, and are grazed upon by many organisms, including marsh snails, amphipods, isopods, leaf bugs, fiddler crabs, ribbed mussels, and mud snails (Pelligrino and Carroll, 1974). Cordgrass seeds also serve as food for waterfowl and other birds, while the rootstalk of the plant is a major food source for geese and muskrat (Pierce, 1977). Spike grasses, found in low dense stands, provide nesting sites for various species of waterfowl and a food source for ducks, small mammals, and marsh and shore birds (Pierce, 1977).

Table 4-1. Predominant wetlands vegetation of the Narrow River Watershed.

Common name	Scientific name	Type	Location
Saltmarsh cordgrass	Spartina alterniflora	sw	lower estuary
Saltmeadow grass	Spartina patens	sw	lower estuary
Spike grass	Distichilis spicata	sw	lower estuary
Saltwort	Salicornia sp.	sw	low/mid estuary
Cattails	Typhus augustifolia	bw	cove/headwaters
Reedgrass (Tall Reed)	Phragmites australis	bw	cove/mid estuary
Sedge grass	Scirpus sp.	bw	mid estuary
Rushes	Juncus sp.	bw	mid estuary
Peat moss	Sphagnum sp.	fw	headwaters
Atlantic white cedar	Chamaecyparis thyoides	fw	upper estuary /headwaters
Black spruce	Picea marina	fw	upper estuary /headwaters

sw=saltwater, bw=brackish water, fw=freshwater

2. The vegetation type changes with salinity and tidal innundation. Salt pannes, present in the lower estuary are hypersaline and partially submerged. Such an environment is almost exclusively inhabited by Salicornia sp., a saltwort. The presence of the reed grass Phragmites sp. is an indicator of disturbed estuarine wetlands, particulary where natural flushing by saltwater has been altered, or sediment loading is occuring (Neiring and Warren, 1977). Reed grasses and cattails (a fresh water plant) are observed in the southwestern end of the cove, where freshwater discharges dilute the seawater (Kenenski, 1986). Other brackish and fresh water species common to the middle and upper reaches of the river are listed in Table 4-1. All of these plant species provide food, nesting sites, and protection for a wide

variety of birds and mammals, and function as a nursery ground for fish where these stands are emergent (Pierce, 1977).

C. Birdlife

1. Birds are the most easily observed and, therefore, the best known group of animals within the watershed. The geographic location of the river makes it a convenient migratory resting spot for many different species of waterfowl (Gould, 1986). The birdlife of the watershed are classified under four categories, based primarily on time of year observed (after Enser, 1986):

(a) Nesting species - these species utilize the area for principally breeding and nesting purposes usually in the spring and summer.

(b) Feeding species - these birds are observed during the same sesonal period as the nesting species, however, do not use the watershed as a nesting area. These species nest elsewhere or are non-breeding in this area.

(c) Transient species - Although bird populations fluctuate all year round, the peak migration season occurs in the late spring and early fall. Transient, or migratory, birds are opportunistic, using only those areas convenient to their migration path.

(d) Wintering species - Several species of birds remain in the watershed for some period of time in the winter. Waterfowl are attracted to the Narrow River in the winter because of the relative rarity of freezing over due to higher salinity.

2. Table 4-2 is a list of birds that have been observed in the wetlands of the Narrow River. Those species which utilize the wetlands as a resting spot are habitat specific and cannot easily adapt to upland or shore habitats. Thus, as more and more wetlands are filled or obscurred by development, the value of these areas as stopovers increases dramatically (Enser, 1986).

C. Other wildlife

Additional species of wildlife reported for the Narrow River wetlands habitat include muskrat (in the less saline regions), snapping turtles and deer in the salt marshes, and salamanders, frogs, toads, snakes, rabbits, raccoons, and deer in the freshwater wetlands (Enser, 1986; Husband, 1986; Cronin, 1986).

D. Rare and Uncommon Species

1. There are several species of plants and animals of the wetlands habitat known to be rare or uncommon. Table 4-3 describes each species and their significance. Rare and uncommon species enrich the natural diversity of the wetlands, augmenting the ecosystem's value as a natural resource.

Table 4-2. Birds of the Narrow River wetlands habitat. (data from Enser, 1986; Gould, 1986).

Common name	Nesting	Feeding	Transient	Wintering
Mute Swan	*	*		*
Canada Goose			*	*
Mallard		*		
Black Duck			*	*
Canvasback			*	*
Greater Scaup			*	*
Golden Eye			*	*
Bufflehead			*	*
Red-breasted Merganser			*	*
Atlantic Brant				*
American Wigeon			*	*
Gadwall			*	*
Blue-winged Teal			*	*
Osprey	*			
Red-winged Blackbird	*			
Sharp-tailed Sparrow	*			
Swamp Sparrow	*			
Song Sparrow	*			
Great Blue Heron		*		
Little Blue Heron		*		
Black-crowned Heron		*		
Glossy Ibis		*		
Great Egret		*		
Snowy Egret		*		
Ring-billed gull		*		
Herring gull		*		
Great BlackBacked Gull		*		
Common Tern		*		
Least Tern		*		
Plovers			*	
Spotted Sandpiper			*	
Rails			*	

Table 4-3. Rare and Uncommon Wildlife of the Narrow River Wetlands Habitat (data from Enser, 1986).

Common Name	Scientific Name	Significance
Sea Pink	Sabatia stellaris	One of 6 sites in Rhode Island, confirmed in the Narrow River only within the past 5 years, considered endangered in Massachusetts.
Olney's Sedge	Scirpus onley	One of three sites in the state, indicative of a good brackish water system.
Robust Sedge	Scirpus robustus	One of 5 sites in the state, occurs in the Narrow River watershed in a stand of 50 ft. diameter.
Osprey	Pandion haliaetus	Nesting site active for 10 years, one of 17 sites in Rhode Island, one young observed in 1985 (Enser, 1986) and again in 1986 (Kenenski, 1986).
Least Tern	Sterna albifrons	Last reported nesting at this site in the 1960's, generally believed to have left the area because of increased recreational use. Observed at 10 other sites in the state, might return if beach access were limited.

E. Human Impacts

1. Almost every major activity of human society can be expected to have some impact on wetlands (Darnell, 1978). Upland alterations can accelerate runoff, reduce groundwater levels, increase sediment load, alter the thermal regime, and increase pollutant loadings (Daiber, 1986). Dredging and filling operations can obliterate entire wetland habitats, severely effecting the productivity of the ecosystem. This, in turn, can lower the resource value to the community and threaten future uses (Darnell, 1978). Ignoring the functions of wetlands which are of direct benefit to society, i.e., flood storage and conveyance, shoreline stabilization, critical habitat for wildlife, and enhancement of estuarine productivity, can lead to irreplaceable losses (Darnell, 1978). Educational, recreational, scientific, and aesthetic qualities are additional values perceived as beneficial to society (Roman and Good, 1983).

2. As Darnell (1978) and Neiring (1978) both agree, wetlands are a natural heritage that are being destroyed before their full values can be realized and utilized efficiently by society. Loss

of the wetlands surrounding the Narrow River can have severe repercussions throughout the entire watershed. In order to perpetuate this natural heritage, a sound program of education, research, conservation, recreation, and ecological management must be developed (Daiber, 1986).

410.3 The Open Water and Aquatic Habitat

A. Description

1. Several aquatic habitats can be found within the Narrow River watershed, each with a different physical, chemical, and biological setting. The aquatic environments range from a well-flushed estuary near the mouth, to freshwater kettlehole ponds in the headwaters region. Each habitat supports a different community where species of plants and animals are specifically adapted to the physical and chemical characteristics of their environment.

2. One of the more important aquatic habitats within the watershed is that which supports the estuarine subtidal community (Clarke, 1977). Typical inhabitants of this community include submerged seagrasses, shellfish and finfish, mudworms, and many planktonic (microscopioc free-floating) forms. This community is recognized as the most productive of all aquatic habitats, which can be related to the combination of natural features in the estuary (tidal flow, freshwater flow, shallowness, confinement), providing an environment which encourages use by a number of different populations.

3. In coastal estuaries, the community composition (plankton, seagrasses, invertebrates, fish and shellfish) enables large quanities of nutrients to be produced and exchanged between wetlands and openwater environments, supporting a growing and complex web of consumer populations. Human activities frequently disturb and interfere with the estuarine productivity, resulting in such far-reaching effects as reduction of finfish and shellfish harvests, lowering income for fisherman, and loss of recreational revenue to municipalities due to reduction in sportfish populations. These effects have already been felt in the Salt Ponds region of southern Rhode Island (Olsen and Lee, 1984).

B. Plankton

1. Plankton are microscopic organisms (bacteria, diatoms, uni- and multicellular algae) which make up the lower levels of the food web and live suspended in the water column. Within the Narrow River, over 150 species of phytoplankton have been identified (Miller,1972; Hanisack, 1973). The number and diversity of phytoplankton varies longitudinally along the river depending on

salinity and temperature conditions as they vary throughout the year (Miller, 1972; Hanisack, 1973). Samples taken from the phytoplankton community of the Narrow River have produced some interesting discoveries. One species, Euglena proxima, normally found only within oxygenated zones, was collected from the anoxic waters of the Lower Pond (Miller, 1972) and had apparently acclimated to the low oxygen conditions.

2. Miller (1972) also recorded the unique occurrence of a species known as Hermesinum adriaticum, typically observed in the Black, Adriatic, and Mediterranean Seas. Only two species of Hermesinum are known to exist in the world. The diatom Chaetoceros fallax and the flagellate Circosphaera roscoffensis have also been collected in the Narrow River and have been seen in only a few locations in the world. One diatom, Chaetocerus ceratosporus var. brachysetus is unique to the Narrow River; it has not been documented in any other area of the world (Hargraves, 1986b). As the river is examined more closely, it is probable that more rare and unique species will be found in the plankton or on the river bottom. Further, the phytoplankton composition for the Lower Pond was found to be very similar to that of a Norwegian anoxic basin, The Hunnebunnen (Miller, 1972). This biologic comparison, preceding Gaines' (1975) physical comparison to the deep anoxic fjords of the boreal zone, further substantiates the unusual character of these estuarine environments.

3. Phytoplankton are the primary food source for zooplankton (microscopic animals), thus, the number and diversity of zooplankton in the Narrow River depends primarily on the abundance and diversity of phytoplankton, in addition to salinity and temperature gradients (Vargo, 1973). Typical zooplankters in the Narrow River include barnacle larvae, mudworm larvae, and copepods (microscopic crustaceans) for which population densities tend to peak in the spring months of March through May (Vargo, 1973).

4. Naturally occurring bacteria act as the scavengers of the plankton community. Unique species which occur in the Narrow River include Chromatium sp., a pink bacteria, and Chlorobium sp., a green bacteria. These species occupy the anoxic zones, acting as decomposers for falling detrital material. In high concentrations, Chromatium sp. gives the two basins a pinkish-colored submerged layer (Miller, 1972). Anthropogenically introduced coliform bacteria have been well-documented within the Narrow River (see Chapter III) and are important in that they are indicators of sewage waste material.

C. Submerged Aquatic Vegetation

1. Submerged aquatic vegetation (SAV) is an often overlooked

group in the coastal community, yet it forms an integral and critical component of the subtidal ecosystem. Many boaters find the submerged grasses a menace to their propellers, while swimmers find its presence to be a nuisance. Without SAV, however, the overall productivity of the estuary can be severely curtailed. Among the more important functions of SAV are (after Wood, et al., 1969):

- a high organic productivity
- providing organic matter to the estuarine ecosystem
- reducing current velocities, promoting sedimentation
- binding the bottom sediments, slowing erosion
- providing a nursery for migrating fish
- a food source for ducks and other waterfowl
- a permanent residence for invertebrates

Table 4-4. Submerged Aquatic Vegetation observed in the Narrow River (from Wright, et al. 1949).

Common name	Scientific name	Mode of Occurrence	Observed Location
Narrowleaf Pondweed	Potamogeton berchtoldi	Infrequent	a single cove in the upper basins
Sago Pondweed	Potamogeton pectinatus	Infrequent-Moderate	sporadically in the upper basins
Claspingleaf Pondweed	Potamogeton perfoliatus	Infrequent	the northern basins
Wigeon Grass	Ruppia maritima	Infrequent	shallow coves
Horned Pondweed	Zannichellia palustris	Infrequent	eastern shore north of Middlebridge
Eelgrass	Zostera marina	Infrequent-Moderate	south and north of Middlebridge, patches in The Cove

2. Six species of SAV have been documented in the Narrow River by Wright, et al. (1949) and are presented in Table 4-4. No

known inventories have occurred since that time to determine the present status of SAV.

D. Finfish

1. Attracted by the shallow, warm, protected waters, finfish have a long history of proliferation in the Narrow River. In the anecdotal "Jonnycake Papers of Shepard Tom" (Hazard, 1915), it was mentioned that as early as 1675, local inhabitants would travel down from Wickford to catch white perch from the Cove. Another account tells of the migration of striped bass that came to winter in the ponds during the late 1700's:

> "two of the Misses Brown from Tower Hill...when they came to the fording place at Narrow River...were forced to dismount [their horses] and pass over afoot on the backs of the fishes that were jammed in such a solid mass as to be unable to move individually in any direction except as the entire mass was carried along by the tide..."

2. Striped bass still winter in the ponds, and, in the 1950's a substantial striped bass fishery is reported to have existed within the river (O'Brien, 1977). However, their present numbers are considerably reduced. O'Brien (1977), using a trawl net, was only able to collect a total of twenty-two specimens during his two year study.

3. Almost fifty species of fish have been documented to use the Narrow River at some point in their life history. A list of species, their location in the river, and use of the river is presented in Table 4-5. Many of the species are small (i.e., mummichugs, sticklebacks, silversides), serving as a food source for the larger, edible sport fish. Among the edible fish, common in the lower estuarine reaches of the river, are winter flounder, white perch, American eel, pollack, and bluefish. In the upper fresh water reaches, chain pickerel, yellow perch, largemouth bass and stocked trout (Silver Spring Lake) are frequently caught (Guthrie and Stolgitis, 1977).

4. There is a considerable spatial overlap between the fresh and marine species (Horton, 1958). For example, chain pickerel (a freshwater species) has been collected from the upper basin, as have those species considered strictly marine, i.e., cod, menhaden and toadfish. This overlap creates a unique and diverse ecosystem in the upper pond, with both fresh and marine finfish cohabitating within the extremes of their preferred natural environments.

Table 4-5. Finfish in the Narrow River

Common Name	Scientific Name	Location	Spawning/ Breeding	Resident	Wintering	Migrant	Transient/ Rare
Alewife	Pomolobus psuedoharangus	L,M,U	*			*	
American eel	Anguilla rostrata	L,M,U	*				
Atlantic silversides	Menidia menidia	L,M,U		*			
Inland silversides	Menidia beryllinia	L,M		*			
Sheepshead minnow	Cyprinodon variegatus	L,M,U					*
Striped mummichug	Fundulus majalis	L,M,U	*	*			
Common mummichug	Fundulus heteroclitus	L,M,U		*	*		
Silver gar	Tylosurus marinus	U	*				*
Anchovy	Anchoa mitchilli	U				*	
Striped anchovy	Anchoa hepsetus	U				*	
Pipefish	Sygnathus fuscus	L,M,U		*			
2-spine stickleback	Gasterosteus wheatlandi	L,M					*
3-spine stickleback	Gasterosteus aculeatus	L,M,U		*			
4-spine stickleback	Apeltes quadracus	L,M,U		*			
9-spine stickleback	Pungitius pungitius	L,M					*
Menhaden	Brevoortia tyrannus	L,M,U				*	
Sand eel	Ammodytes americanus	L,M					*
Short horned sculpin	Myoxocephalus scorpius	L,M					*
White flounder	Psuedoplueronectes americanus	L,M,U	*	*	*		
Herring	Clapea harengus	M,U					*
Tautog	Tautoga onitus	L,M,U					*
Pollack	Pollachias virens	L,M,U	*				*
White Perch	Merone americum	L,M,U		*			
Striped bass	Morone saxatalis	L,M,U			*	*	
Tomcod	Microgadus tomcod	L,M,U		*	*		
Blueback	Pomolobus aestivalis	U	*				
Halfbeak	Hyporhamphus unifasciatus	U				*	
Cod	Gadus callarias	M,U					*
Hake	Urophcus sp.	U	*				*
Hogchoker	Achirus faciatus	U		*			
Mullet	Mugil cephalus	U				*	
N. Barracuda	Syphraena borealis	U				*	
Hardtail	Caranx crysos	U				*	
Lookdown	Selene vomer	U				*	
Rudderfish	Seriola zonata	U				*	
Threadfin	Alectis ciliaris	U				*	
Round pompano	Trachinotus falcutus	U				*	
Common pompano	Trachinotus aerolinus	U				*	
Bluefish	Pomatus salatrix	U	*				
Common bigeye	Pricantus arenatus	U				*	
Naked goby	Gobisoma bosci	U		*			*
Toadfish	Opsanus tau	U					*
SPECIES USUALLY FOUND IN FRESHWATER:							
Large mouth bass	Micropterus salmoides	L,M,U				*	
Brown bullhead	Amerius nebulosus	U					*
Chain pickerel	Esox niger	U					*
E. Banded killifish	Fundulus diaphanus	U	*				*
Yellow perch	Perca flavescens	U					*

L=lower estuary, M=middle estuary, U=Upper and Lower Pond
Data compiled from Horton, 1958; Gordon, 1960; Mulkana, 1964; Bond, 1968; Burgess,1971; O'Keefe, 1972; O'Brien, 1977; and Bengston, 1982.

5. The Narrow River is reknown in the state for its annual run of alewives, or buckies, which spawn in Pausacaco (Carr) Pond. Once the alewives reach the pond and spawn, they turn immediately and head back to open ocean, passing others still migrating upstream (Cooper, 1961). However, the alewives suffer a huge mortality rate; 50% of the migrating population never return to the sea (Durbin, et al., 1979). The spent alewives sink to the bottom and become an important source of nutrients for the lower reaches of the river, turning a potentially nutrient poor region into a productive nursery for young fish (Durbin, et al., 1979). Resident fish in Pausacaco (Carr) Pond have growth rates considered much higher than the statewide average which is also attributed to the alewife migration (Guthrie and Stolgitis, 1977).

6. The fish population of the Narrow River, although diverse, does not support any commercial operations of economic significance. There are a large number of people involved in recreational fishing, however, the revenue from this is not known.

E. Shellfish

1. The Narrow River also supports a modest shellfish population, the distribution of which depends on the bottom sediment type and the salinity regime. Common sessile species encountered in the river include quahogs, mussels, razor clams, and softshell clams. The bluecrab is able to move freely throughout the estuary and is commonly encountered near the shore searching for food (Campbell, 1957).

2. It is interesting to note that Campbell's 1957 survey found almost no soft shell clams within the river. The following year, Wright (1958) surveyed the beds and determined that the river had been over-exploited, eventually leading to special catch and enforcement regulations enacted by the DEM (Table 4-6). Results from Baczenski and Ganzs' 1980 survey indicate several dense softshell clam beds. Thus, it is clear that the shellfish populations fluctuate, whether or not this is a result of natural cycles or the DEM's catch regulations cannot be determined.

3. The location and mean densities of shellfish species found in the river, as surveyed by Baczenski and Ganz (1980), are illustrated in Figure 4-4. The shellfish population supports a few small commercial operations, concentrating primarily on bluecrabs and oysters. The economic significance of these operations are minimal (Ganz, 1986). The major harvestors and consumers of shellfish in the river are the year-round and summer residents.

F. Rare and Uncommon Species

A rare seacucumber has been documented in the southern portion of

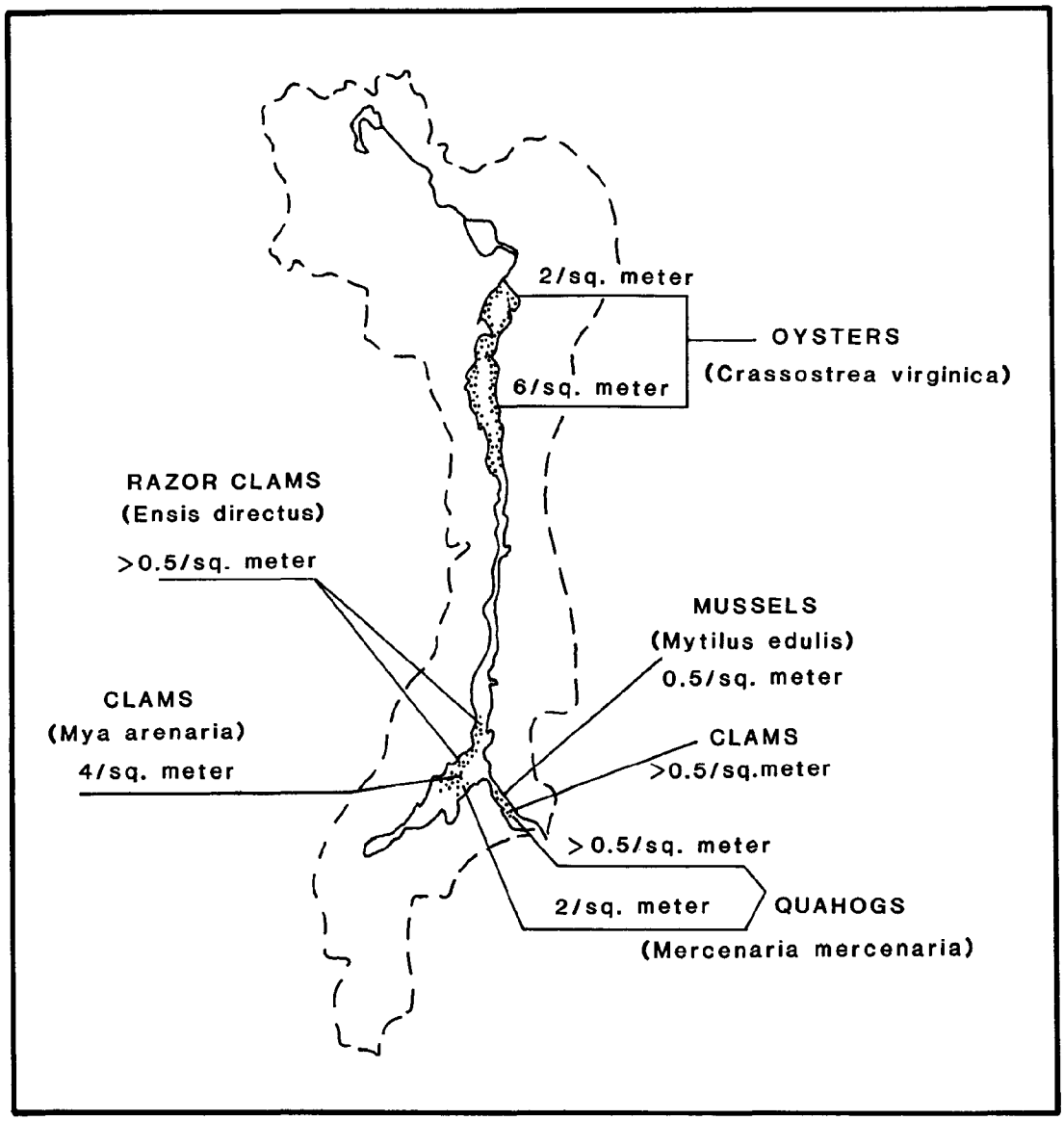


Figure 4-4. Location of shellfish beds in the Narrow River. Numbers indicate the approximate mean density of shellfish recorded (Data from Baczenski and Ganz, 1980).

Table 4-6. Minimum Size and Catch for shellfish.

Species	Size	Catch commercial, resident
Quahaug	1" smallest diameter	1/2 bu/day, 1 peck/day
Clam	1 1/2" maximum diameter	" , "
Mussel	1 1/2" maximum diameter	----------
Oyster	3" longest axis	" , "
Blue crab	4 1/8" tip to tip	----------

Data from R.I. DEM, 1985 & 1986.

the estuary, near the Cove, the only location in the state where this species occurs (Seavy, 1975). Several uncommon fish species have also been known to inadvertently enter the estuary. Such species include the Atlantic Sturgeon (Enser, 1986), Northern Barracuda (Gordon, 1960), and a moonfish (preserved at the URI Bay Campus).

G. Human Impacts

1. Phytoplankton utilize sunlight to convert nutrients for growth and are in turn consumed by zooplankton. When nutrient levels are elevated, either naturally or by increased human inputs, phytoplankton populations bloom, often causing an unsightly slime on the water surface. A high incidence of cell death and consequent decay depelete the oxygen available to finfish and shellfish populations.

2. Increased sedimentation loads, resulting from upland alteration and construction, or from dredge and disposal activity (Chapter VI), can have the opposite effect. The sediments increase turbidity and decrease the light available to phytoplankton which results in a reduction of population densities, thus depriving the estuarine ecosystem of its most basic food source.

3. The need for a relatively high intensity of light and slightly sheltered waters places most SAV beds in shallow marginal waters, historically the most prominent area for competing with human activities. Eutrophication, increased runoff rates, and dredging are all events resulting in high turbidity, in turn, decreasing light available for photosynthesis, eventually obliterating submerged seagrass beds (Zeimann, 1977). Filling in seagrass beds reduces the habitat available for larval fish nurseries, which would affect the overall population stock, and eliminate the habitat for use by resident invertebrates. Unfortunately, when seagrass beds are disturbed or destroyed, recovery times are slow; up to 30 years were required for beds to recover from the "wasting disease" of Zostera sp. beds in the 1930's (Zeimann, 1977).

4. Shellfish filter large quantities of water through their bodies each day, extracting planktonic forms and other particulate matter as a food source for growth and development. Because of this somewhat nondiscriminatory mode of feeding, shellfish frequently concentrate nonessential or detrimental particles (i.e., trace metals and pathogens) in their gut, depending on the ambient water quality. If the shellfish are collected and consumed uncooked by humans, the chance for contraction of such diseases as infectious hepatitis, typhoid, chlorea, and streptococcus are high. For this reason, when water quality is tested for specific parameters (i.e., coliform bacteria) and found to exceed state standards, bans must be imposed for the protection of the general public health. Two shellfish bans have been imposed in the Narrow River within the past seven years due to high coliform bacteria counts; the first closing was in August of 1979 lasting until the following spring; the second closing, July, 1986, was imposed until water quality standards were restored to SA quality.

410.4 The Terrestrial Habitat

A. Description

1. Characterization of the terrestrial habitat has not been extensively documented in the past. Generally, the habitat covers the area upland of the wetland edge and extends to the boundaries of the watershed. The species which inhabit the uplands perform several functions which are vital to the maintenance of the habitats downslope.

2. Vegetation, in an undisturbed watershed, virtually eliminates impacts associated with sudden discharges of freshwater, such as increased sediment loads and erosion, due to storm events (Hewlett and Nutter, 1970). The roots, stems, and leaves help to absorb and slow the runoff, allowing filtration into the soils and mitigation of erosive events (Palfrey and Bradley, 1981).

3. Terrestrial wildlife migrate back and forth each day utilizing the wetlands for food and nesting purposes (Golet, 1986). Thus, the wildlife are serving as vectors for the import and export of nutrients to the food web. This establishes yet another link in the web of interrelationships which exist within the Narrow River ecosystem.

B. Flora and Fauna

1. Vegetation is typical of the oak/mixed hardwood of the region, indicating generally sandy soils and a history of forest fires in the eastern watershed (River Landscapes, 1976). Second-

ary growth consists of both shrubs and trees (eastern red cedar, dogwood, aspen, birch) and is typically found in disturbed and/or abandoned areas (the southern portion of the watershed).

2. A large number of small mammals can be found, i.e., mice, squirrels, skunks, foxes, raccoons and rabbits. Large mammals such as deer, and more recently the coyote (in North Kingstown) have been observed (Narragansett Times, 1986). Birdlife abounds and includes such common species as sparrows, owls, blue jays, cardinals, quail, and meadowlarks (River Landscapes, 1976) that can be seen frequently near the watershed boundaries.

3. Several rare and uncommon plants are known to occur within the terrestrial bounds of the watershed. One such plant is a rare luminescent moss (Schistostega sp.) found within the entrance to one of several abandoned graphite mines in the region and is believed to be one of only a few sites in New England. In addition, there exists a plant community composed of a large variety of ferns. At this site, approximately a dozen different fern species can be found, an unusually diverse assemblage for a considerably small area. The site is utilized for educational purposes by the University of Rhode Island.

C. Human Impacts

1. The clearing of land, for construction and development, obliterates vegetation and its mitigative effects on surface water runoff impacts. This is extremely important in those regions of the watershed characterized by steep slopes. Without the extensive root systems of mature trees, the slopes are destabilized, increasing the potential for erosive processes (Sidle, et al., 1985). Rain, falling on bare sandy soils, dislodges particles and further increases the likelihood of erosion and high sediment loads (Palfrey and Bradley, 1981). Ultimately, erosion results in excessive turbidity in the river, reducing water quality and affecting fish, shellfish, SAV, and plankton populations. Increased discharges of freshwater to the wetlands and river, due to lack of attenuation of flow by vegetation, can eventually disturb the natural salinity and hydrology of the habitat, in turn, effecting the faunal communities (Daiber, 1986).

2. As the region suburbanizes and develops, some animal species considered undesirable will increase, however, most will be crowded out of the region as a result of the habitat destruction and disurbances (River Landscapes, 1976). The loss of these species weakens the link which helps to maintain watershed diversity and productivity.

410.5 Summary

A. The wetlands of the watershed are highly productive, and supplement the productivity of the adjacent estuary. The vegetation forms the basis of this productivity, serving as a major food source for fish, birdlife, and upland animals. The wetlands also provide several significant functions which are beneficial to the surrounding residential communities. These include a nutrient source, a rudimentary water filter, erosion control, flood abatement storage, and a critical wildlife habitat. Destruction of the wetlands can reduce the value of these functions, drastically changing the value of the watershed as a natural resource (Darnell, 1979).

B. The aquatic habitat supports a diverse community with several unique species. In the upper basins of the river, rare microorganisms flourish, phytoplankton populations simulate those found in Norwegian climes, and freshwater and marine fish intermingle. The best known alewive run in the state occurs in the Narrow River each year, yielding a rich source of nutrients in an otherwise nutrient poor region. A rare sea cucumber is known to exist in the lower Cove region of the estuary. Productivity in the estuarine environment is, in part, provided by submerged aquatic vegetation (SAV), which also serves as a nursery for young fish and invertebrates. The fish and shellfish populations increase the resource value of the river by supporting many recreational and sport fishing activities, as well as a few small commercial operations.

C. The terrestrial uplands surrounding these environments contribute to overall productivity of the region by maintaining a structurally diverse habitat which increases wildlife species abundance and diversity. A rare moss is known to exist on the western slopes, and an unusually diverse stand of ferns can be found in the headwaters region. Upland vegetation aids in the maintenance of water quality and in mitigating runoff, the impacts of which can be devastating to the wetland and aquatic communities.

D. The ecological processes of the Narrow River watershed make it a complex support system for a very diverse floral and faunal community utilizing several different habitats. Inextricable ties have evolved which contribute to the productivity of the estuary and consequently to the abundance and diversity of animal populations which inhabit the watershed. Numerous factors, in whole or in part, may be responsible for population decreases; keeping the overall resource value of the Narrow River high requires the protection or preservation of all components of the ecosystem, the wetlands, water quality, and the surrounding land uses. The watershed's ecological productivity is highly subject to human intervention; the manner in which human activites are managed now, and in the future will determine the degree to which the environment of the Narrow River watershed can be maintained.

420. MANAGEMENT REGULATIONS AND INITIATIVES

Based on Section 410, Findings of Fact, and the goals to preserve and protect the resources of the river, the following regulations and iniatives are deemed necessary:

420.1 Controls for Habitat Protection

A. Alterations to salt marshes and contiguous freshwater or brackish water marshes within the watershed are prohibited.

B. A buffer zone shall be established contiguous to the most inland edge of the coastal habitat of concern. The width of the buffer shall be no less than 200 feet in those lands classified as Lands of Critical Concern (Section 320.1B,2,f) and not less than 100 feet for those lands which abut tributatries in Self-Sustaining Lands (Section 320.1A,2,d).

C. Filling, removing, and grading (CRMP, Section 300.2) is prohibited on any shoreline, wetland, or buffer zone throughout the watershed.

D. Dredging and Disposal

1. Dredging (CRMP, Section 300.9) is prohibited within the Narrow River watershed.

2. Disposal (CRMP, Section 300.9) of foreign dredged material is prohibited on the shoreline, wetlands and buffer zones of the watershed, unless a Council-approved program of wetland building or rehabilitation has been established. Subaqueous dumping of dredged material is also prohibited in the Narrow River.

420. Acquisition of Environmentally Sensitive Lands

The most permanent protection afforded to sensitive lands is the prevention of their alteration through direct acquisition. It is the mutual responsibility of local groups and municipal and state agencies to promote such efforts in order to ensure continued existance of these fragile resources.

A. Conservation Easements

1. Definition. A conservation easement is a contract between a landowner and a conservation group or land trust, in which the landowner agrees not to develop her/his land, but to preserve it in its natural state. The easement permantly prevents residential, commercial and industrial development of the property,

inproper or unnecessary removal of vegetation, and the dumping or excavation of any materials. Executing the contract commits the landowner to "donating" development rights to the towns, conservation group or land trust, but retains all other rights of ownership not restricted by the agreement.

2. CRMC will encourage conservation easements to be held by each town, and such organizations/agencies as the Narrow River, Narragansett, and South Kingstown Land Trusts or the Audubon Society.

B. Natural Heritage Preservation Revolving Loan Fund

1. Definition. The Department of Environmental Management is administering a $2 million fund that will allow preservation societies, land trusts, non-profit organizations, and local communities to preserve open space/agricultural lands deemed of scenic or ecological value, in perpetuity. The monies are available on a revolving loan basis ($250,000 maximum loan) and are for lands not less than 5 acres.

2. The CRMC encourages the appropriation of such monies by the individual towns, local communities, Narrow River Preservation Association, Narrow River Land Trust, and the Nature Conservancy, for the preservation of lands in the watershed. Priorities for acquistion and preservation should include those lands which support rare, uncommon or endangered species, in addition to wetlands, banks and slopes, and significant cultural resources located along the river's edge.

C. Critical Resource or Conservancy Zoning

The towns are encouraged to make provisions in their respective zoning ordinances for the rezoning of critical areas for conservation purposes in an effort to preserve the unique amenities of the watershed. Such efforts are currently underway in the town of Barrington, Rhode Island.

D. Municipal Easements

Municipal agencies are encouraged to utilize provisions of their respective subdivision ordinances to maintain open space areas through dedication and easements.

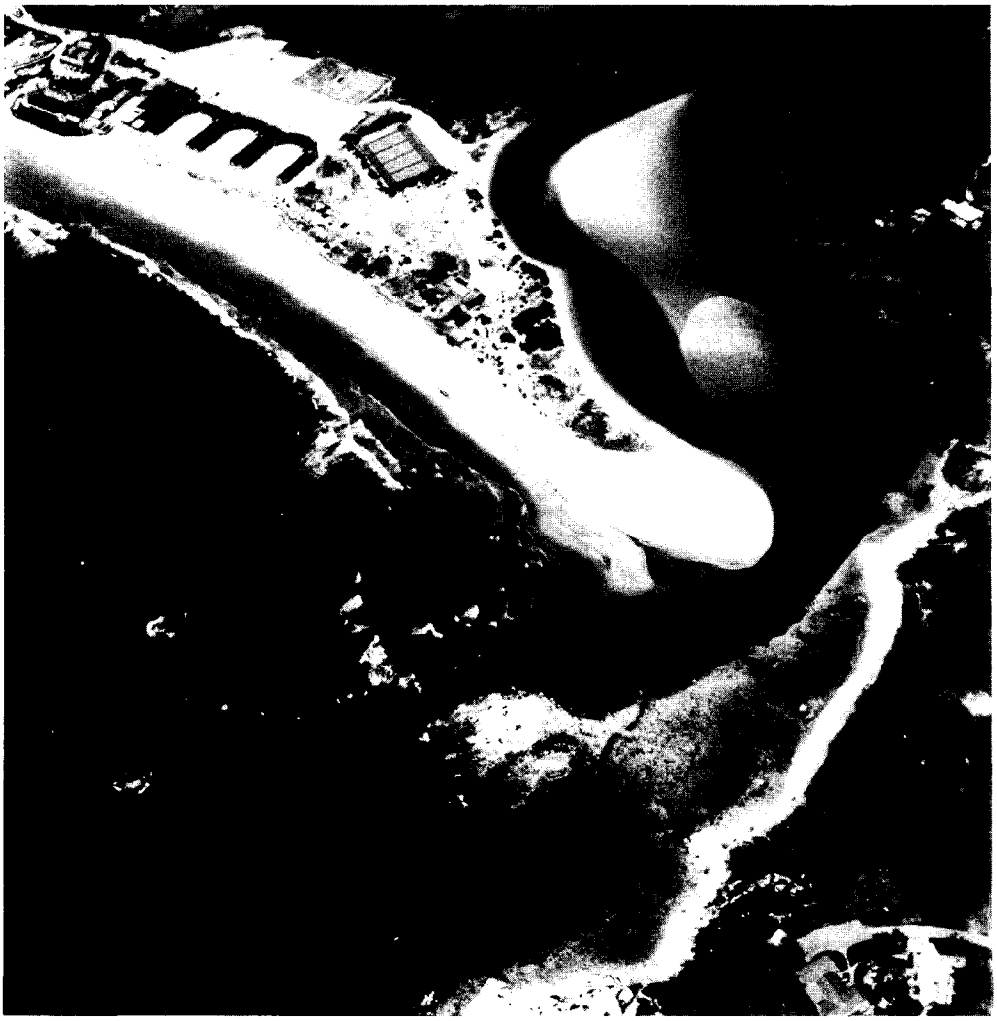
420.3 Public Education Programs

Educational programs, informing the general public as to the function of the different habitats (wetlands, aquatic and open water, terrestrial) and their value to society, should be initiated. These programs should be aimed at community residents and local elementary

and secondary schools. Emphasis at the community level should be placed on how land gifts and dedications, conservation easements, and special registration of unique amenities found on private properties will serve to protect critical habitats. The R.I. DEM is investigating the applicability of such educational programs within the Wood-Pawcatuck watershed.

Chapter Five.

Flood and Storm Hazards



510.0 FINDINGS OF FACT

510.1 Introduction

A. The Floodplain Along The Narrow River

1. The character of the Narrow River drainage system is related to the interaction of several factors, including climate, topography, vegetation, and soil. Sediments transported by the river are periodically deposited in the channel and adjacent floodplain (Figure 5-1). The floodplain is defined as that land adjacent to a watercourse or drainageway which has periodically been inundated by flood waters and sediment (Thurow et al. 1975).

2. When water overflows the channel, usually during intense rain events and storms, the river is known to be in flood stage and can be expected to cause damage to property within the flood prone areas. A river channel is formed and maintained by this overflow, or discharge, and can be expected to emerge from its banks and cover part of the adjacent land area with water and sediment once every year or so (Keller, 1975). This has been apparent in the Middlebridge area in the past several years where, during storms, the bank flow has reached the level of the bridge and spilled onto the adjacent parking area (Lewis, 1986).

3. Flood-prone areas exist throughout the Narrow River watershed area, from Silver Spring Lake in the north, to the Kinney Road area in the south (Map 13). The boundaries are delineated on flood insurance maps by the Federal Emergency Management Agency (FEMA), and incorporate estimates of the land area located in the A zones (subject to 100-year flood elevation), and the high hazard, or V zone (subject to 100-year coastal flood and high velocity waves). In addition to these areas, there also exists a proportional amount of land subject to flood elevations from 100-year to 500-year flood events.

B. Threats to Development in the Floodplain

1. Several factors controlling flood damages include land use within the flood prone areas and the magnitude and duration of flooding event. Land clearing and the associated development increase runoff, erosion, and the occurrence of flood hazards, and is related to the percentage of impervious surfaces and area served by storm sewers (Keller, 1975). While certain sections of the Narrow River drainage basin are densely developed, impervious surfaces and storm drains in the watershed as a whole account for only slightly more than 5 percent of the land area, and does not greatly increase the flood hazard above its present level.

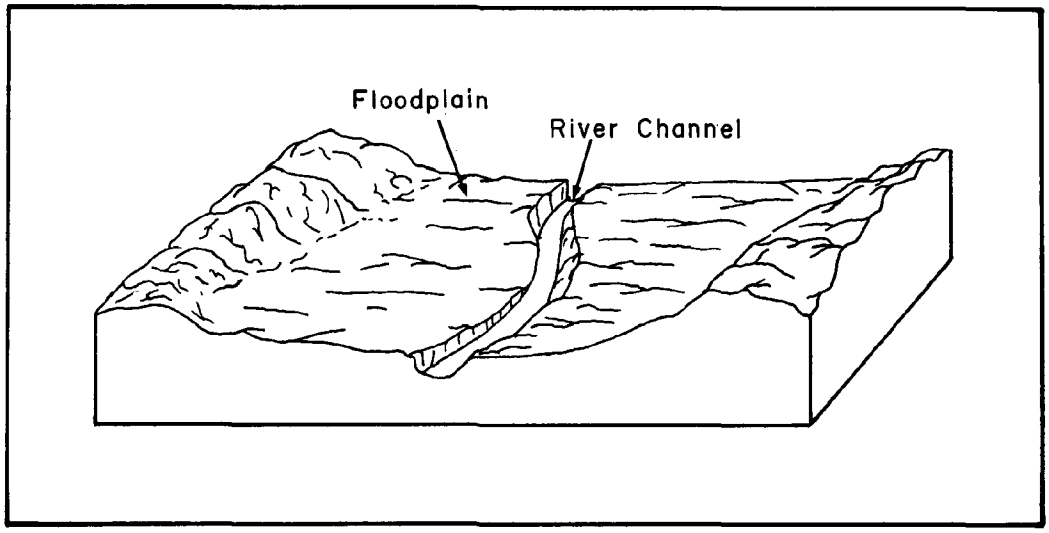


Figure 5-1. A simplified model of the Narrow River channel and floodplain (from Keller, 1975).

2. Concern over flooding in the largely undeveloped northern area is related chiefly to rainfall-runoff events, while flood effects in the lower and middle estuarine areas are compounded by tidal surges entering through the Narrows. According to the most recent FEMA flood insurance maps and town tax maps, more than 900 lots of record are currently located wholly or partially within the 100-year flood zone, with a total structural value exceeding $15 million (Table 5-1). The majority of the houses located in the A zone are in the middle estuarine region, adjacent to the river, and in low depression areas scattered throughout the watershed. Those in the V zone lie in a small area near the rocky headlands at the Narrows.

Table 5-1. Lots of Record Located within the Narrow River Floodzones (data from 1985 aerial photographs and municipal tax records.)

Town	A Zone	V Zone	Estimated Value of Structure
South Kingstown	277	-	$6,817,500
Narragansett	519	5	$10,406,976
North Kingstown	101	-	N/A

N/A - not available

3. Theoretically, a 100-year flood (used as the basis for flood zone mapping and regulation) has a one in 100, or one percent,

chance of occurring in any one year, although two or more 100-year floods, or none, could occur (FIAC, 1985). Planning for such hazardous events is tenuous, at best.

4. The floodplain consists of two distinct areas: the floodway, located in flood conveyance areas adjacent to streams and, the flood fringe, the outer areas subject to lower flood depths and velocities (Figure 5-2). State and local floodplain programs usually prohibit permanent buildings and fills in floodway areas, while permitting a wide range of structural uses in flood fringe areas, if elevated or flood-proofed above the base (100-year) flood level. Within the extent of the floodway area, permitted uses have typically included wildlife sanctuaries, hiking trails, outdoor plant nurseries, etc. (Keller, 1975). In the Narrow River watershed, much of the floodplain has been developed for residential use, with the potential for creating a host of problems in the event of flooding, therefore different regulations must be developed. For example, ISDS, commonly used throughout the watershed, are located within these flood prone areas. In the event of innundation by flood waters, effluent from the ISDS, along with other pollutants, could flush to the surface, thus contaminating the river. The threat of such an occurrence compounds the existing concern over water quality problems.

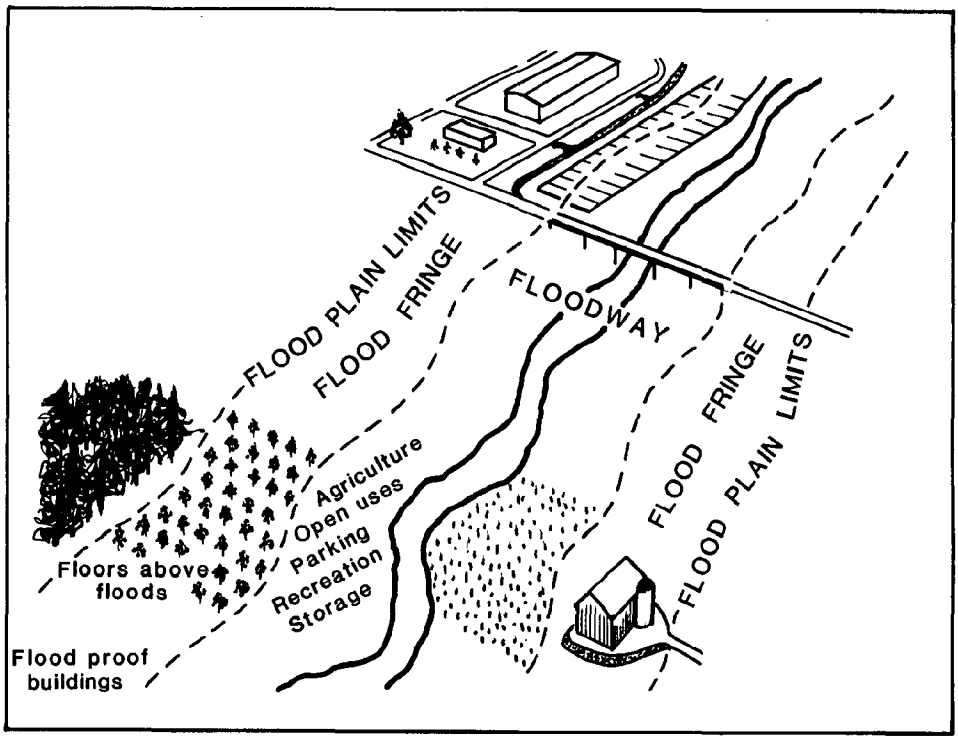


Figure 5-2. Flood hazard areas (Minnesota Department of Natural Resources, Flood Insurance, St. Paul, 1972)

510.2 Occurrences of Past Storm Events

A. Physiographical Characteristics Influencing Storm Events

1. The New England area lies in the path of the "prevailing westerlies" and is influenced by meteorological factors which produce such effects as the tropical hurricanes and coastal storms from the west and southeast. Because of exposure to these climatic effects and due to topographical influences, the river is subject to periodic flooding events.

2. Although a severe storm has not impacted the area in more than 30 years, several of the more than 71 storms to have impacted Rhode Island (Olsen and Lee, 1984) have affected the Narrow River area (Table 5-2). While irregular in occurrence, the average hurricane frequency within Rhode Island has been about once every seven years (Olsen and Lee, 1975). Damages from such storms are caused most often from tidal surge, flooding from heavy rain, action of stormdriven waves, and high velocity winds (Keller, 1975). The location of the Narrow River, within the lower reaches of Narragansett Bay and behind the Narragansett Pier Beach area, reduces its exposure to the direct force of hurricanes and coastal storms approaching the south coast and thus, is somewhat protected.

3. The official hurricane season extends from June through November, however, hurricanes most frequently occur during the months of August, September, and October (Frank, 1985). National Weather Service representatives suggest that the area is long overdue for a major hurricane (McCarthy, 1985).

B. Physical Characteristics Of Hurricanes

1. Hurricanes are powerful, tropical storms, characterized by low barometric pressure, high wind speeds (greater than 74 miles per hour), torrential rain, large waves and swells, and tidal surges. The highest velocity winds associated with hurricanes, known to exceed speeds of 150 mph, occur at points to the right of the storm center. Because destruction by the wind and waves is greatest in this area, it is called the "dangerous semi-circle" (U.S. Army Corps, 1960). A hurricane following a track over Westerly, Rhode Island, 20 miles west of Narragansett Pier, would place the Narrow River within this general area, as was the case during the most recent and severe hurricanes of 1938 and 1954.

2. Large ocean waves, generated by hurricane winds, can travel great distances and reach distant shores one or two days prior to the onset of the hurricane, causing damage even before the full fury of the storm is released. These large waves have caused massive destruction to the dunes along the south shore of Rhode

Table 5-2. Hurricane Events Impacting the Narrow River Watershed (data from archives of the Narragansett Times)

Date	Comments
Aug., 1635*	"...tide rose at Narragansett 14 feet higher than ordinary and drowned 8 Indians..."
Aug., 1638*	"...It flowed twice in 6 hours, and about Narragansett it raised the tide 14 or 15 feet above the ordinary spring tide ..."
Sept., 1815**	"...40 foot waves..., trees uprooted, fences, stone walls blown down...the middlebridge over Pettaquamscutt River was swept away, as water extended from the foot of the hill to a considerable distance up the pasturage..." Several drownings were reported in the cove and river area.
Sept., 1869	"...barns, chimneys, fences, trees whirled about,.. horses killed..., closed tourist season..."
Aug., 1924	(northeaster) "...trees knocked down, roads blocked, utilities cut off, "
Sept., 1938	"...sand dunes between the Dunes Club and Narrow River were leveled...13 cars, school bus,... bodies pulled out of Pier Pond...bathhouses and seawall crushed and carried across Beach Street... 2 cars washed off Boston Neck..., middlebridge washed out...Oct. 21, still clearing debris..."
Sept., 1944	"...high tides as far as Boon Street..."
Aug., 1954	"...buildings in pond on Boston Neck and Ouida... Boston Neck and Beach Street blocked by debris... properties in areas above Beach Street and Narragansett Avenue flooded to depths of more than 6 feet"
Sept., 1960	"...trees blown down..., sand washed over Boston Neck..., 75 mph winds..."
Sept., 1985	"..little rain...high winds, tree limbs, branches blown down..., power lines down..., roof shingles blown off..."

* data from U.S. Army Corps Eng., 1960
** data from Cole, 1889

Island, most notably during the 1938 hurricane. During this storm, the sand dunes behind the Dunes Club in Narragansett were leveled and deposited into the Narrows and the Cove (U.S. Army Corps, 1960). The sediment deposition that occurs during such severe events can cause changes to an estuary not only by creating shoals such as now exist in the Narrows and Pettaquamscutt Cove, but also by altering circulation patterns and the aquatic habitat (Olsen and Lee, 1985).

3. The most threatening element associated with hurricanes is the tidal surge. Surge heights, sometimes extending upwards to 25 feet above mean sea level, combined with forward speeds of 50 mph or greater, could cause immediate inundation of low lying areas (Gordon, 1980). In the Narrow River, the general increase in elevation, proceeding up the estuary, and the constricted shallow nature of the river channel serve to slow the tidal surge and, thus, to protect this area somewhat from the full force of the tidal surge during severe hurricane events.

4. The 1938 and 1954 hurricanes, both arriving within one hour of high tide, produced tidal flood levels of 13.8 and 12.8 feet, respectively, indicating that tidal stage is another important factor of storm events (U.S. Army Corps, 1960). On the west side of Narrow River, in South Kingstown, the flood level during the 1938 hurricane extended across Middlebridge Road to the base of "Torrey Hill" (Rosenbalm, 1986). During the hurricane of 1954, tidal flood levels again reached across Middlebridge Road in South Kingstown, and at least as far as South River Road in the Mettatuxet area of Narragansett (Christensen, 1986). The hurricane of 1944 arrived almost 2 hours before low tide and therefore did not sustain flood levels as high as the other two storms (U.S. Army Corps, 1960). Because much of the watershed is characterized by steep slopes, the amount of shoreline submerged during severe hurricanes is not as great as would be for flat low-lying areas.

5. Coastal winter storms, known as northeasters', are usually large, cyclonic storms representing the same hazards present for hurricanes with the exception of severe rainfall (Gordon, 1980). Although waves from these storms are comparable to those of a hurricane, wind speeds are lesser, usually gale force (40 mph and greater). The cumulative effect of the storm's weaker components can sometimes cause damages exceeding those of a hurricane because of a greater duration at one location (Gordon, 1980). As with hurricanes, the stage of the tide influences the reach of the ocean and the resulting damages. These storms, occasionally driving water levels 6 or 7 feet above mean sea level, have caused overtopping of the seawall at Narragansett Pier, often inundating the adjacent streets with water, sand, and rubble from the beach (U.S. Army Corps, 1960).

510.3 Vulnerability of the Floodplain

A. Damages fom Past Storms

1. According to archives of the Narragansett Times, Middlebridge bridge, constructed of wood, was swept away for the second time by the storm surge (the first washout occurred during the "Great Gale of 1815"). During a peak 2 hour period, the Great Atlantic Hurricane of 1938 caused extensive destruction throughout the Rhode Island coastal region, although actual damage estimates are not available. Hurricane Carol in 1954 produced tidal flood losses amounting to approximately $112,000 to 10 cottages and 2 commercial establishments within the Middlebridge and Bridgetown sections of Narrow River (U.S. Army Corps, 1960). Damage to docks and retaining walls affected nearly 60 summer properties.

2. During the hurricanes of 1938 and 1954, the majority of houses located within the Narrow River floodplain were limited to summer residences. Today, while many of the dwellings are situated in the same general area , most are now year-round residences (Rosenbalm, 1986). Furthermore, during the 32 years which have passed since the 1954 hurricane, many new houses have been built within this high risk zone, most notably in Narragansett (Figure 5-3). Many were built before the 1968 institution of the National Flood Insurance Program and its updated standards for new and/or improved construction. The mid-estuary region experienced the brunt of the damages during the 1938 and 1954 hurricanes and may be expected to receive similar, if not greater, damages in the next severe storm, due primarily to the increase in residential property within the floodplain.

3. Of particular concern when considering floodplain management is the natural storage capacity of floodwaters afforded by the estuary. Like many of the river systems within New England, the Narrow River has extensive wetlands located throughout the estuarine system which function as flood abatement and water storage areas for the watershed (Map 4). These wetlands, which include approximately 350 acres of salt marsh immediately adjacent to the lower reaches of the estuary, act as modifiers for the effects of flooding by trapping and temporarily storing rainfall and surge waters from major storms. During flood-ing events, water covers the marsh in a broad sheet flow through the vegetation, attenuating the effects of waves and flash flooding. Gradual release of floodwaters from these areas reduce flood heights and the subsequent damages (Burby and French, 1985). Also, shrubbery along the periphery of marshes serve to buffer surrounding areas from high winds associated with such events (Diaber, 1986). Alteration of these natural flood abatement and storage areas diminishes the protection afforded to the flood zone and the adjacent areas, thus increasing damages associated with flood events (U.S. Army Corps of Engineers,

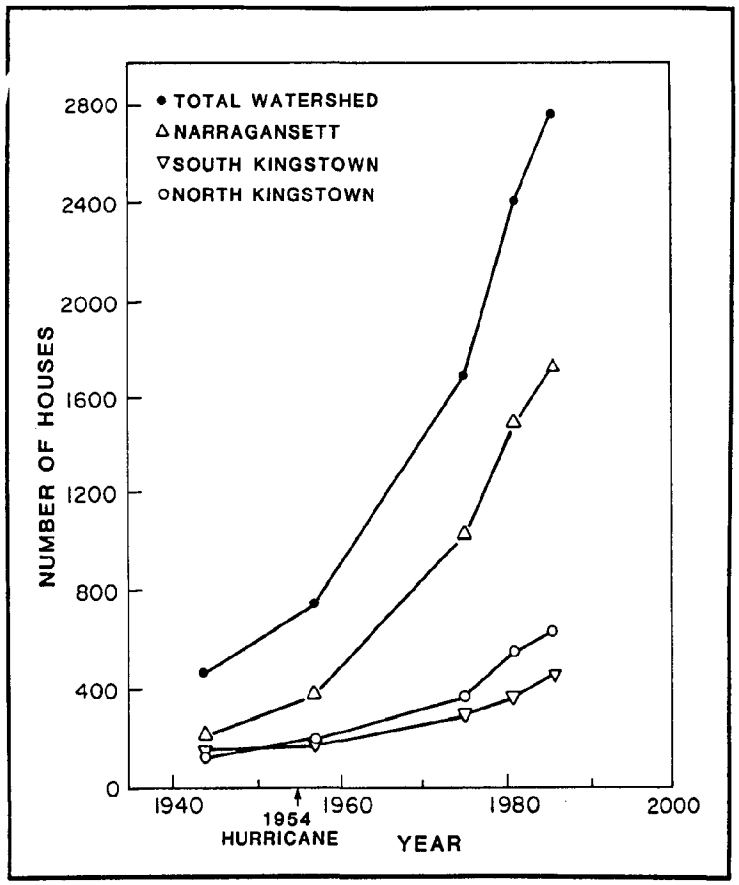


Figure 5-3. Trends in residential development within the watershed since the last major hurricane (1954).

1960). Once lost, these areas cannot be regained, therefore, in the undeveloped floodplains, preservation is a high priority and strong protective measures should be implemented.

B. Potential Damages to the Developed Floodplain

1. Land values along the shoreline of the river, including those susceptible to flooding, continue to command a high price; an average home subject to flooding within the Middlebridge and Mettatuxet areas is currently valued at more than $100,000. Within the 100-year flood zone, major damages to homes and commercial establishments can be expected from river flooding and wind-blown debris. Damage estimates within this area could easily exceed the million dollar mark. Public properties are also at risk and include roads, bridges, and water and sewer lines. Much of the damage could be prevented if hurricane warnings are heeded early, by securing boats and other loose objects. Wave induced effects including boat and dock accumulation can be expected to occur along the river edge. Because the area located in the high hazard zone

is small and does not include structures, it is expected that damages here will be low.

2. Another factor associated with storm events is debris storage and removal. As a result of the hurricanes in 1938 and 1954, massive amounts of debris were accumulated along the coastal areas, creating a major clean-up task (Olsen and Lee, 1984). Major roads such as Tower Hill and Boston Neck Road, as well as local roads, were literally impassable immediately after the storms (Narragansett Times, 1938 and 1954). Scattered debris from structures, automobiles, and other items were deposited during such storms into Beach Pond and the surrounding Pier area (Narragansett Times, 1938). Because increased development and capacity constraints of local landfills may make the removal and subsequent disposal more problematic, sites for storage of debris and removal should be established prior to the next major event.

3. Another factor to be considered in determining future flood levels is the effects of rising sea level which is taking place along the entire eastern seaboard. This phenomena and its consequences are discussed in Chapter VI.

510.4 Storm Hazard Management

A. The National Flood Insurance Program

1. The character of current development within the Narrow River watershed makes this area particularly susceptible to flooding during major storm events. While actual damage estimates for this area exist only for the hurricane of 1954, the level of sustained damages that have occurred indicate a potential threat. The National Flood Insurance Program (NFIP), which provides insurance for flood prone property through the FEMA, was made available in order to alleviate high financial burdens to individuals and local and federal governments by combining flood damage protection with land use/construction performance standards. This program, providing billions of dollars in coverage, has had a strong effect in inducing communities to adopt policies and regulations to reduce property losses from flooding (Burby and French, 1985). Unfortunately, it has also had the effect of encouraging development within vulnerable and high-risk flood zones.

2. All three towns encompassing the Narrow River participate in the NFIP and utilize building codes in accordance with state and federal standards. It remains highly controversial, however, whether the seemingly beneficial financial provisions of the NFIP outweigh the apparent increase in development, particularly within sensitive coastal regions, which has occurred since its institution (Gordon, 1980; Burby and French, 1985).

B. Coordination of Regulating Authorities

1. In the event that a serious hurricane or storm event impacts Rhode Island, the FEMA regional office in Boston is in close contact with the state throughout the disaster. Immediately after the storm, initial damage assessments are determined by the local official in each town and reported to the Governor's office. The FEMA, in conjunction with the Governor's office, will survey and designate those areas severely affected and help coordinate federal disaster assistance programs. At this time, emergency crews will remove debris from roads and begin essential repairs. Subsequently, emergency permits to rebuild in storm damaged areas may be issued by local officials (Lee and Simpson, 1985).

2. Presently, the CRMC, mandated with setting policy and permitting activities in the coastal zone, including debris removal and replacement of public and private facilities, is not formally linked to the state disaster response process (Lee and Simpson, 1985). Because the local officials are responsible for determining the permits necessary for rebuilding, state and local coordination prior to such an event is a critical factor. It is apparent that the CRMC should be formally involved with the FEMA and the Governor's emergency response procedure, which includes local officials, to ensure that immediate intervention occur, thus preventing haphazard redevelopment within the flood prone areas.

510.5 Summary

A. The Narrow River, as a coastal estuary, is particularly susceptible to infrequent, yet damaging coastal storms and hurricanes. Damages from such events are caused by high winds, heavy rains, tidal surge, and consequent flooding. Steady growth within the floodplain of the river has occurred over the past 40 years, with much development occurring before the adoption of standard regulations for construction in the flood-prone areas. While the National Flood Insurance Program has been a major factor in establishing construction standards within these zones, it has also served to provide an incentive for development.

B. Because the floodplain of the lower and middle regions of the river has been developed, natural protective and mitigative barriers have been lost, intensifying the likelihood of severe impacts. Damages which can be expected by storm events include structural losses, as well as contaminant outflow from ISDS and leaching fields. Currently, there are no post-storm restoration policies at the state level which address the reconstruction of areas that may be severely impacted by the next major hurricane or storm event.

520. MANAGEMENT REGULATIONS AND INITIATIVES

Based on Section 510, Findings of Fact, and the goal to preserve and protect the resources of the river, the following regulations and initiatives are deemed necessary:

520.1 Construction Standards in Flood Zones

A. Construction in coastal high hazard flood zones (V zones), as defined by federal flood insurance rate maps, shall follow the regulations as listed in Section 300.3 of the CRMP, as amended.

B. Construction in areas of coastal stillwater flood hazards (A zones), as defined by flood insurance rate maps, shall follow the regulations as listed in Section 300.3 of the CRMP, as amended.

C. Reconstruction After Storms

1. A CRMC assent is required of all persons proposing to maintain or rebuild shoreline structures which have been destroyed 50% or more by storms, tidal surges, or other natural processes which may occur in the Narrow River watershed.

2. Structures shall be rebuilt according to the construction standards required for the flood zone in which the structure is located.

D. Post-Storm Restoration

A feasibility study is currently being performed for the CRMC to determine the most efficient and effective approach for post-storm restoration procedures. Upon adoption of the recommendations, ammendments shall be made to this Special Area Management Plan where applicable and deemed necessary.

E. Debris Removal And Disposal

1. Plans for debris removal and disposal which designate disposal sites for debris should be established, recognizing the capacity constraints of local landfills and the prohibition of debris in the wetlands. Temporary storage sites shall be identified and should be located conveniently near areas where large amounts of debris are expected to accumulate. These sites should be listed with local and state civil defense offices as part of the coordination process.

2. Sites along the Narrow River that might be considered include:

(a) DEM boat launch @ Mitchell and River Court
(b) DOT scenic overlook/parking areas @ Sprague Bridge
(c) DOT commuter lot @ Tower Hill Road
(d) Narragansett Pier Town Beach parking lot

520.2 Controls For Protection of Flood Prone Areas

A. Flood Storage Areas

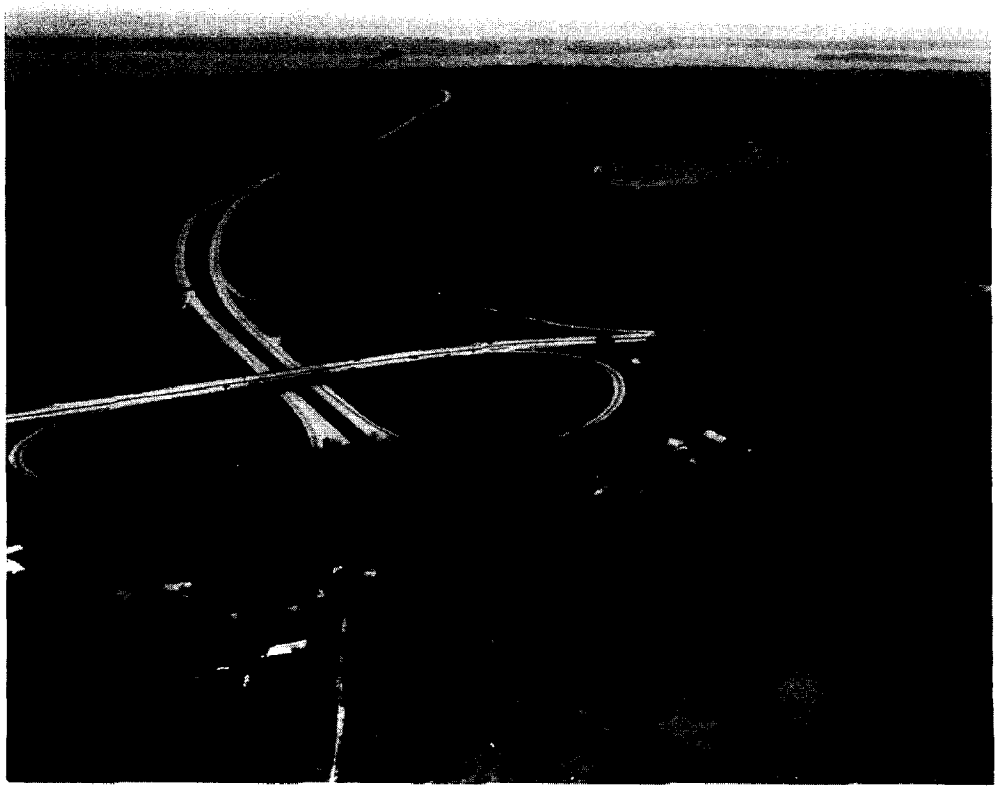
Wetlands which are significant in shielding flood-prone areas from storm damage, particularly those salt marshes surrounding the Cove and the lower reaches, are priorities for preservation in their natural state as primary flood abatement and storage areas by utilizing such techniques as buffers zones, conservation easements, and/or aquisition programs.

B. Coordination of Regulating Authorities

Upon occurrence of a damaging hurricane, the CRMC and the local municipalities throughout the coastal region may be faced with a workload of thousands of permits for private and public reconstruction within the 100-year flood zones and possibly more within the adjacent flood-prone areas. Regulatory policies should be established prior to such an event to ensure that local emergency permits for reconstruction be coordinated with the CRMC permitting process.

Chapter Six.

Impacts of Planned and Future Projects



610. FINDINGS OF FACT

610.1 Dredging

A. History of Dredging in the Watershed

1. Dredging is the removal of submerged materials by hydraulic or mechanical means to create or maintain waterways or to mine material for fill, construction aggregate or other commercial purposes. Regulation and permitting of dredging activities throughout the United States is monitored by the Army Corps of Engineers. The New England Division is responsible for those projects which concern the Narrow River and has been requested many times in the past, by local town officials and state legislators, to perform feasibility studies for dredging some part of the river. The first official request came in 1871, the latest in 1971; no project has ever resulted.

2. Collapse of the majority of the project proposals came as a result of lack of funding by the individual towns, a general wane in public interest, and more recently, intense public opposition as evidenced by the latest public hearing held by the Corps of Engineers on May 27, 1971:

"proponents for improvement requested 20 foot wide channels four feet deep throughout the area, and a rock jetty at the entrance...others only wanted spot dredging to be done by the local communities, a very large number of individuals stated they were not in favor of any dredging...others said they wanted the study, but not the Corps of Engineers..."

3. The impetus behind the many requests for dredging projects lies in the fact that the Narrow River is not amenable to heavy boat traffic or very large vessels. The Narrows, sinous in form, is 150 feet (45 m) wide at mean high water, with depths ranging from less than a foot (0.3 m) to approximately 8 feet (2.5 m). Submerged boulders and rocks near the entrance can only be detected at low tide. Currents in the Narrows are strong and variable; the Corps of Engineers reports measurements of 2 to 5 knots (1 to 2.5 m/s). The Cove region, although very wide, is extremely shallow; navigation is restricted to the natural distributary channels during the flood stage of the tide. In the central reach of the river, between Middlebridge Bridge and Bridgetown Bridge, the width attains a maximum of only 60 feet (20 meters), and depths average 3 feet (1 meter). The two bridges, with clearances less than 10 feet (3 meters) at mean low water, prohibit sailing vessels and large craft from travelling upriver.

B. Dredging Impacts

1. Economic gain is the principle incentive behind a large number of dredging projects. Dredging for the purpose of mining, creating channels, anchorages or marinas, are all expected to yield financial benefits (LaRoe, 1977). It has only become apparent in the past decade, with the realization that a relatively small segment of the population truly benefits from dredging activities, that the often irreplaceable loss of a worthy public resource can be much greater than the anticipated revenue from these proposed projects (LaRoe, 1977).

2. The adverse environmental impacts, both long and short term, of dredging activity has been well-documented for many years. The most catastrophic of all dredging impacts is the total obliteration of a specific area which has provided a habitat for a species vital to the function of the ecosystem (Chapter IV). Second in impact to the complete loss of habitat, is the actual process of dredging, which disturbs and disperses large quantities of sediment, often reaching far beyond the the project boundaries. The resuspension of sediments increases turbididty which degrades water quality and primary produtivity (Ingle, 1952; Kaplan, 1974). Sediment can settle and smother sea grass beds and shellfish beds, clog the gills of fish, and alter the character of the bottom substrate (Saila, et al., 1972; Carriker, 1967).

3. Estuarine sediments can act as a trap for a variety of pollutants, nutrients, trace metals and pesticides, absorbing them onto individual particles which settle and eventually are buried with time. Dredging can resuspend these pollutants, again degrading water quality, and posing a severe threat to shellfish, finfish, and other organisms. Reintroduction of nutrients can increase productivity and trigger eutrophic conditions, resulting in blooms and associated hazards (Biggs, 1968; Sabba Rao, 1973; LaRoe, 1977). Resuspension of reduced (low oxygen) sediments can alo deplete the ambient oxygen supply available to other organisms (USACOE, 1973; LaRoe, 1977). Increased turbidity, resuspension of pollutants and decreased oxygen are all relatively short term effects. Long term effects include changes in circulation, flow, and flushing patterns, which can alter the salinity, dissolved oxygen level, temperature, and sediment and erosion patterns, disturb habitats, wipe out non-motile species, and force motile species to move to other regions.

4. Creating deeper channels, through dredging techniques, reduces the surface area of shallow substrates available for colonization by light requiring SAV and algae. These species normally function as a food source to other organisms; SAV also provides valuable nursery and hatchery functions for fish and in-

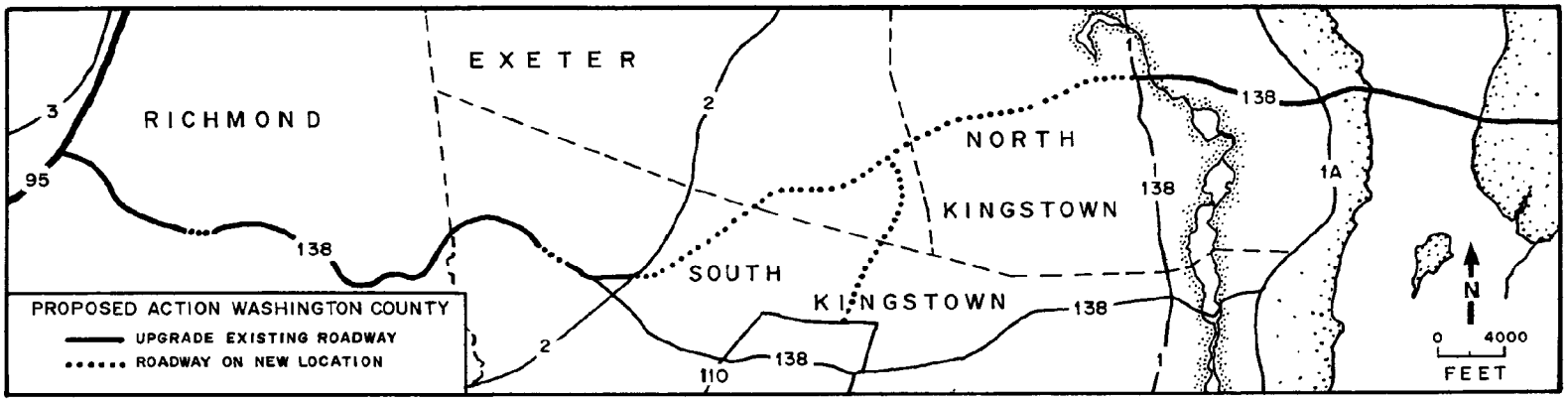


Figure 6-1. Planned alterations to Route 138. New construction and upgrading extend from Route 1, in the Narrow River watershed, to Interstate Highway 95 (From R.I. DOT, 1984).

vertebrate species (Chapter IV).

5. The ecological impact of dredging vary from site to site (Saila, 1980). Because the Narrow River is such a small, sensitive estuary (Chapter III), it is generally thought that changes wrought by dredging may have a more immediate and readily observable impact than in a much larger estuary. The accumulation of a series of stresses may result in a loss of biological productivity, diversity, and desirable or rare and endangered species (Chapter IV); increase the amount of trash species and; ultimatley destroy the biological system (LaRoe, 1977).

610.2 Road and Bridge Alterations

A. Route 138 Extension

1. Much concern has focused on the planned extension of Route 138 westward from its present termination point in the northern portion of the watershed. The extension will connect Route 138 to Route 2 in South Kingstown, creating a more direct path to Interstate Route 95 (Figure 6-1). The plans for the extension require new construction of a four-lane highway in the headwaters region of the Narrow River. This poses several threats to the watershed, primarily, increases in surface water runoff and associated roadway pollutants and the subsequent deterioration in water quality. Hoffman and Quinn (1985) have found that road runoff, transporting trace metals, oils, tar, gasoline, and sediment particles, is a major source of pollution to Narragansett Bay. Further, salts applied during winter snow and ice storms may also contaminate groundwater and freshwater ponds. Additional threats to the watershed include loss of critical habitat and desirable wildlife species, and the high aesthetic and scenic qualities of the region.

2. A final Environmental Impact Statement (EIS) has been issued by the Rhode Island Department of Transportation (1984). However, several issues continue to generate questions of concern, including the location of the groundwater recharge zone relative to the extension, the nearness of a fragile plant community, and the close proximity of the highway to Pendar Pond (one of several ponds which discharge freshwater into the Narrow River) and the related wetlands.

3. Figure 6-2 shows the location of the groundwater recharge zone with the extension of Route 138 superimposed. Groundwater recharge zones are important water resources, providing a surface through which rainfall can percolate and "recharge" the aquifer, ensuring an ample supply of water for the region (Wilson, 1977). Figure 6-3 is the final plan of the proposed extension relative

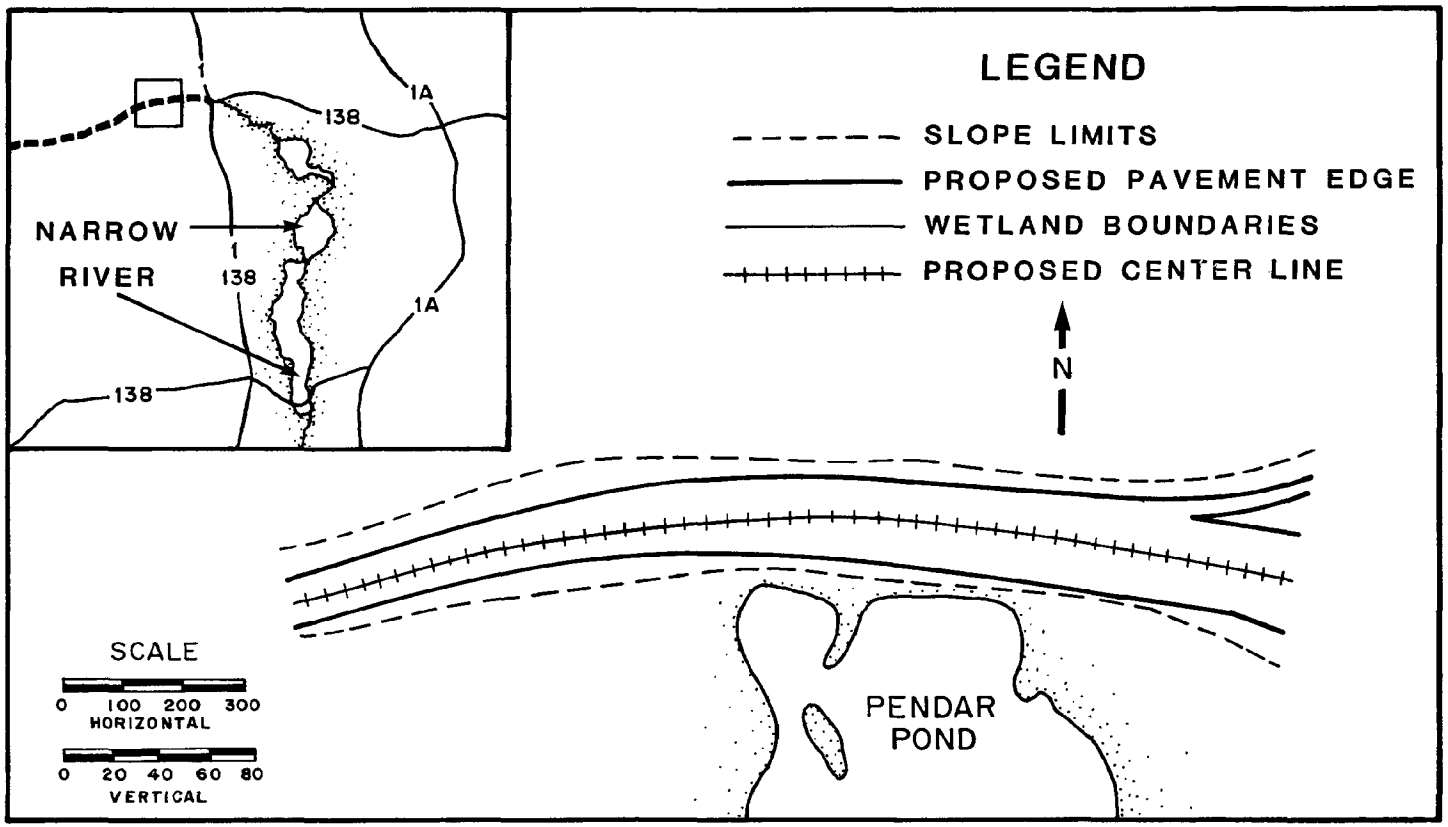


Figure 6-2. Location of the proposed construction of Route 138 relative to Pendar Pond (From R.I. DOT, 1984).

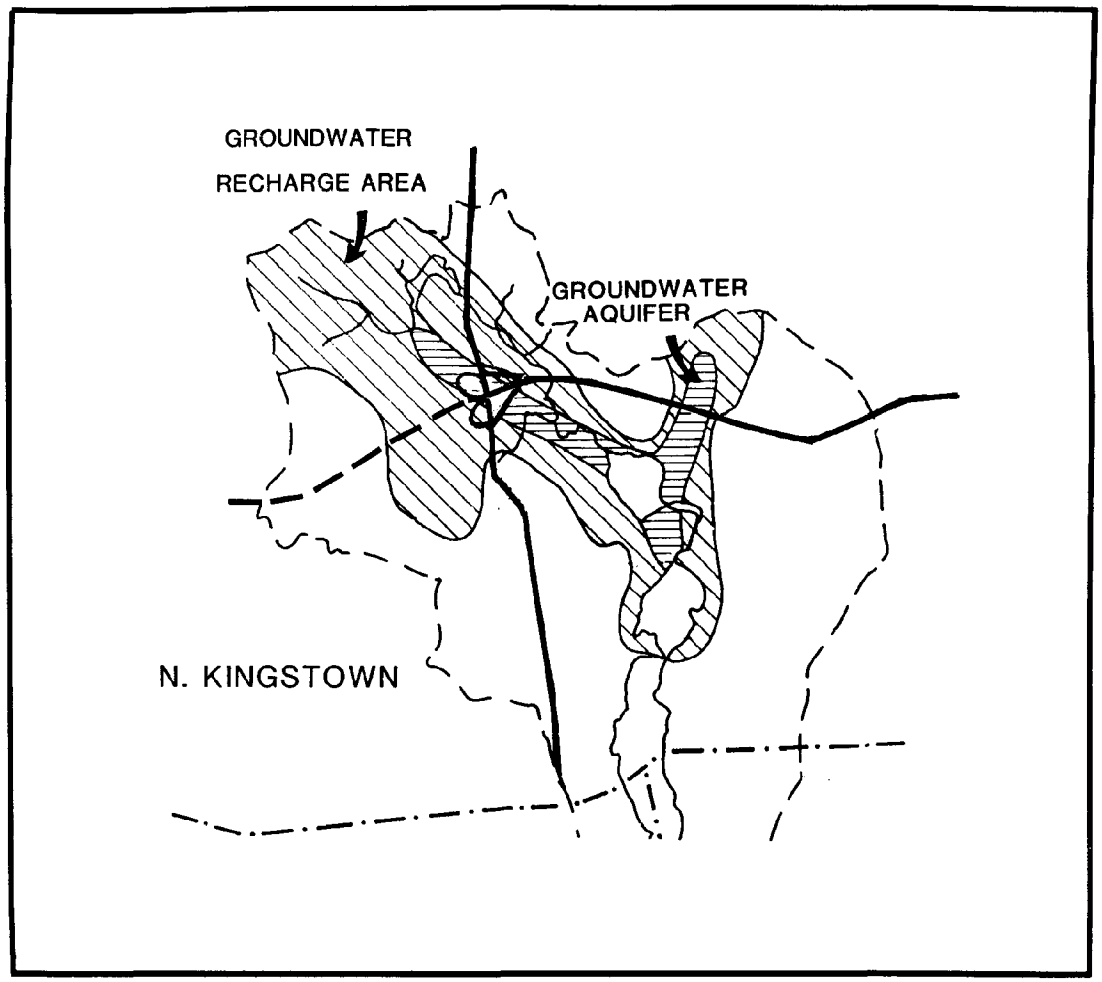


Figure 6-3. Location of the groundwater recharge and aquifer in the headwaters region with Route 138 superimposed. Solid line indicates existing road; dashed line represents planned extension (Johnson and Marks, 1959).

to Pendar Pond. The highway edge is less than 100 feet from Pendar Pond. Chapter III, Section 310.5, discusses the importance of maintaining an adequate buffer width between upland construction projects and receiving water bodies. The proximity of the road to the pond raises serious concerns and suggests that adequate mitigative techniques be employed to ensure that adverse impacts are avoided.

5. The wetland through which the extension traverses supports a small stand of ferns, composed of approximately twelve different species. This stand, referred to as Fern Glen, is considered unusually diverse and productive, and is included in a survey of significant open space sites by the Audubon Society of Rhode Island (1983). Although, none of the species which compose Fern Glen are rare or endangered, the concentration of all of these species in a single stand is a noted feature of the region. Unfortunately, just consideration is not given to unique areas, and thus, this irreplaceable amenity is imminently threatened.

B. Route 1A (Boston Neck Road) Project

1. Route 1A coincides with the eastern boundary of the watershed. It follows the top of the eastern ridgeline, from which drainage to the west ultimately enters the Narrow River. This road, one of the major roads within the town of Narragansett, is currently a two lane heavily travelled .. page break for figure 6-2 corrider, which provides access from the northern urban areas to the coastal communities and beaches.

2. This road is slated for rehabilitative work by the Rhode Island Department of Transportation, and specifically requires structural and planned drainage, where none presently exists. The original DOT proposal called for utilization of drainage pipes located near the road and currently in use by the local neighborhoods (Collins, 1986). The increased volume of surface water runoff, the potential increase in the amount of pollutants entering the river, and other associated negative effects (Chapter III) could have seriously countered the effective restoration of water quality.

3. However, consideration of the adverse impacts on the Narrow River, has led to modifications to the proposal, reducing the amount of runoff to the watershed (Brown, 1986; Narragansett TImes, 1986). The intergovernmental consultation process which led to the modification and incorporation of water quality concerns, exemplifies how major projects should be assessed. Cumulative and direct impacts to the natural processes of the watershed, and implementation of mitigative techniques must be considered and evaluated at the beginning of major projects, cognizant of the various interests involved.

C. Bridge Alteration and Reconstruction

1. Several bridges and causeways have been constructed, or reconstructed, along the Narrow River over the past several hundred years. The bridge at Middlebridge has been the subject of many debates regarding its potential effects on the hydrodynamics of the river. This bridge, last reconstructed in 1954, consists of a filled causeway with a short span (Gaines, 1975). The causeway, extends outward into the river, forcing an unnatural constriction in the river width. This constriction decreases the cross sectional area through which the water flows, subsequently, increasing the velocity of the current. Deflation features (delta-like sand bars) can be observed on either side of the bridge where the currents slow, dropping the sediment load picked up at faster velocities.

2. Suggestions have been made regarding reconstruction of the bridge, particularly, the elimination of the causeways which extend into the river. It is believed that doing so would help the flushing character of the river and alleviate the water quality problems which have prevailed over the years. However, reconstruction of the bridge could have more complex consequences than anticipated and may not be the solution to water quality concern. Increasing the cross-sectional area, by removal of the causeway, will only serve to decrease the current speeds in the immediate vicinity. The net flushing from the river may not change at all, since these rates are primarily a function of the influx of water to the system.

610.3 Sea Level Rise

A. Gasses, such as carbon dioxide, chloroflourocarbons and methane, which reside in the atmosphere, absorb much of the sun's infrared radiation. These gasses, warmed by radiation, radiate energy back to the earth, thus raising its temperature. The larger the percentage of infrared radiation blocked by the atmosphere, the warmer the earth's surface temperature. As the gas content of the atmosphere continues to increase, "the greenhouse effect" (Charney, et al., 1979; Keeling, Bacastow, and Whorf, 1982) of global warming will continue. As temperatures rise, thermal expansion of sea water, melting of mountain glaciers, and meltwater runoff from Antarctica will cause sea level to rise (Hoffman, et al., 1983; Meier, 1984; Revelle, 1983; Thomas, 1985). The anticipated rise in sea level is expected to be between 4.8 feet (144 cm) and 7 feet (217 cm) by the year 2100 (Hoffman, et al., 1983). Along the east coast of the United States, this rise is expected to be slightly higher due to local subsidence (Hoffman, et al., 1983).

B. The rise in sea level is expected to produce a variety of adverse

impacts. As seawater encroaches on the coastline, beaches and coastal marshes will be lost due to increased erosion and innundation; flooding problems will increase, particularly as vulnerable inland areas are approached; freshwater marshes will be lost; and saltwater intrusions will extend further inland, possibly contaminating groundwater aquifers and private wells. Many communities are ignoring these potential impacts by continuing to build in coastal flood prone areas and near marshlands (Titus, et al., 1984). It is possible, through adequate planning and timely decisions, to alleviate adverse impacts of sea level rise (Hoffman, et al., 1983).

C. In the Narrow River watershed, the implications of rising sea level need to be more fully understood before preventive measures can be undertaken. Information gained from archeological excavations have demonstrated that the Narrow River is dissimilar from other estuaries located along the Atlantic Coast. Because of its right angle morphology relative to the ocean, and its steepening slope in the northward direction, transgression of the sea was severely curtailed (Cox, et al., 1983). Figure 6-4 shows the extent of sea level rise horizontally along the Narrow River and the Taunton River, an estuary considered typical of southern New England. The Taunton River lost 23 kilometers of its ength, whereas, the Narrow River only lost 3.5 kilometers in the very final stages of the last marine transgression (Cox, et al, 1983). Gaines (1975), however, states that there may have been a possible increase in the surface area of the upper basins as a result of rising sea level, suggesting a greater impact.

610.4 Summary

Several potential future projects and events exist which threaten to adversly impact the Narrow River watershed. These include dredging and disposal activities, construction and reconstruction of several roads and highways, alteration of existing bridges and the rise in sea level. The projected outcome of these projects could result in catastrophic and irreversible losses of a valuable resource to the surrounding communities. The vulnerability of the Narrow River has been well documented in the preceeding chapters. Hasty decisions and lack of anticipation of future impacts could expose the Narrow River to unwarranted degradation.

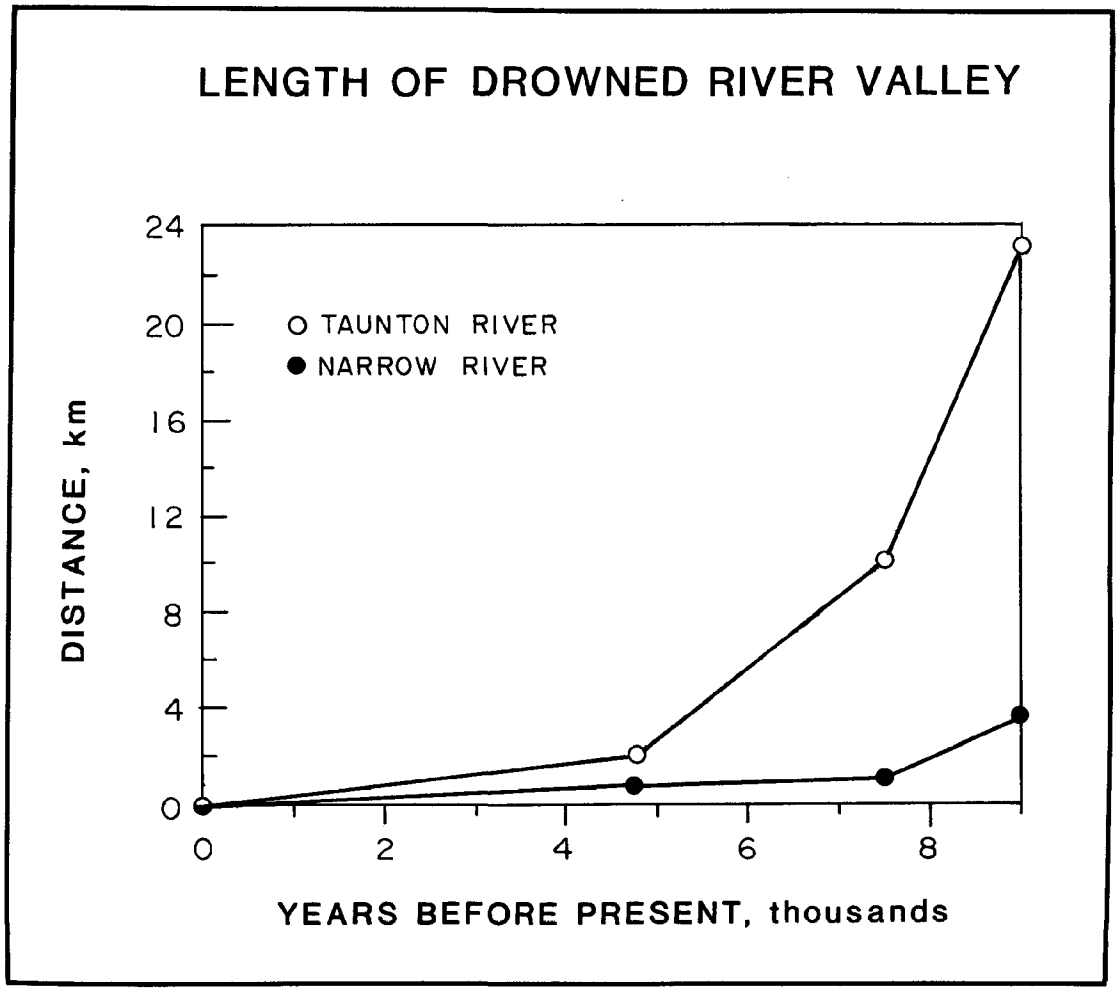


Figure 6-4. Comparison of the length of river basin drowned by the rise in sea level in two southern Rhode Island Rivers (Cox, et al., 1983).

620. MANAGEMENT REGULATIONS AND INITIATIVES

A. Structural and Mechanical Alterations

1. Dredging and disposal activities are prohibited in the Narrow River watershed in accordance with Section 420.1D.

2. Major road, highway, and bridge projects within the watershed should be reviewed by the CRMC to assess direct and cumulative impacts on coastal resources.

B. Areas with Special Consideration

1. All structural and mechanical alterations proposed within the watershed should include in their environmental considerations the aesthetic value of the region.

2. Efforts should be made to incorporate consideration of areas or resources judged to be significant by organizations other than state agencies.

C. Future Research

1. It is recommended that before any action be performed on alterations to Middlebridge Bridge that a feasibility study be undertaken to determine the potential environmental impact.

2. A study should be conducted which would consider the potential future impacts on the Narrow River Watershed from the predicted rise in sea level.

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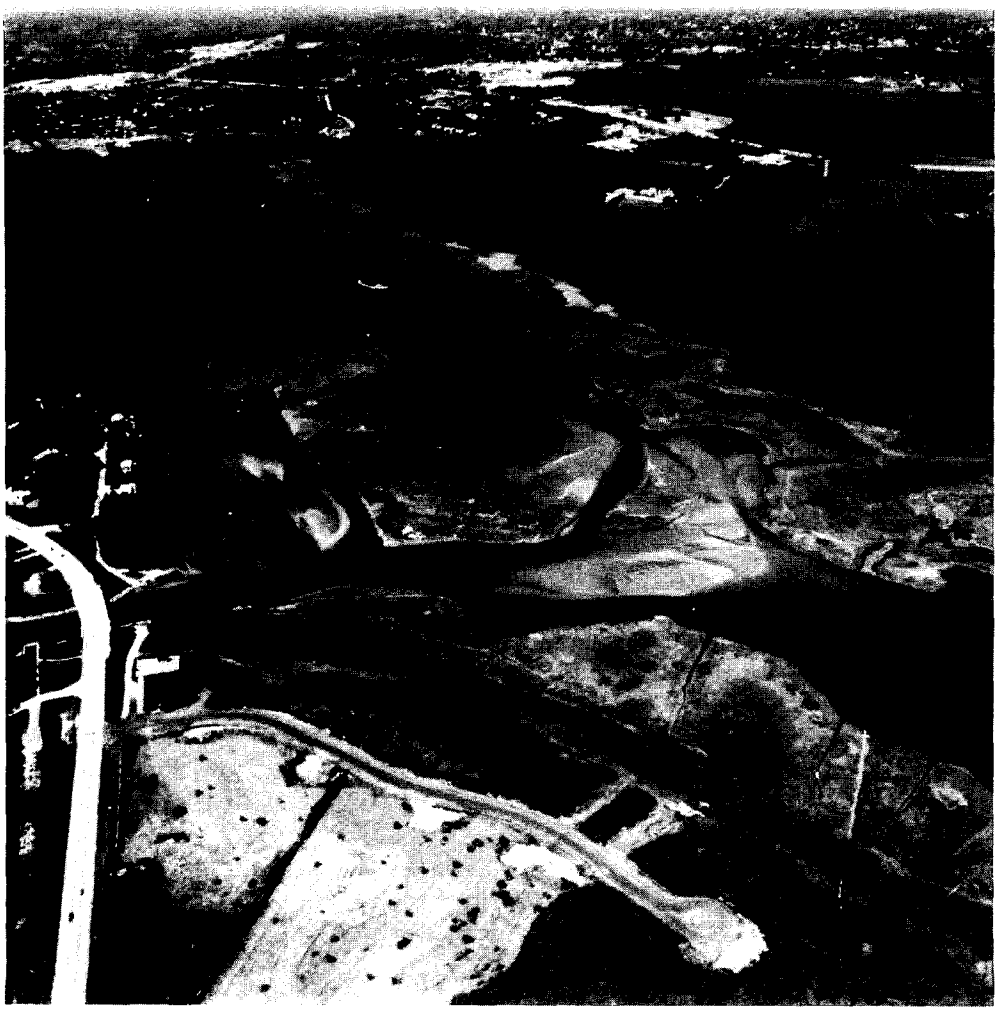

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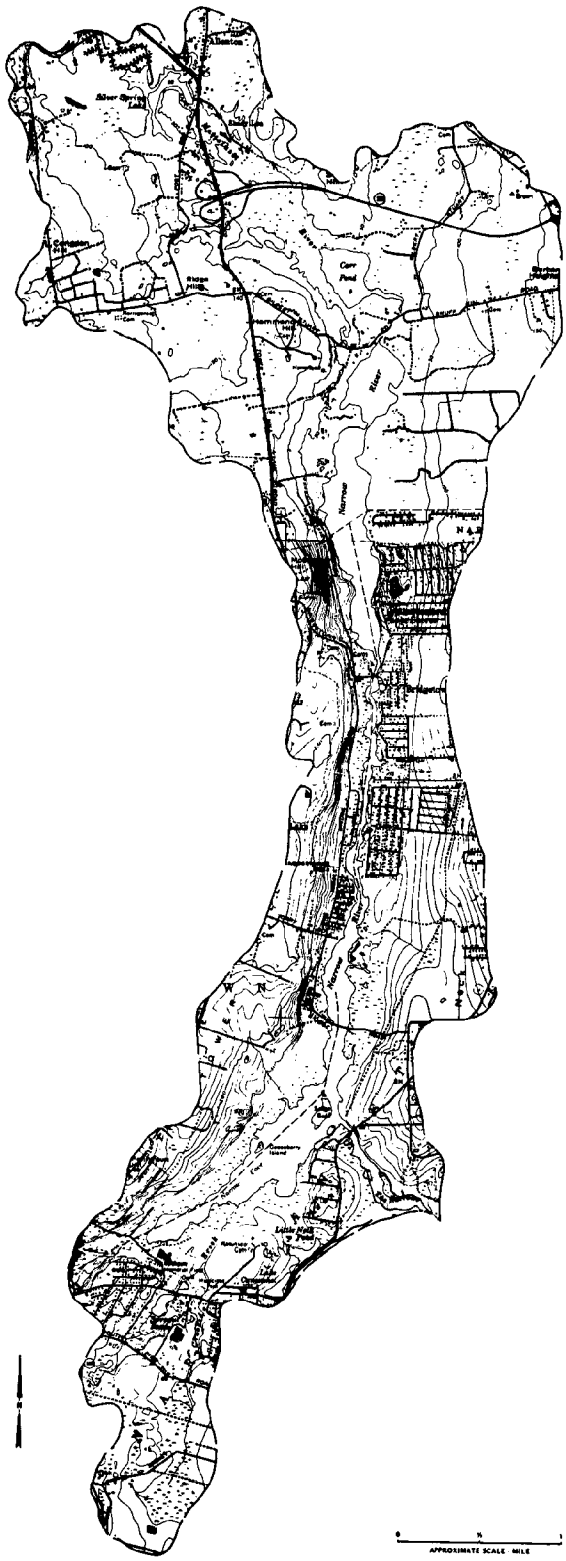
Appendix

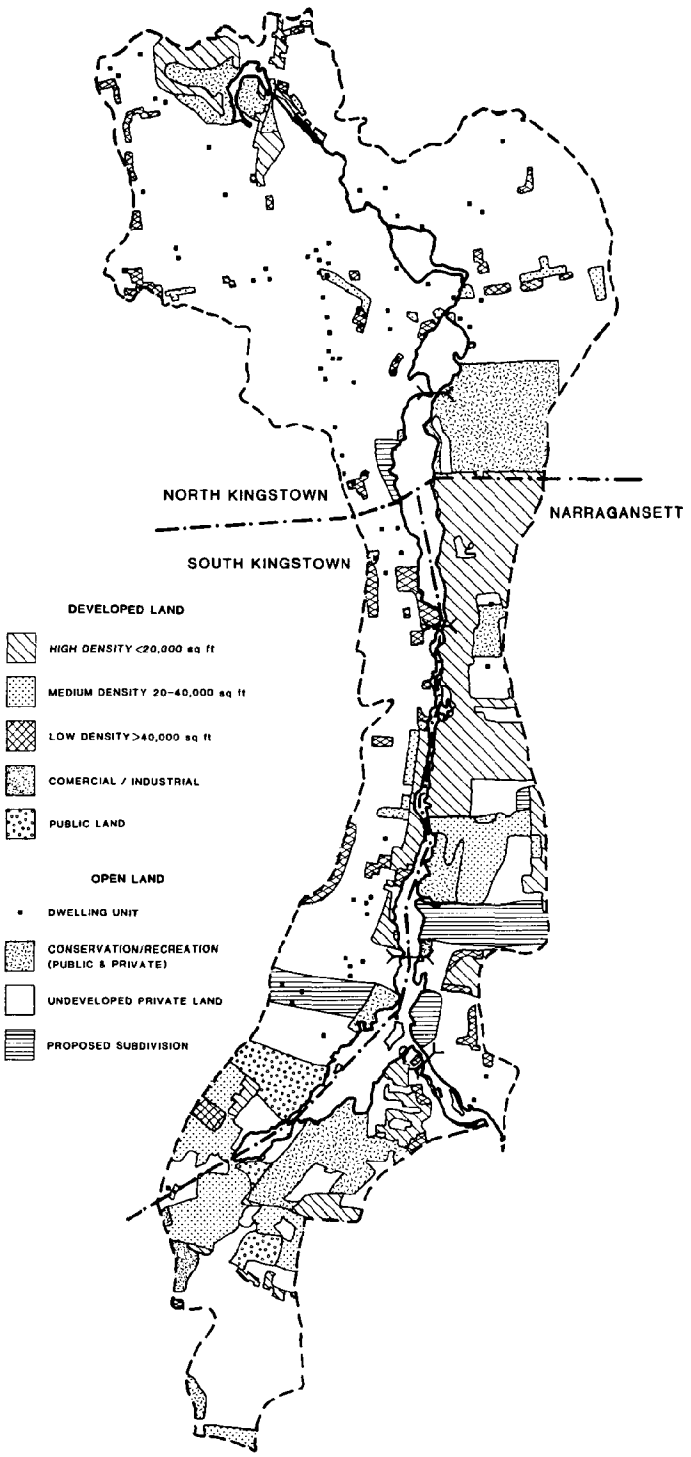
APPENDIX A
Watershed Maps

The following maps are meant to serve as general guidelines for describing the character of the Narrow River watershed. All information is subject to field confirmation by CRMC staff for regulatory purposes.

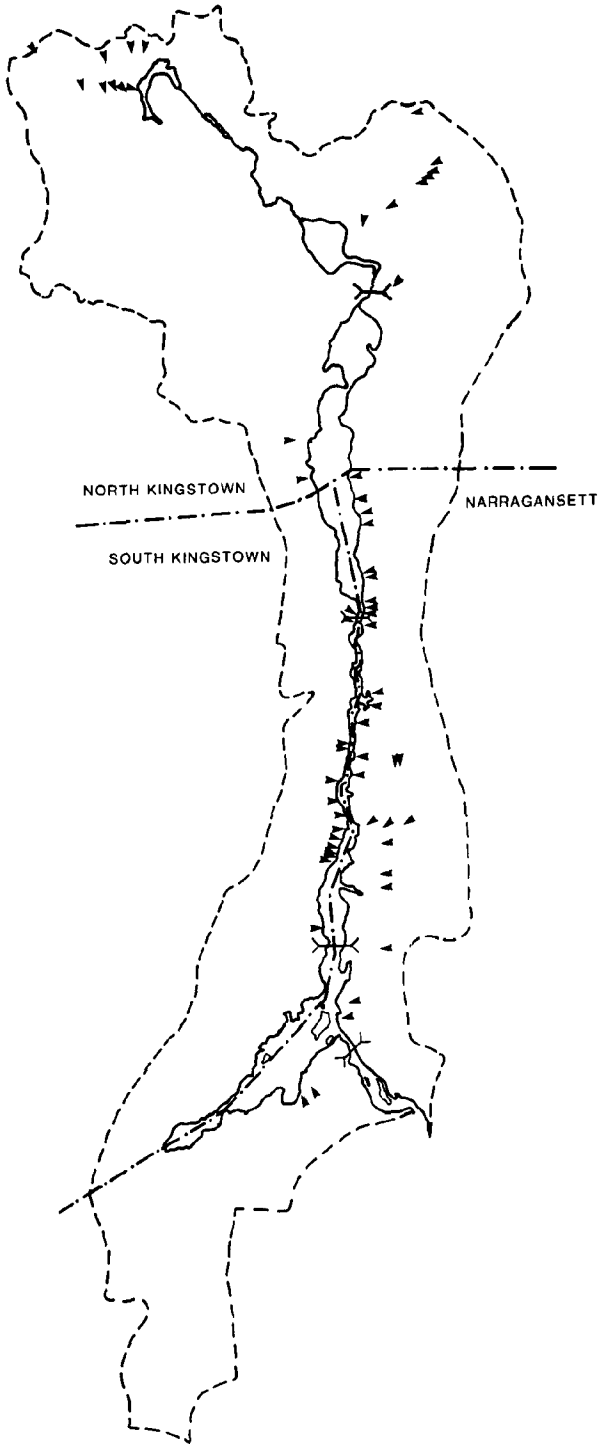
MAP 1 WATERSHED LOCATION



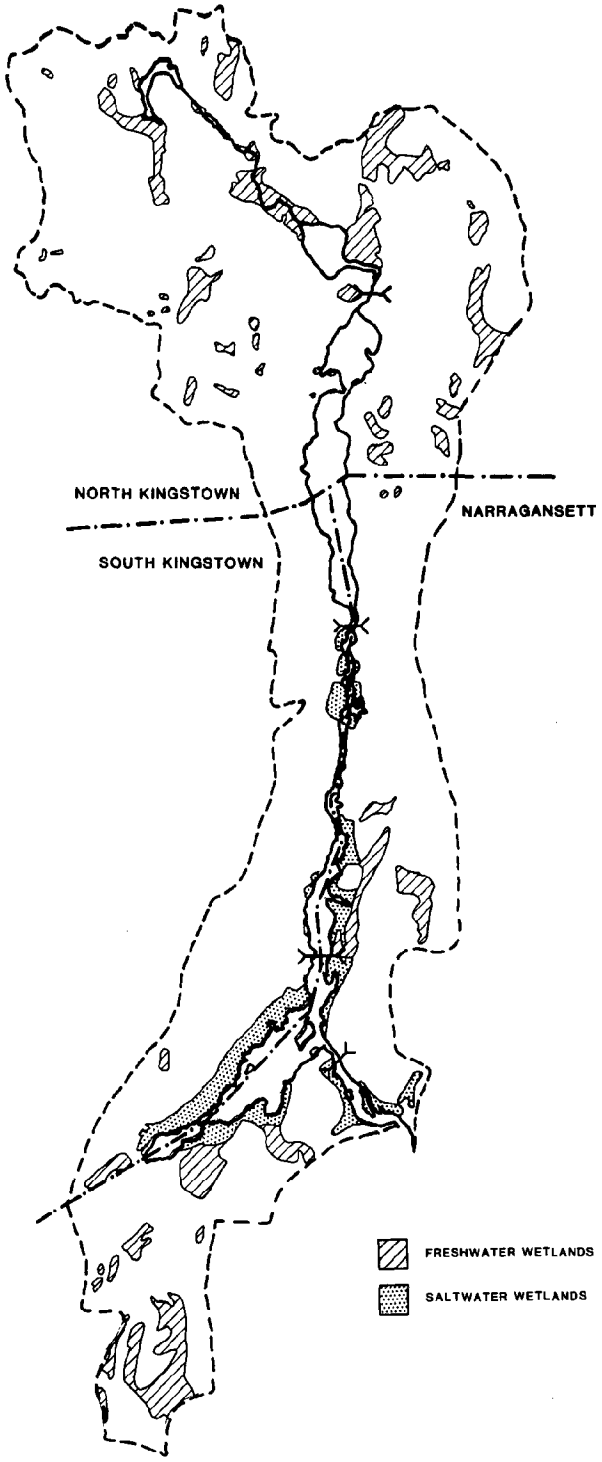
MAP 2 EXISTING LAND USE



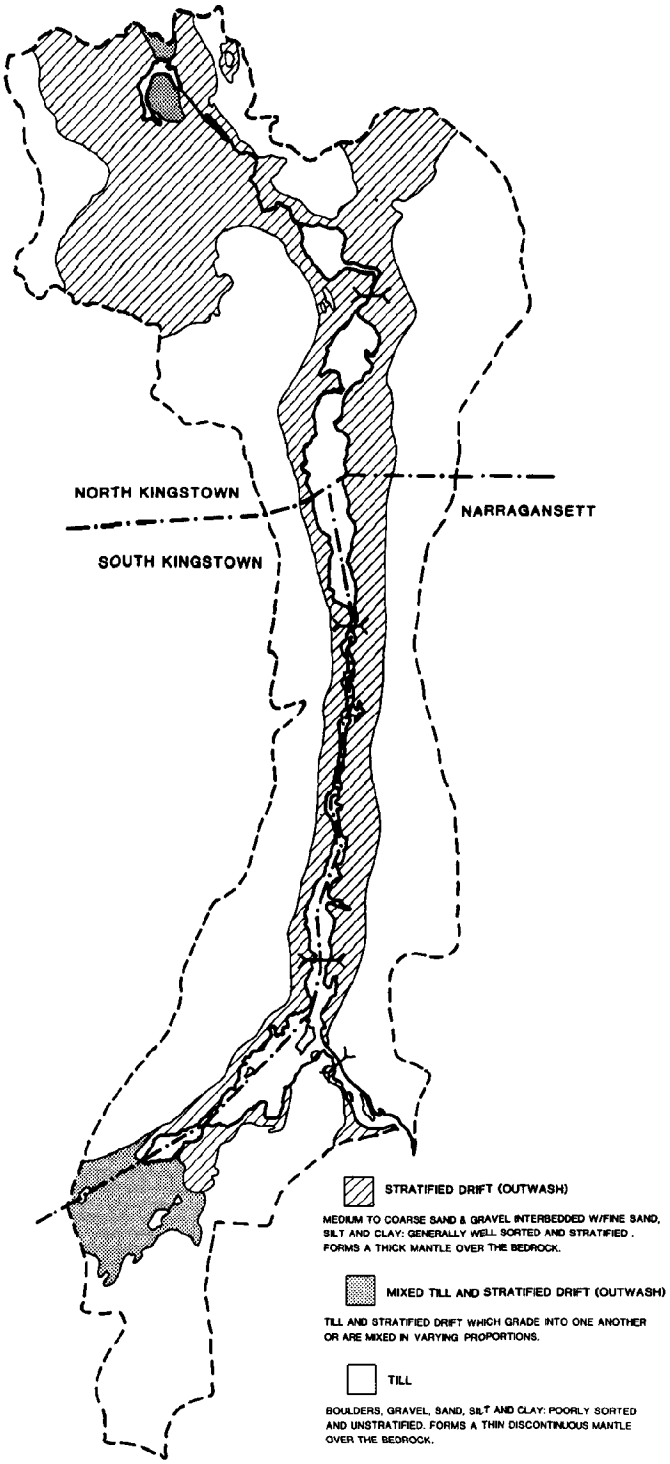
MAP 3 STORM DRAIN OUTFALLS



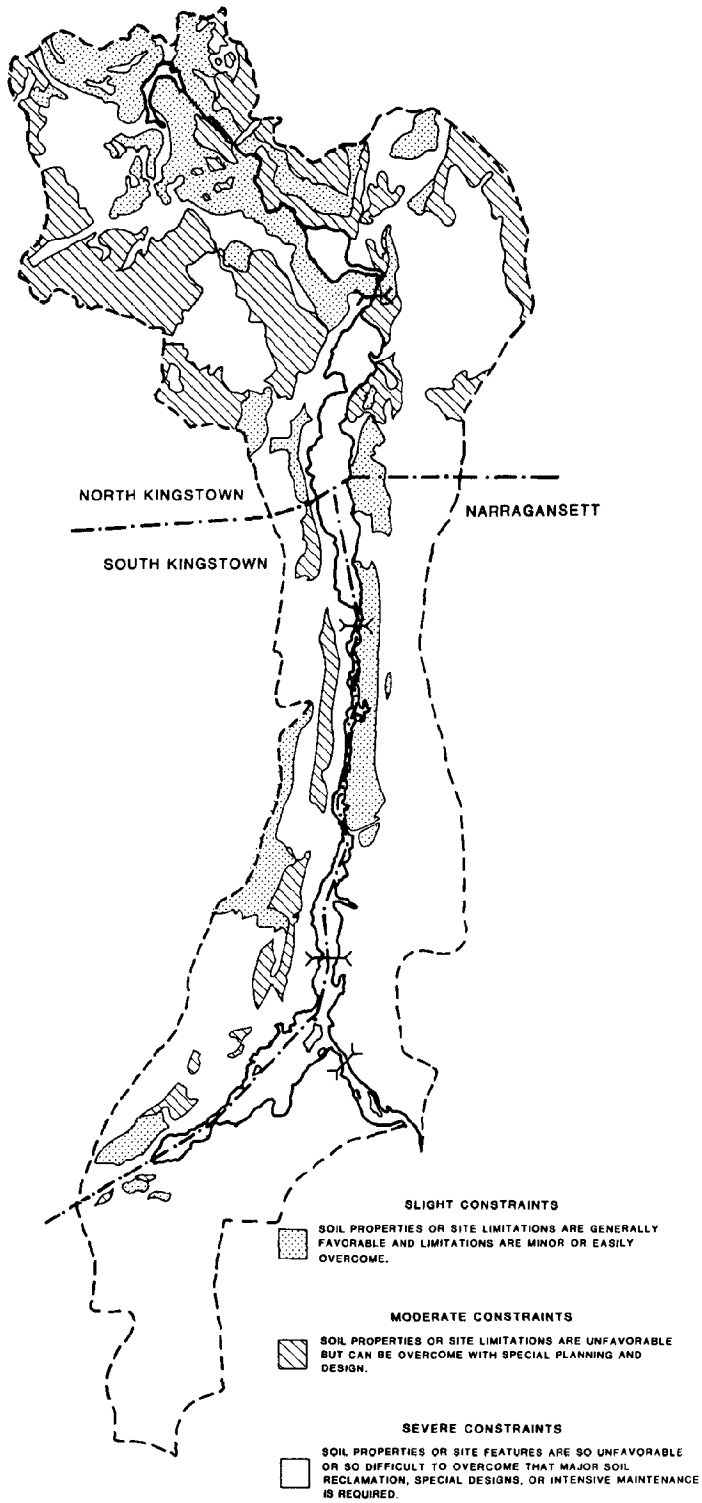
MAP 4 WETLANDS



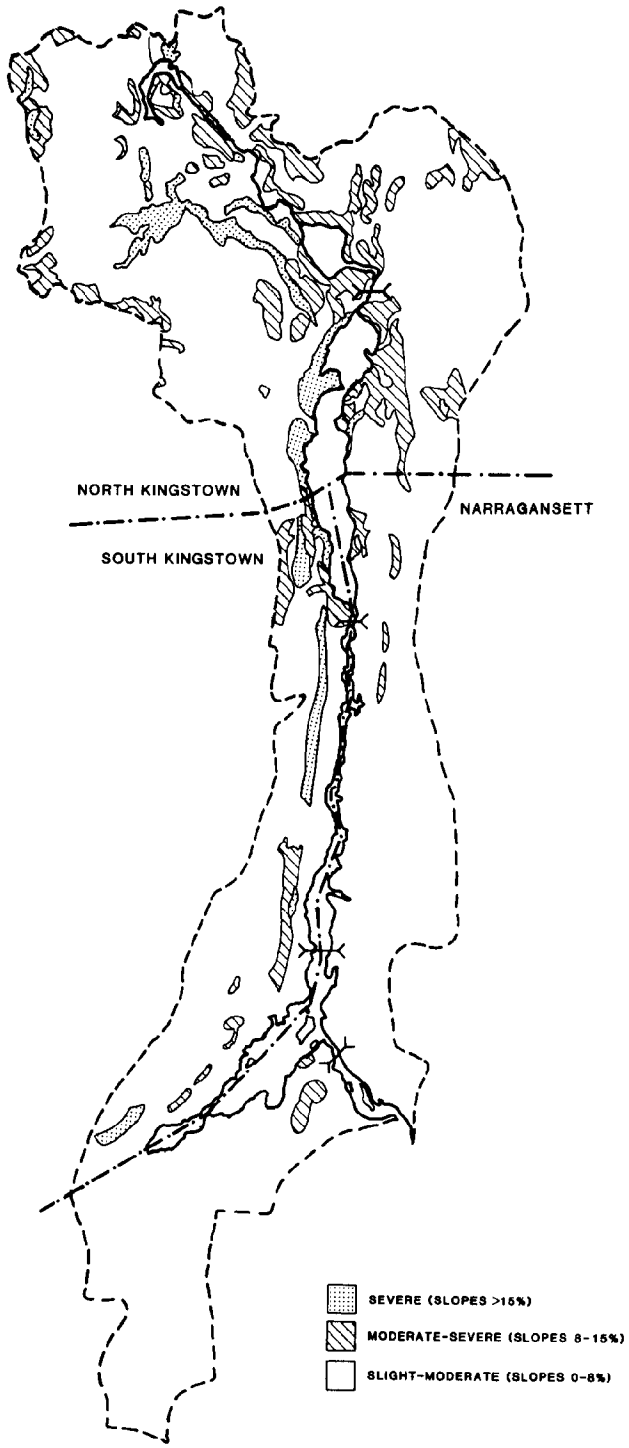
MAP 5 SURFICIAL GEOLOGY



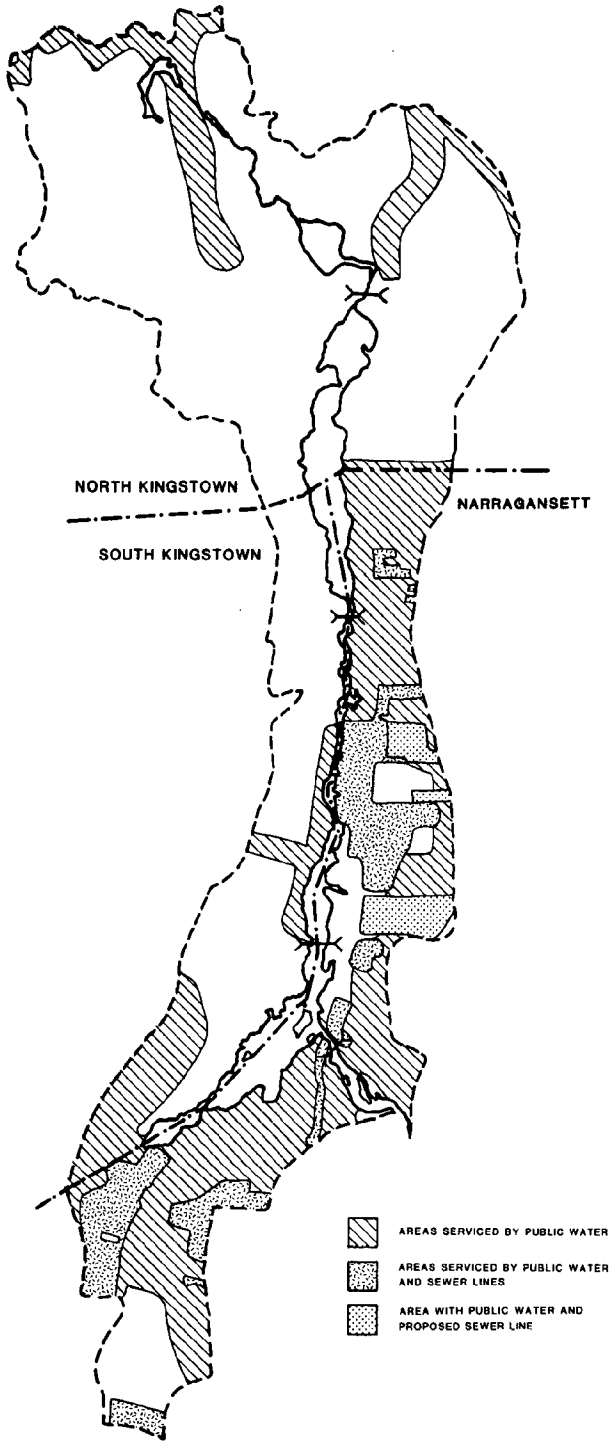
MAP 6 SEPTIC SYSTEM CONSTRAINTS



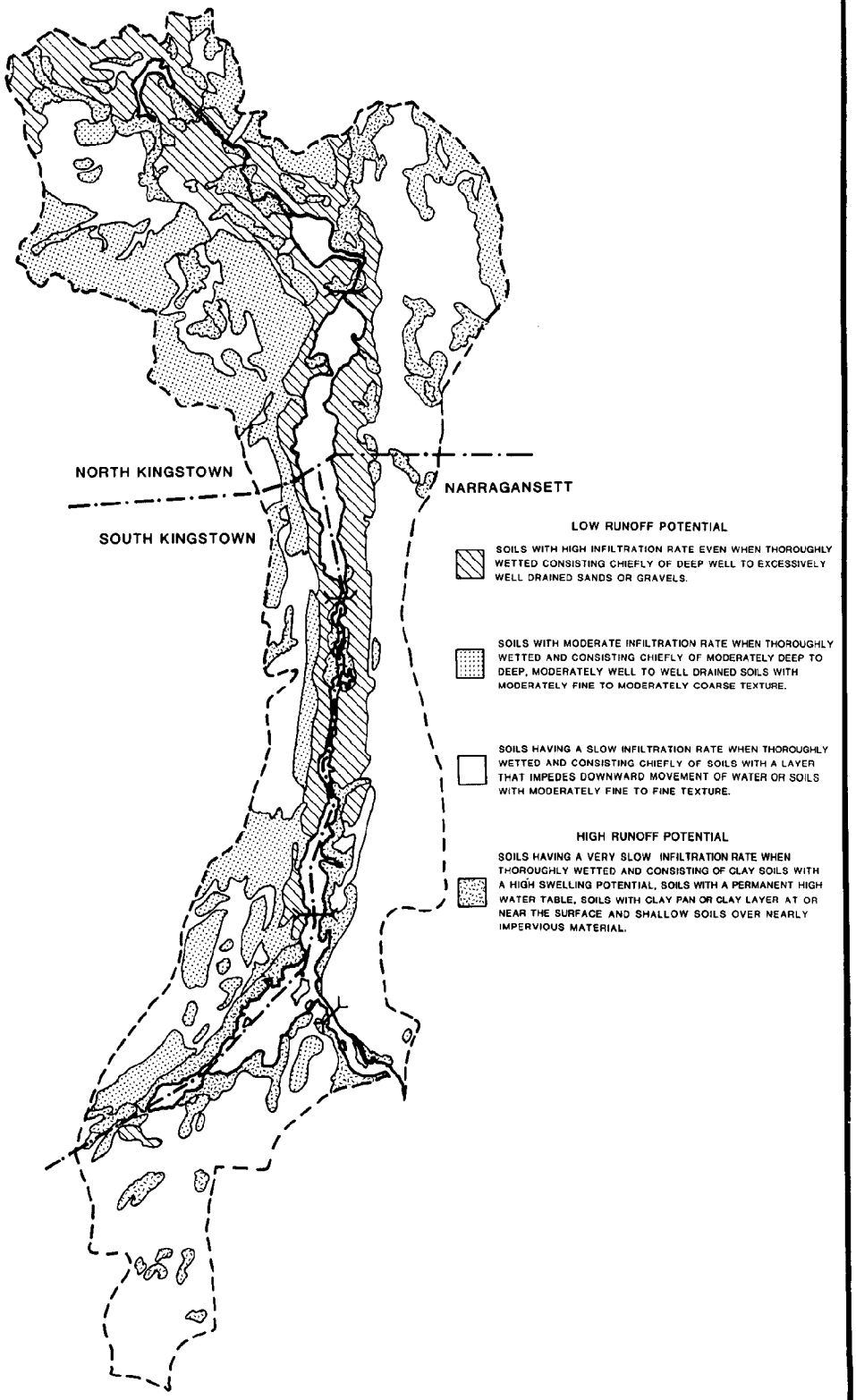
MAP 7 EROSION POTENTIAL



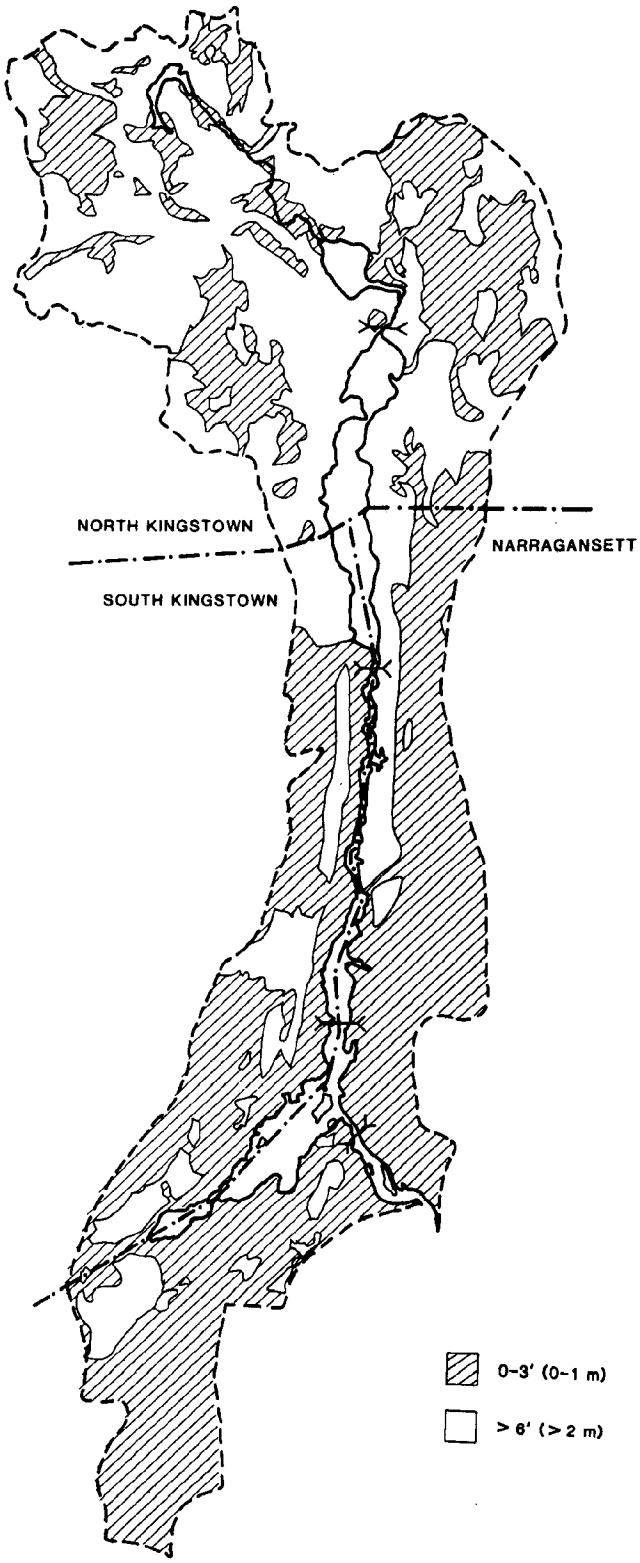
MAP 8 AREAS SERVICED BY PUBLIC UTILITIES



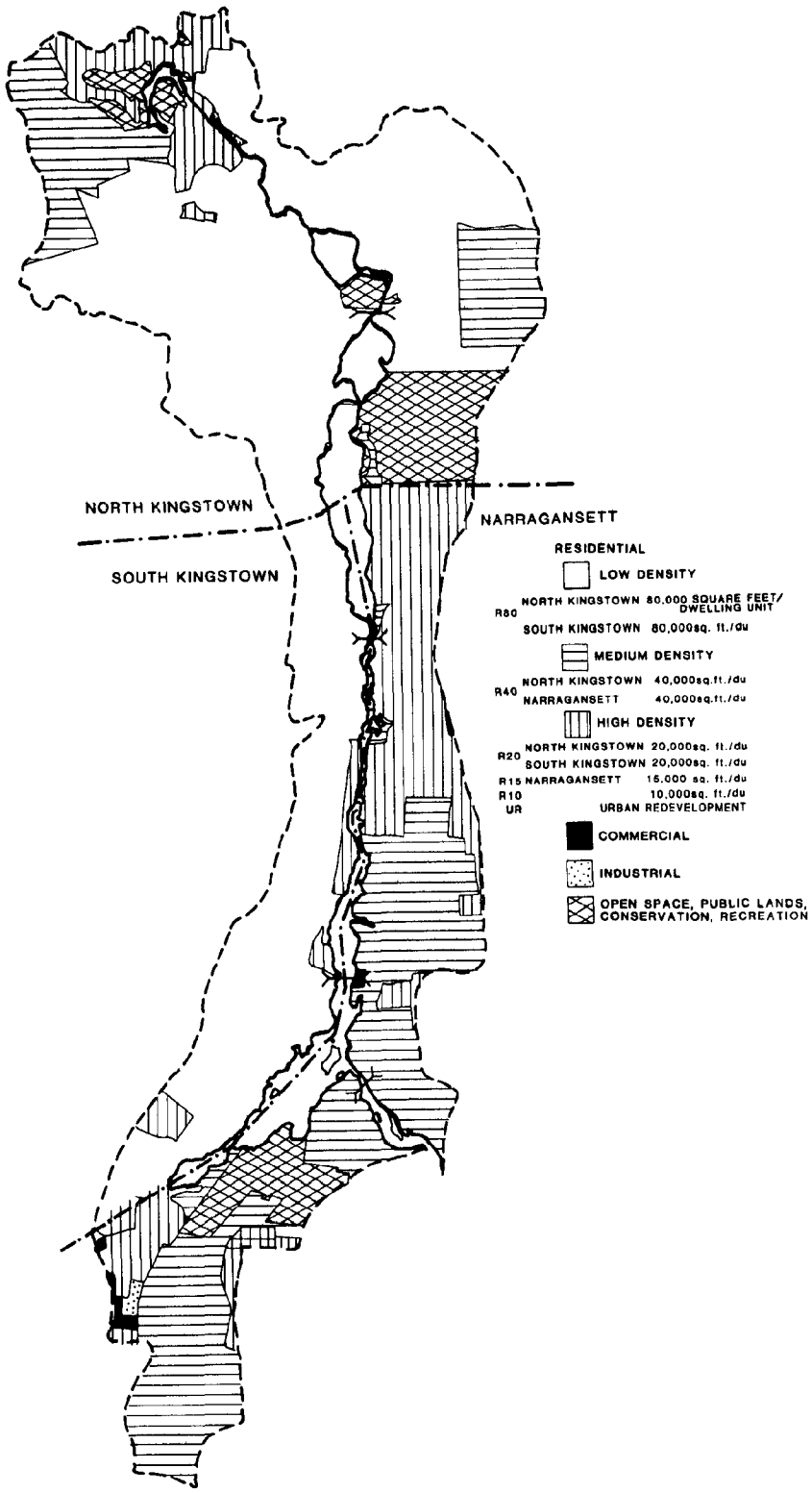
MAP 9 HYDROLOGIC SOIL TYPES



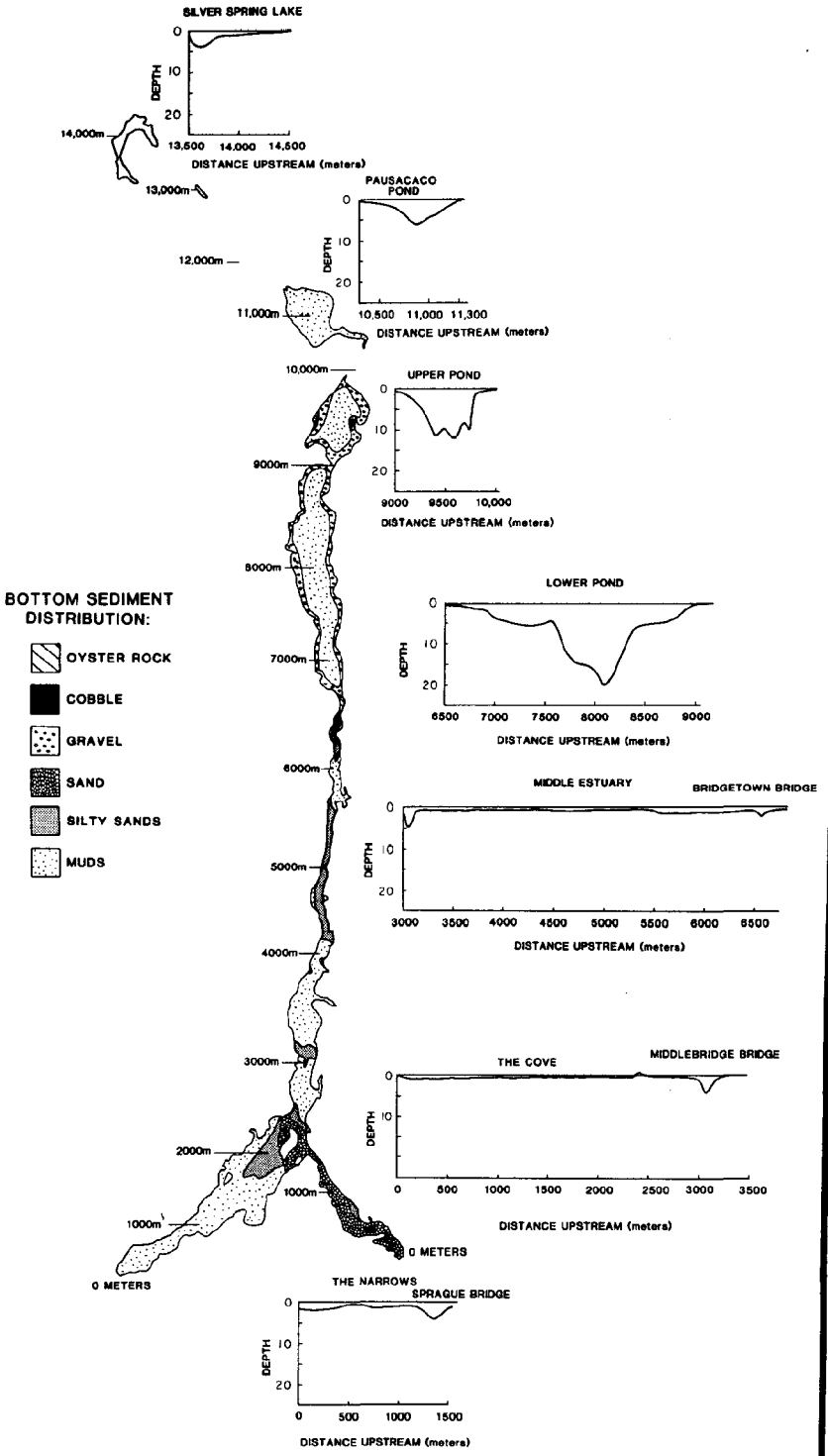
MAP 10 DEPTH TO WATER TABLE



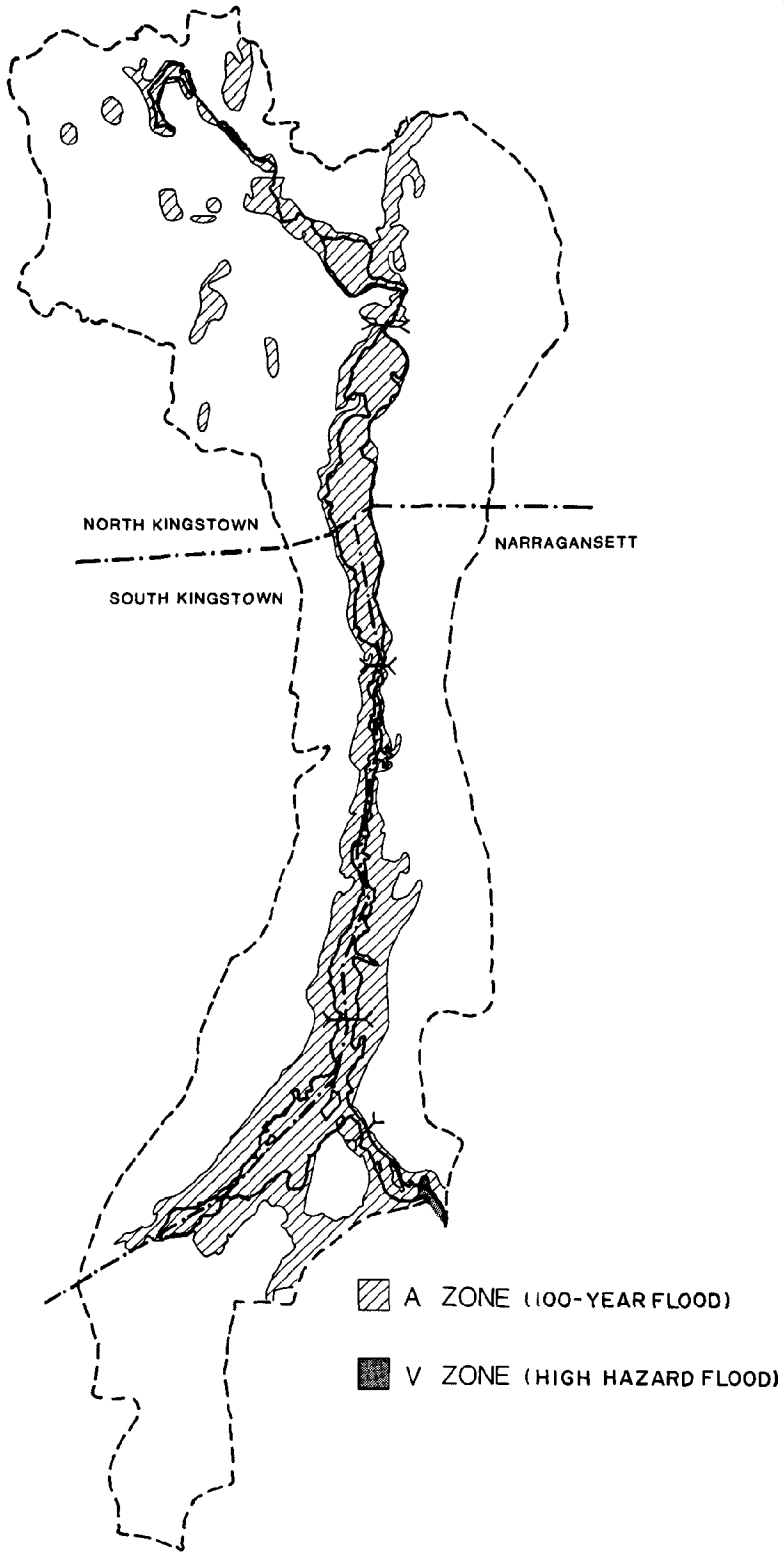
MAP 11 ZONING



MAP 12 BATHYMETRIC PROFILE



MAP 13 FLOOD HAZARD ZONE



APPENDIX B
Glossary

GLOSSARY

Unless specifically defined below, words or phrases shall be interpreted so as to give them the meaning they have in common usage and to give this Special Area Management Plan its most effective application. Words used in the singular shall include the plural and the plural the singular; words used in the present tense shall include the future tense, where appropriate. The word "shall" connotes mandatory and not discretionary; the words "may" and/or "should" are permissive and discretionary.

(a) Adverse impacts - are any modifications, alterations or effects on a feature or characteristic of waters or wetlands, or coastal feature, including their quality, hydrodynamics, surface area, species composition, living resources, aesthetics or usefulness for human or natural uses which are or may potentially be harmful or injurious to human health, welfare, safety or property, to biological productivity, diversity, or stability or which unreasonably interfere with the enjoyment of life or property, including outdoor recreation. The term includes secondary and cumulative as well as direct impacts.

(b) Clearing - means the removal of trees and brush from the land but shall not include the ordinary mowing of grass.

(c) Detention - refers to the collection and storage of surface water for subsequent gradual discharge.

(d) Developer - means any person who engages in development either as the owner or as the agent of an owner of property.

(e) Development or Development Activity -

1) The construction, installation, alteration, demolition, or removal of a structure, impervious surface, or drainage facility;
2) clearing, scrapping, grubbing, or otherwise removing or killing the vegetation of a site;
3) adding, removing, exposing, excavating, leveling, grading, digging, burrowing, dumping, piling, dredging, or otherwise significantly disturbing the soil, mud, sand, or rock of a site;

(f) Drainage facility - means any component of the drainage system;

(g) Drainage system - is the system through which water flows from the land. This includes all watercourses, waterbodies, and wetlands.

(h) Erosion - is the wearing or washing away of the soil by the action of wind or water.

(i) Flood - is a temporary rise in the level of any waterbody, watercourse, or wetland which results in the innundation of areas not ordinarily covered by water.

(j) Impervious surface - means a surface which has been compacted or covered with a layer of material so that it is highly resistant to infiltration by water. It includes semi-impervious surfaces such as compacted clay, as well as most conventionally surface streets, roofs, sidewalks, parking lots and similar structures.

(k) Natural systems - means systems which predominantly consist of or use thsoe communities of plants, animals, bacteria and other flora and fauna which occur indigenously on the land, in the soil or the water.

(l) Owner - is the person in whom is vested fee ownership, dominion, or title of property, i.e. the proprietor. This term may also include a tenant, if chargeable under his lease for the maintenance of the property, and any agent of the owner or tenant including a developer.

(m) Person - means any and all persons, natural or artificial and includes any individual, firm, corporation, government agency, business trust, estate, trust, partnership, association, two or more persons having a joint or common interest, or any other legal entity.

(n) Predevelopment Conditions - are those conditions which existed before alteration, resulting from human activity, of the natural topography, vegetation and rate, volume, or direction or surface or groundwater flow, as indicated by the best available historical data.

(o) Receiving Bodies of Water - shall mean any waterbodies, watercourses or wetlands into which surface waters flow either naturally, in manmade ditches, or in a closed conduit system.

(p) Retention - refers to the collection and storage of runoff without subsequent discharge to surface waters.

(q) Sediment - is fine particulate material, whether mineral or organic, that is carried by water, in suspension or has settled in a waterbody.

(r) Sedimentation facility or device - means any structure or area which is designed to hold runoff water until suspended sediments have settled.

(s) Site - means any tract, lot or parcel of land or combination of tracts, lots or parcels of land which are in one ownership, or are contiguous and in diverse ownership where development is to be performed as part of a unit, subdivision, or project.

(t) Structure - means that which is built or constructed, an edifice

or building of any kind, or any piece of work artificially built up or composed of parts joined together in some definite manner.

(u) Subdivide - means to divide the ownership of a parcel of land, whether improved or unimproved, into two or more contiguous lots or parcels of land, whether by reference to a plat, by metes and bounds or otherwise, or, if the establishment of a new street is involved, any division of a parcel of land. Subdivision includes a resubdivision and when appropriate to the context, relates to the process of subdividing or to the land subdivided.

(v) Vegetation - means all plant growth, especially trees, shrubs, vines, ferns, mosses and grasses.

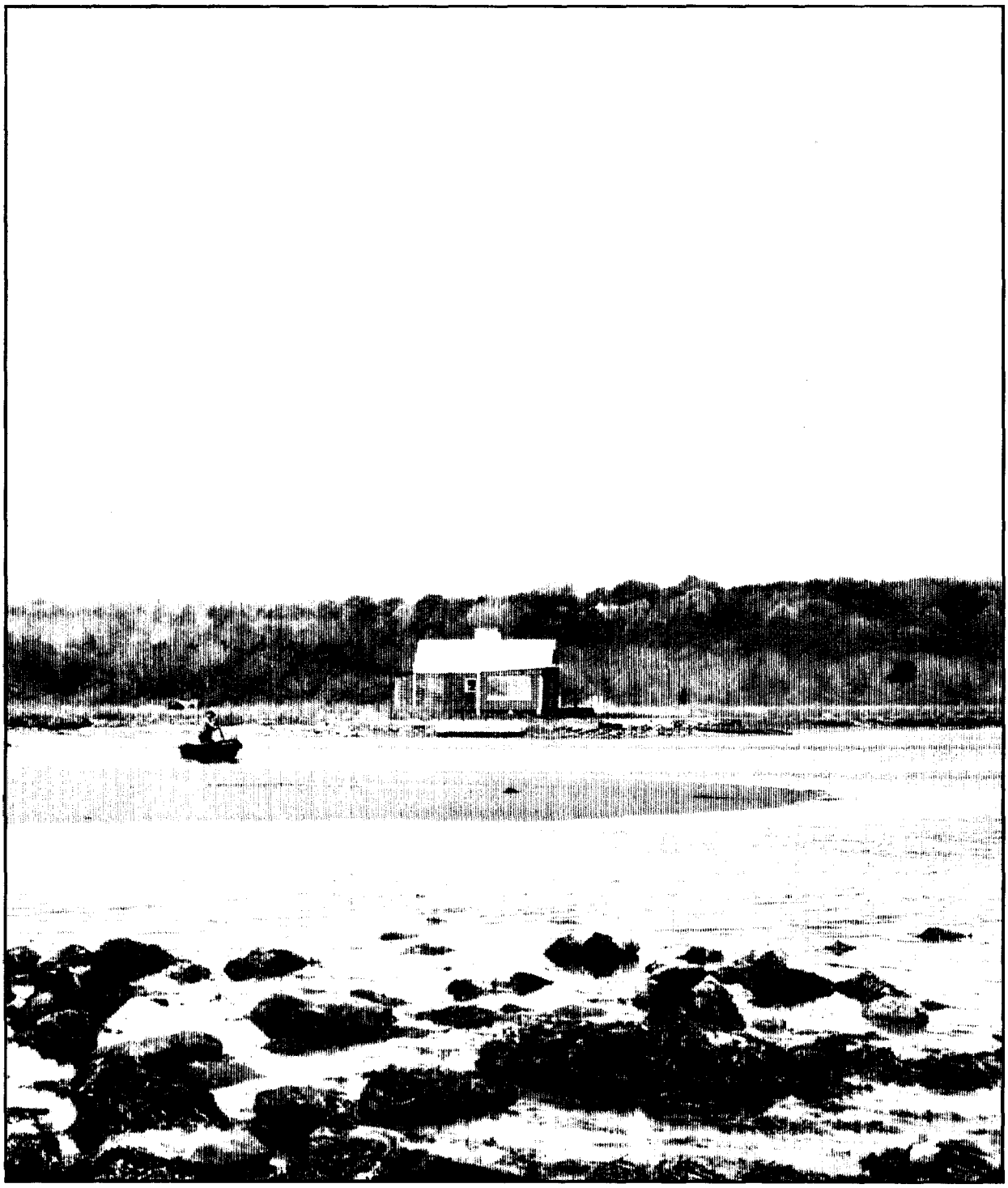
(w) Waters - means any and all water on or beneath the surface of the ground. It include the water in any watercourse, waterbody or drainage system. It also includes diffused surface water and water percolating, standing, or flowing beneath the surface of the ground, as well as coastal waters.

(x) Watercourse - means any natural stream, river, creek, or waterway in which water flows in a definite direction, either continuously or intermittenly, and which has a definite channel, bed, or banks.

(z) Waterbody - means any natural or artifical pond, lake, reservoir or other area which ordinarily or intermittently contains water and which has a discernible shoreline.

(aa) Watershed - means a drainage area or drainage basin contributing to the flow of water into a receiving body or water.

(bb) Wetlands - means those areas so defined in the Freshwater Wetlands Act and the Coastal Resources Management Program.



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