**Narrow River Special Area Management Plan**

This document is the NOAA Office of Coastal Management federally-approved CRMC Narrow River Special Area Management Plan (SAMP). It was first adopted by the Council in 1986 and underwent a substantial revision in 1999. In 2016, the Rhode Island legislature passed an amendment to R.I. Gen. Laws § 42-35-5(b) that required the Secretary of State to oversee the publication of an updated uniform code of state regulations. In conformance with state law, the CRMC has codified the enforceable policies and regulations of the Narrow River SAMP into the Rhode Island Code of Regulations format, which are identified as 650-RICR-20-00-4. A copy of this RICR codified rules and regulations are provided herein strictly for the convenience of users of this SAMP document and may not contain all of the up-to-date regulatory content. Users are directed to the official version of these RICR rules and regulations [650-RICR-20-00-4] posted on the RI Secretary of State's "State Rules and Regulations" web page at: http://sos.ri.gov/divisions/open-government/state/rules-and-regulations.

# The Narrow River
# Special Area Management Plan

for the watershed of the Narrow River in the
Towns of North Kingstown, South Kingstown and Narragansett
April 12, 1999

**Prepared for the**
**Rhode Island Coastal Resources Management Council**




**This document was prepared by:**
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CRMC Coastal Resources Management Council

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# Special Area Management Plan

for the Towns of North Kingstown, South Kingstown and Narragansett
April 12, 1999


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CRMC
Coastal Resources Management Council

## FORWARD

The revisions to the Narrow River Special Area Management Plan (SAMP) reflect the concept of partnership and community participation which began with the development and use of special area management planning in Rhode Island during the early 1980s. The Rhode Island Coastal Resources Management Council (CRMC) is fortunate to have the scientific and management expertise available at Rhode Island Sea Grant, the University of Rhode Island's (URI) Coastal Resources Center, Department of Geology, Department of Natural Resources Science, Environmental Data Center, Graduate School of Oceanography, and Cooperative Extension, the Rhode Island Department of Environmental Management's (RIDEM) Division of Fish and Wildlife and Water Resources, the Rhode Island Historical Preservation Commission, and the federal resources agencies: Fish and Wildlife Service, National Marine Fisheries Service, Environmental Protection Agency, Geological Survey and the Natural Resources Conservation Service.

CRMC partners throughout the revision process included the three municipalities of North Kingstown, South Kingstown and Narragansett, the Narrow River Preservation Association, URI Watershed Watch, the URI Cooperative Extension, the URI On-Site Wastewater Training Program, the RIDEM Septic System Maintenance Policy Forum, the Rhode Island Mmarine Trades Associationindustry, the Rhode Island Builder's Association, The Nature Conservancy and many others. The input of these partners was valuable and has enabled CRMC to present more complete and pertinent data, and better management measures and policies.
The revisions to the SAMP are the result of the Rhode Island Coastal Resources Management Council's Strategy for enhancing the Rhode Island Coastal Resources Management Program in accordance with the requirements of Section 309 of the 1972 Coastal Zone Management Act (16 U.S.C. §1451 et seq.) as amended by the 1990 Coastal Zone Act Reauthorization Amendments.
The purpose of the revisions to the Narrow River SAMP are to reassess issues addressed in the original document.s As a result, policies, standards and recommendations to municipalities and federal and state agencies have been revised and updated. CRMC also modified the SAMP boundary to reflect the surface watershed boundary of the Narrow River.

The focus of these revisions is primarily on density controls and other regulatory requirements thato better manage nonpoint source pollution and cumulative and secondary impacts which can result in habitat loss, erosion and sediment control problems, stormwater impacts and groundwater contamination from septic systems. The revisions also address other important issues such as wetlands protection, breachway modifications, dredging, recreational boating, storm hazards, and public access.

The revisions to the SAMP are the result of implementing the CRMC's Strategy for enhancing the Rhode Island Coastal Resources Management Program in accordance with the requirements of Section 309 of the 1972 Coastal Zone Management Act (16 U.S.C. §1451 et seq.) as amended by the 1990 Coastal Zone Act Reauthorization Amendments.

**ACKNOWLEDGMENTS**

Special thanks are due to so many people who had a hand in the revisions to the Narrow River Special Area Management Plan (SAMP). Members of the Planning and Procedures Subcommittee of the Rhode Island Coastal Resources Management Council (CRMC), including George DiMuro, Chairman, Turner C. Scott, Vice Chairman, Michael M. Tikoian, Lloyd Sherman, Eileen Naughton, Peter Troy, Robert Ellis Smith, Pam Pogue, Augustinho Nunes and Andrew McLeod, attended meetings, providing their expertise in dealing with coastal resources management issues. The CRMC staff members, Jim Boyd and Donna Lynne Doyle and Jim Boyd, who began to work on the SAMP revisions in 1994, set the foundation. Dave Reis, Ken Anderson, Jeff Willis and Laura Miguel all made important contributions to Chapter 1, Objectives, Chapter 2, Framework of Management and Chapter 9, Regulations. The entire permitting staff at CRMC (Tom Medeiros, Tim Motte, Rich Lucia and Mike Deveau) were excellent at identifying problem areas in the 1984 SAMP. Special thanks to Joanne Moore, Lisa Mattscheck and Gerry Higgins for assisting in compilation, Kevin Cute for formatting and Brian Kavanagh for production.

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the nonprofit groups: Julia Sharpe, Melissa Hughes and Dr. Jon Boothroyd from the Narrow River Preservation Association, Linda Steere from the Narrow River Land Trust, Linda Green and Elizabeth Herron from URI Watershed Watch, Eugenia Marks from The Audubon Society,, and Allison Walsh from Save the Bay; and Dave Monk from the Salt Ponds Coalition

the North Kingstown Conservation Commission and Town Council, for their extensive interest and input;

Mr. Joe Frisella from the Rhode Island Builder's Association;

and the concerned residents who attended the many public meetings.

To all of you who gave of your time and effort in this revision, and in the initial formidable task of writing this plan in the first place, the Narrow River and the CRMC staff thank you.

**DEDICATION**

This plan is dedicated to the memory of John "Skinny" Sposato. His work and love of the coastal environment continue to be a valuable contribution to the effectiveness of this program.

**Narrow River Special Area Management Plan**

## Table of Contents

## Chapter 1
## Objectives of the Special Area Management Plan

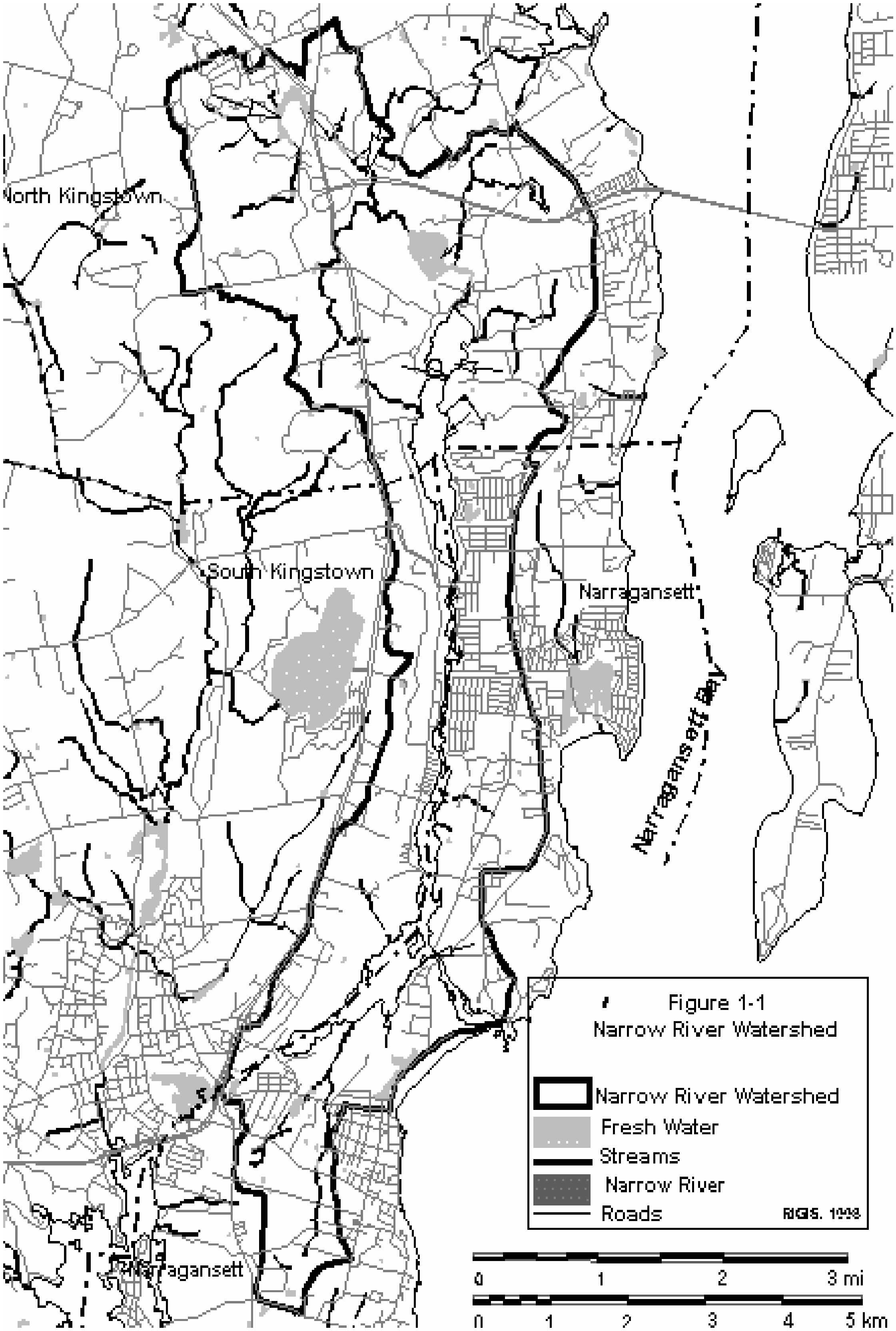
### Section 100. Narrow River Special Area Management Plan Development

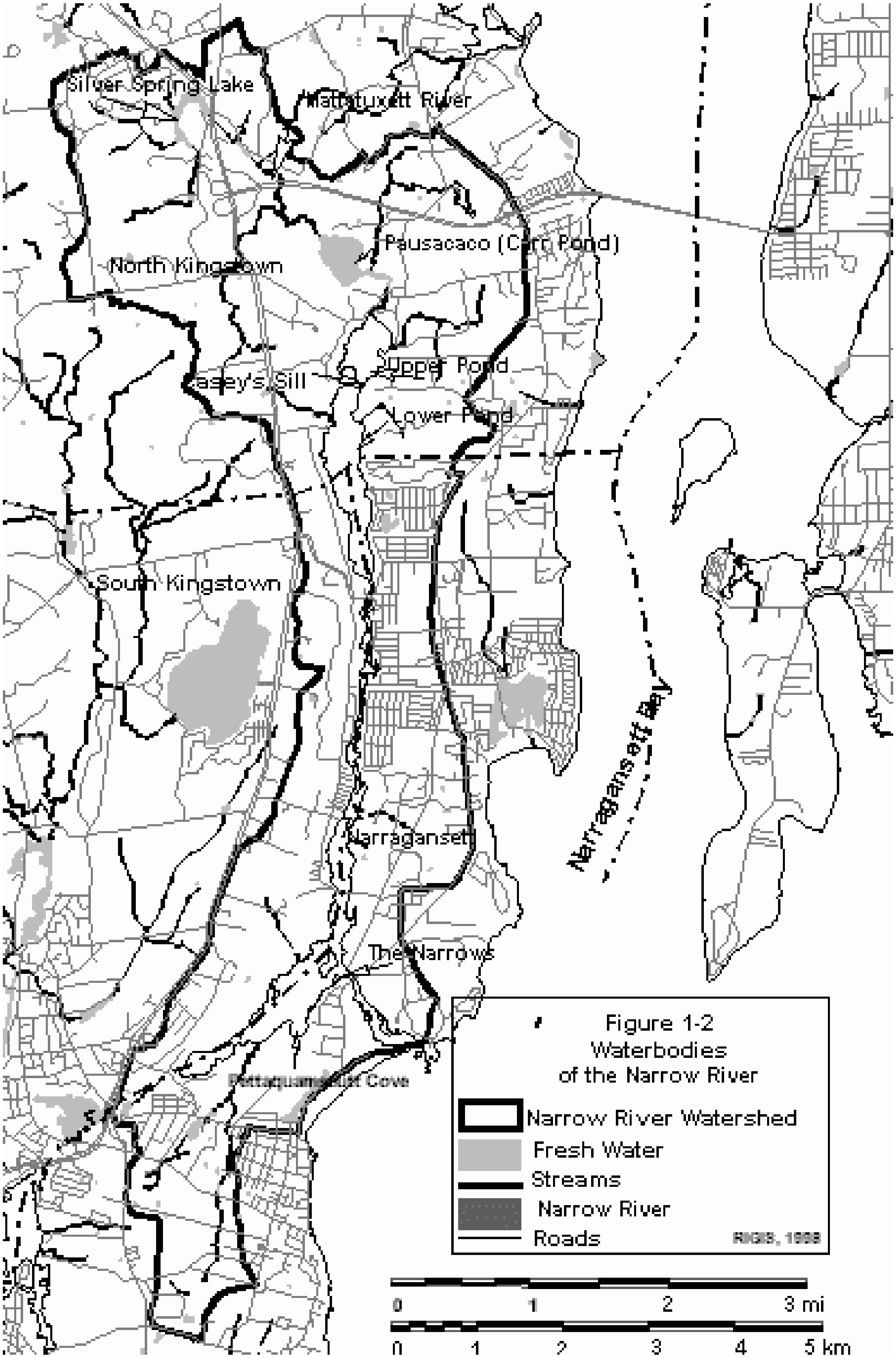
A. The SAMP is part of the Rhode Island Coastal Resources Management Council's (CRMC), ongoing responsibility under the Coastal Zone Management Act (CZMA). The CRMC is empowered by Rhode Island state statute 46-23-15 to administer land and water use regulations as necessary to fulfill their responsibilities under the Federal CZMA (16 U.S.C. §1451). 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. When the Narrow River SAMP was first developed, Special Area Management Planning represented a new phase in environmental planning. The underlying theme of the SAMP was that disturbance of or alteration of just one component of the ecosystem can have far-reaching effects, often unexpected and occasionally irreversible. The strategy behind the development of the Special Area Management Plan (SAMP) is to recognize how water quality, land-use, habitat, storm hazards and geology all interact on an ecosystem level to impact the health of the Narrow River.

B. The development of the SAMP 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 initiatives. The first initiative was the adoption of a SAMP 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 CRMC to the specific problems of the salt ponds. The second initiative was the urgent need to develop strong management policies within the Narrow River watershed, which encompasses several unique water bodies (Figure 1-2). Past building practices and current building pressures within the watershed had led to water quality degradation, human encroachment on critical habitat areas, limited public access, and a decrease in the aesthetic value of the watershed.

C. In September, 1985, the Narrow River SAMP effort began, with the aim of detailing specific management strategies for the CRMC through a plan tailored to the watershed which considered 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 included 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


North Kingstown
South Kingstown
Narragansett
Narragansett Bay
Narragansett
Figure 1-1
Narrow River Watershed
Narrow River Watershed
Fresh Water
Streams
Narrow River
Roads
RIGIS, 1998
0
1
2
3 mi
0
1
2
3
4
5 km



Silver Spring Lake
River
Pausacaco (Carr Pond)
North Kingstown
Upper Pond
Lower Pond
South Kingstown
Narragansett Bay
Narragansett
The Narrows
Figure 1-2
Waterbodies
of the Narrow River
Narrow River Watershed
Fresh Water
Streams
Narrow River
Roads
0
1
2
3 mi
0
1
2
3
4
5 km

were combined to create the SAMP. The focus of the SAMP 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 into unsuitable areas, 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. The SAMP was adopted by CRMC in 1986 and provided for nine years of coordination between property owners, the towns and CRMC. There was an increased understanding of the steps needed to protect the watershed, and a more unified approach by regulators with regard to their decisions within the watershed.

F. Since adoption of the 1986 SAMP, interest in the Narrow River watershed has grown tremendously by the towns, URI, the Rhode Island Department of Environmental Management, the Narrow River Preservation Association, the Narrow River Land Trust, the US Fish and Wildlife Service and many others through permit review of proposed development, land acquisition for preservation, water quality monitoring, etc. A cooperative effort between the Towns of Narragansett, South Kingstown, North Kingstown, RIDEM, CRMC and the Narrow River Preservation Association resulted in a plan to address the recommendations of Section 320.2 of the 1986 SAMP which provided guidelines for the preparation of a cooperative (tri-town) comprehensive stormwater management plan. The Tri-town Plan provided for three phases: phase I - problem assessment and design feasibility; phase II - design specifications and permitting; and phase III - construction. Phase I of the stormwater study was conducted by SAIC Engineering in association with Applied Science Associates, RI Watershed Watch, and URI in August, 1994.

The University of Rhode Island Watershed Watch program has over 200 water quality monitors who sample on a weekly or biweekly basis at seventy-nine sites on sixty-eight distinct water bodies, with monthly monitoring on an additional seventeen river sites in Rhode Island (Herron and Green 1998). The Watershed Watch program has been sampling in the Narrow River since 1992. Volunteers collect data for water temperature, dissolved oxygen content, salinity, chlorophyll and, in deep areas, Secchi depth transparency measurements. In 1996, water samples were collected on five Saturdays for analysis of bacterial indicators and for nutrients (total and dissolved phosphorus, nitrate, and total nitrogen) (Herron and Green 1998).

In the May 1991 issue of *Maritimes* (35,2) the URI Graduate School of Oceanography's published quarterly, the University devoted a whole issue to the Narrow River addressing such issues as geology and metal pollution. In 1994, the URI Coastal Resources Center in cooperation with CRMC began a Secondary and Cumulative Impact Study of Development which became the basis for a new chapter in the future revision of the SAMP.

G. In 1994, as part of the CRMC Strategy for Enhancing the Rhode Island Coastal Resources Management Program and in accordance with requirements of Section 309 of the 1972 federal Coastal Zone Management Act, CRMC began revisions to the Salt Pond Region and Narrow River SAMPs. The proposed program changes were focused on density controls and other regulatory requirements to manage nonpoint source pollution and cumulative and secondary impacts which result in habitat loss, surface water quality pollution, and groundwater contamination from septic systems. Other issues addressed included wetlands protection, breachway modifications, dredging, recreational boating, storm hazards and public access. CRMC began a cooperative effort to address these issues with the help of staff at CRMC, the URI Geology Department, RIDEM Division of Fish and Wildlife and the URI Coastal Resources Center.

## 110. Objectives of the Narrow River Special Area Management Plan

### A. An Ecosystem-Based Management Strategy

1. The SAMP is designed to address a diversity of issues on a watershed scale and is rooted in the CRMC's legislative mandate that states:

> "...the coastal resources of Rhode Island, a rich variety of natural, commercial,industrial, recreational, and aesthetic assets, are of immediate and potential value to the present and future development of this state; that unplanned or poorly planned development of this basic natural environment has already damaged or destroyed, or has the potential of damaging or destroying, the states coastal resources, and has restricted the most efficient and beneficial utilization of these resources; that it shall be the policy of this state to preserve, protect, develop, and, where possible restore the coastal resources of the state for this and succeeding generations through comprehensive and coordinated long range planning and management designed to produce the maximum benefit for society from these coastal resources; and 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 (G.L.R.I. 46-23-1)."

Central to the SAMP's management strategy is recognition that there is a complex interrelationship among the many elements of the ecosystem and often far-reaching and unexpected consequences resulting from a change to one element of the ecosystem.

**B. Objectives of the 1986 SAMP**

1. The objectives for the 1986 Plan were derived from several advisory committee planning sessions and served as a guide for establishing the recommendations included in the final 1986 version. These goals included the following:

(a) 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;

(b) 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;

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

**C. Objectives of the 1998 revisions of the Narrow River SAMP**

1. The objectives for the 1998 revisions of the SAMP were established by the CRMC Planning and Policy Subcommittee and are consistent with the original goals. Additional goals of the 1998 SAMP include the following:

(a) update the SAMP to reflect new research, data and management strategies for water quality, land use, habitat, fish and wildlife, and storm hazards;

(b) recommend changes for the CRMC Land Use Classification System based on findings from the Cumulative and Secondary Impacts of Development Study;
(c) identify ways nitrogen sources can be reduced in the watershed through new technologies;

(d) revise and update existing policies and standards as well as recommendations to municipalities and federal and state agencies;

(e) update all maps using the Rhode Island Geographic Information System, and modify boundaries of the SAMPs as needed to manage for erosion and water quality pollution;

(f) consolidate all regulations into one chapter for easier reference, and revise the format of the SAMPs to distinguish between policies, standards and prohibitions and clarify responsibility for implementing recommendations;

(g) incorporate the review mechanisms mandated by the Land Development and Subdivision Review Enabling Act of 1992 (G.L.R.I. 45-23);

(h) incorporate the requirements of Section 6217 of the federal Coastal Zone Act Reauthorization Amendments of 1990 for managing coastal nonpoint sources of pollution;

(i) identify and prioritize future research agendas for the region.

## 120. Resource Values of the Narrow River Watershed

1. 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 water ski. 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.

2. 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.

3. Scientists from the nearby University of Rhode Island use the estuary and bounding habitats frequently for scientific in vestigations. Topics of the resulting studies range from the geologic evolution of the basin and river valley (Gaines 1975) to the habitats of the marsh dwelling hermit crabs (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.

## 130. Summary

The following chapters characterize the physical, chemical, biological and recreational condition of the Narrow River and its watershed. The following chapter (Chapter 2) explains the management framework for the SAMP, identifying the regulatory bodies and processes which apply to development within the Narrow River and its watershed. The next five chapters cover Water Quality, Geologic Processes, Living Resources and Critical Habitats, Storm Hazards, and Cultural and Historical Resources. The information and issues presented in these chapters provide the foundation for the regulations and policy initiatives contained in Chapter 9.

Two new chapters were created in the 1998 revision of the SAMP. Cumulative and Secondary Impact has been added to the SAMP to set up a framework for addressing those activities which together have an impact on the water quality and habitat of the river. Chapter 10 Land Preservation and Acquisition presents information on land protection which has become a critical means of protecting the landscape and environmental integrity of the watershed.

In conclusion, Chapter 9 contains all the policies and regulations pertaining to the SAMP. It is divided into sections for Definitions, Policies, Regulations and Recommendations. The CRMC Land Use Classification Maps are found in Chapter 9, and the metadata for the RIGIS maps which explains the coverages used to create the maps are in Appendix A. The Rhode Island Coastal Resources Management Program (RICRMP) (the Red Book) should be referred to for additional specific regulatory requirements on buffers, setbacks, subdivisions, recreational docks, barrier beach development, beach replenishment and any other activities which occur within the watershed of the Narrow River.

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# Chapter 2
# Framework of Management

## 210. Findings of Fact

### 210.1 The Need for Growth Management in the Region

### A. Introduction

1. The Narrow River watershed is located in one of the fastest growing areas of the state, and has experienced steady growth over the past forty years. Development pressures place powerful economic incentives on the conversion of 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 manner, cognizant of the natural constraints within the watershed.

2. Nearly 65% of the Narrow River watershed is presently undeveloped. The manner in which continued residential development is regulated and managed in the Narrow River watershed is the critical factor in preventing degradation of the coastal system due to impacts from improper or insensitive development practices (See chapter 3). The major factors that determine how and when further development will proceed are: municipal zoning and subdivision regulations; state regulatory programs; and the acquisition, conservation, and local tax management of undeveloped lands.

## 220. Management Efforts in the Watershed

### A. Tri-town Narrow River Planning Committee

1. 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. Narrow River Watershed Advisory Council

1. The Narrow River Watershed Advisory Council (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 Advisory Council, in turn, appointed a Narrow River Watershed Advisory Commission (Watershed Commission), also composed of representatives of the three towns (Howard-Strobel 1986). 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.” The compilation, publication and adoption of the 1986 SAMP was the result of the Watershed Commission’s work (Howard -Strobel 1986).

### C. Narrow River Land Trust

1. The Narrow River Land Trust, established in 1982, is a private non-profit group able to acquire property and certain property rights in order to preserve lands within the watershed. The Land Trust and NRPA continue to work toward their goal of preserving and protecting the watershed.

## 230 Management Authorities

### 230.1 Rhode Island Coastal Resources Management Council

### A. State and Federal Mandate for Special Area Management Planning

1. The CRMC has direct authority over the Narrow River, its shoreline, the oceanfront shoreline, and associated coastal resources. The SAMP is part of CRMC’s ongoing responsibility under the CZMA (16 U.S.C. §1451). CRMC is also responsible for developing and implementing the Rhode Island Coastal Nonpoint Pollution Control Program under Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990. The CRMC has been empowered by Rhode Island state statute 46-23-15 to administer land and water use regulations as necessary to fulfill their responsibilities under the Federal CZMA, as amended. The state legislative mandate for ecosystem-based planning describes the resource management process as follows:

- Identify all of the state’s coastal resources: water, submerged lands, air space, finfish, shellfish, minerals, habitat, physiographic features, and so forth.
- Evaluate these resources in terms of their quantity, quality, capability for use, and other key characteristics.
- Describe the current and potential use or problem of each resource.
- Formulate plans and programs for the management of each resource,

identify permitted uses, locations, protection measures, and so forth.
- Carry out these resource management programs through implementing authority and coordination of state, federal, local, and private activities.
- Formulate standards where they do not exist, and reevaluate existing standards (G.L.R.I. 46-23-6(A)).

2. The CRMC authority to develop SAMPs is based on Section 309 of the Coastal Zone Management Act of 1972 as amended (CZMA). This section sets up the process for awarding the Coastal Zone Enhancement grants to states as part of the state's development and implementation of their program objectives. The CZMA defines a SAMP as a "comprehensive plan providing for natural resource protection and reasonable coastal-dependent economic growth containing a detailed and comprehensive statement of policies; standards and criteria to guide public and private uses of lands and water; and mechanisms for timely implementation in specific geographic areas within the coastal zone" (16 U.S.C. 1451 et seq.).

3. The CRMC has direct and comprehensive authority over the Narrow River, its shoreline, and associated coastal resources. It also has comprehensive authority over the entire watershed through the federal consistency process as mandated in section 307 of the Coastal Zone Management Act of 1972 (CZMA). The CZMA, as amended, requires that activities proposed or funded by the federal government, that are reasonably likely to affect any coastal use or resource, must be consistent, to the maximum extent practicable, with the enforceable policies of a state's federally approved coastal zone management program (16 U.S.C. 1451 et seq.).

## 230.2 Other Regulatory Bodies in the Watershed

### A. Introduction

1. Through the SAMP, the CRMC coordinates with the other inland regulatory authorities, including state and municipal authorities, to take a comprehensive approach to management of the watershed. Other regulatory bodies with authority within the Narrow River watershed include but are not limited to: The Rhode Island Department of Environmental Management (RIDEM); the Marine Fisheries Council; the municipal governments of the towns of Narragansett, North Kingstown and South Kingstown; the Natural Resources Conservation Service, the Army Corps of Engineers, the Environmental Protection Agency, the Fish and Wildlife Service, and the National Marine Fisheries Service.

### B. Rhode Island Department of Environmental Management

1. RIDEM enforces its water quality standards for the state's surface waters which are

intended to restore, preserve and enhance the physical, chemical and biological integrity of the waters of the State, to maintain existing water uses and to serve the purposes of the Clean Water Act and Rhode Island general Laws Chapter 46-12. RIDEM standards provide for the protection of the surface waters from pollutants so that the waters shall, where attainable, be fishable and swimmable, be available for all designated uses, taking into consideration their use and value for public water supplies, propagation of fish and wildlife, recreational purposes, and also taking into consideration their use and value for navigation, and thus assure protection of the public health, safety, welfare, a healthy economy and the environment. RIDEM implements its program through water quality monitoring and watershed management initiatives like the Partners in Resource Protection project which is a collaborative effort between local, state and federal authorities to identify the state's most important natural resource areas. As part of this project, the state has been divided into nine resource protection areas with the Salt Pond Region and Narrow River watershed making up the South Coastal Pond Resource Protection Area. RIDEM is also responsible for implementing and enforcing the Rhode Island Freshwater Wetlands regulations, the placement of underground storage tanks, discharges to groundwater and surface water, and septic system siting and design.

**B. The Marine Fisheries Council**

1. The Marine Fisheries Council has authority over the fish, lobsters, shellfish and other biological resources of marine waters of the state according to Rhode Island General Laws
20-1-2. The Marine Fisheries Council is authorized, after holding a public hearing to promulgate and adopt rules and regulations governing the manner of taking fish, lobsters, and shellfish, to regulate the following: the legal size limits of fish, lobsters, and shellfish to be taken or possessed; the seasons and hours during which fish, lobsters, and shellfish may be taken or possessed; the numbers or quantities of fish, lobsters, and shellfish which may be taken or possessed; and the opening and closing of areas within the coastal waters to the taking of any and all types of fish, lobsters, and shellfish.

**C. Municipalities**

1. The Towns of North Kingstown, South Kingstown, and Narragansett all have land use and zoning ordinances which require wetland setbacks, groundwater aquifer protection areas, individual sewage disposal system technologies, etc. CRMC and RIDEM are trying to coordinate with the towns on land use activities like individual sewage disposal systems which impact the surface and groundwater of the Narrow River.

**D. Natural Resources Conservation Service**

1. The Natural Resources Conservation Service (NRCS) lends technical services to local farmers and communities under programs set up under the Farm Bill. The Federal

Agricultural Improvement and Reform Act of 1996 contains the most recent amendments to the Farm Bill and there are three programs which can benefit farm operations within the Narrow River watershed. The Wildlife Incentives Program (WHIP), the Wetlands Reserve Program(WRP), and the Environmental Quality Incentives Program (EQIP) provide incentives among other things for buffer strip establishment. In addition to these programs, the NRCS through the Southern Rhode Island Conservation District has been working with the town of Narragansett to develop a stormwater runoff treatment system at Wampum and Conanicus Roads to capture suspended sediments and achieve reductions in nutrient levels.

**E. Environmental Protection Agency**

1. The Environmental Protection Agency (EPA) has legislative authority under the Clean Water Act (33 U.S.C. 1251 *et seq.*) to regulate and manage water quality. EPA can establish discharge permits, oil and hazardous substance spill programs, toxic pollutant and pretreatment programs, regulate vessel sewage discharge, etc. EPA is also the partnering agency with the National and Oceanic Atmospheric Agency for the Coastal Nonpoint Pollution Control Program established under the Coastal Zone Act Re-authorization Amendments of 1990 (16 U.S.C. 1455b). Other EPA responsibilities include control of non-indigenous aquatic species, environmental impacts of proposed federal activities under the National Environmental Policy Act (42 U.S.C. §4321 1994) and regulation of coastal litter and pollution.

**F. Army Corps of Engineers**

1. The Army Corps of Engineers (ACOE) has legislative authority under the Clean Water Act (33 U.S.C. 1251 *et seq.*) to regulate dredge and fill activities in waters of the United States, including wetlands. The ACOE also is involved in environmental restoration, wetlands conservation, fish and wildlife mitigation, and environmental protection under the Water Resources Development Act of 1990 (42 U.S.C. 1962d-5f).

**G. Fish and Wildlife Service**

1. The Fish and Wildlife Service manages the Pettaquamscutt Cove National Wildlife Refuge (Refuge). The Refuge was established in 1988 for the purposes of protecting black ducks and other migratory species and to provide for the conservation and management of native fish, wildlife, and plant species. The 174 acre refuge has key habitats including coastal saltmarsh, mudflats, shrublands, and grasslands (USFWS 1998).

**H. National Marine Fisheries Service**

1. The National Marine Fisheries Service (NMFS) conserves and manages fish stocks

throughout a 200-mile U.S. Fishery Conservation Zone by developing fishery management plans and designating essential fish habitat under the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 *et seq*.)

**240. Management Changes since the 1986 Special Area Management Plan**

A. **Introduction**

1. Since the adoption of the Narrow River SAMP in 1986, there have been federal, state, and local regulation and management changes which have had some impact on the way land is developed, the process for permit approvals, and protection of the natural resources of the Narrow River. Two major initiatives are the Rhode Island Coastal Nonpoint Pollution Program (RICNPCP 1995), required by the 1990 amendments of the federal Coastal Zone Reauthorization Act and the state Land Development and Subdivision Review Enabling Act of 1992 (G.L.R.I. 45-23). The framework of management for the SAMP has changed to reflect the mechanism provided in the State of RI Land Development and Subdivision Review Enabling Act for permit review and the management measures required by the state Coastal Nonpoint Pollution Control Program (RIDEM, CRMC and the Department of Administration 1995).

**B. Rhode Island Coastal Nonpoint Pollution Control Program**

1. The 1990 federal Coastal Zone Act Re-authorization Amendments (CZARA), Section 6217 entitled "Protecting Coastal Waters," required each coastal state to develop a Coastal Nonpoint Pollution Control Program (CNPCP). The intent of Congress in mandating the CNPCP was to address the growing nonpoint pollution problems affecting the nation's coastal waters (RICNPCP 1995). The legislation required that each state CNPCP be approved by the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA) by July 1995. The central purpose of Section 6217 was to strengthen the coordination between federal and state coastal and water quality management programs.

2. The programmatic requirements for developing state CNPCPs are contained in the Guidance Specifying Management Measures for Nonpoint Sources of Pollution in Coastal Waters (EPA 1993) and the Coastal Nonpoint Pollution Control Program Development and Approval Guidance (NOAA and EPA 1993). Section 6217 required states to develop management measures using a technology based approach and are defined as:

> "...economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution

control practices, technologies, processes, siting criteria, operating methods, or other alternatives."

Management measures apply to agriculture, forestry, urban (new development, septic systems, roads, bridges, highways, etc.), marinas, and hydromodifications. There are also management measures to protect wetlands and riparian areas, and to promote the use of vegetative treatment systems (EPA 1993a).

3. The Rhode Island CNPCP was submitted in 1995 and conditionally approved in 1997. Implementation of the management measures occurs through existing state regulatory programs, namely the CRMC and RIDEM.

**B. Rhode Island Land Development and Subdivision Review Enabling Act**

1. The State of Rhode Island Land Development and Subdivision Review Enabling Act of 1992 (GLRI 45-23), otherwise known as the Development Review Act went into effect December 1995. The Development Review Act requires the towns to administer three levels of review (for any subdivision of land, regardless of the number of units); level one - the master plan, level two - the preliminary plan, and level three - the final plan. The Development Review Act requires the towns to designate an Administrative Officer to administer the Act and to coordinate all joint reviews.

2. The CRMC currently has a preliminary determination process which is independent of the town's review process, but meets the requirements of the level one master plan review under the Development Review Act. CRMC's preliminary determination gives applicants up-front information pertaining to a specific site and activity. The preliminary determination review process enables applicants or municipalities to request a preliminary application meeting with all applicable boards, commissions, and where appropriate, state agencies for information on CRMC standards, regulatory process, etc. Likewise, at the Town's master plan level, the town can bring local, state, and federal agency comments together, and provide a public forum prior to any planning board action. The CRMC preliminary determination process allows the CRMC to:

(a) Reduce possible conflicts with regulatory program requirements by making the applicant aware of what is expected prior to entering into the regulatory process.

(b) Evaluate development proposals on the basis of shared expertise from permitting agencies and municipalities alike.

(c) Identify and evaluate major impacts on the ecosystem at the beginning of the ermitting process, thereby identifying the issues needing to be addressed by the applicant.

(d) Reduce time and expense incurred by the applicant during the permitting process.

3. At the towns' second or preliminary plan level, all state approvals required prior to construction must be in place (including CRMC, RIDEM Wetlands, ISDS, etc.), and a formal public hearing must be held. The town will then move on to the final plan approval, where local regulatory requirements and any mitigation through public improvements are made final.

## 250. Management Initiatives of the SAMP

### A. Local and State Government Coordination

1. The primary management initiative of the SAMP is to coordinate the regulatory and management activities of the CRMC with those of the RIDEM and the municipalities in order to:

(a) Improve coordination of the regulatory permitting process, particularly for nitrogen removal technologies;

(b) Identify resource areas of particular concern within the watershed;

(c) Identify pollutant sources which are causing shellfish closures and questionable swimming conditions; and

(d) Identify research needs and find sources of funding.

2. Recognizing the need to combine the expertise and resources of all the groups active in the Narrow River and its watershed, CRMC also proposes to form an interagency working group of non-profit, state, federal and municipal representatives. This group will be modeled after the Watershed Advisory Council of 1981 which made recommendations on town and regional policies, formulated a comprehensive plan for the watershed and collected and analyzed data on watershed resources. Important initiatives for the group include: developing recommendations for best management practices to address runoff from storm drain outfalls, and habitat restoration possibilities; identification of fish habitats, and identification of bacteria and nitrogen sources which are not being addressed by existing regulations.

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U.S. Environmental Protection Agency. 1993. Guidance Specifying Management Measures For Nonpoint Pollution in Coastal Waters. US Environmental Protection Agency, Office of Water, Washington, D.C.

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# Chapter 3
# Water Quality

## 310. Water Quality of the Narrow River

### A. Introduction

1. A primary goal of the SAMP is to protect and restore Narrow River water quality. Water quality of both groundwater and surface water continues to be degraded as a result of residential and commercial development within the region. The SAMP establishes regulatory standards to protect and improve the Narrow River water quality. Because the watershed is the major source of freshwater to the Narrow River, management of the watershed will enable the Narrow River ecosystem to sustain fish, shellfish and other wildlife, as well as provide recreational and commercial opportunities for the benefit of residents and visitors to the Narrow River region.

2. Increasing use of the Narrow River is causing pollutant loadings that threaten water quality, the quality of life of local residents, and ultimately the economy of the region. The uses are residential and commercial development, and the resultant increase in impervious surfaces and recreational boating. According to the 1986 SAMP and 1992 aerial photographs, development through 1992 has increased approximately 30% since 1985 (ASA 1995) and there is the potential for another 36% increase at full development of the watershed.

3. State regulatory agencies have been focusing on two primary water quality pollutants in the Narrow River for over twenty years: coliform bacteria and nitrogen. These pollutants are associated with nonpoint sources, specifically septic systems, lawn fertilizers, domestic pets and atmospheric deposition. Since 1959, the Narrow River has failed to meet state standards for total coliform bacteria levels, and in 1979, parts of the Narrow River were closed to shellfishing. Beginning in 1994, the entire expanse of the Narrow River was closed to shellfishing and remains closed today due to high coliform bacteria levels. Although there are state standards for bacterial pollution in the Narrow River, there are none for nitrogen. Levels of nitrogen are monitored only through volunteer water quality monitoring under the direction of the URI Watershed Watch program.

### B. Sources and Pathways of Contamination of Narrow River Water Quality

1. Sewage disposed through septic systems is a major documented source of nitrogen and bacteria loading for many coastal environments. This is the case in the Narrow River (Howard-Strobel et al. 1987 and ASA 1995) as well as Cape Cod (Eichner and Cambareri 1992, Eichner 1993, Valiela and Costa 1988, Persky 1986, Costa et al. 1992), the Chesapeake Bay (Chesapeake Bay Program 1995, Kemp 1983), the Delaware Inland Bays (State of Delaware 1995), Long Island Bays (Koppleman 1976, Wolfe et al. 1991), and Tampa Bay (Johansson and Lewis 1992).

In densely developed areas where septic systems are the primary form of sewage disposal, nitrogen and bacteria contaminate groundwater, the source of private and public drinking water supplies. Septic system contamination comes from failed systems where untreated sewage may move overland to the Narrow River, from poorly designed and sited septic systems, and from systems that are located in areas which are sensitive to nitrogen and fecal coliform pollution. The cumulative effect of many septic systems discharging to groundwater can degrade coastal water quality, impacting aquatic vegetation, fish and shellfish habitat, and the marine food chain.

2. Stormwater runoff carries sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons and pathogenic bacteria and viruses to coastal waters (EPA 1995). As paved or impervious surfaces increase over a watershed, runoff increases, groundwater recharge is reduced, and more pollutants are carried into coastal waters and tributaries (Turner et al. 1977, Ikuse et al. 1975, Okuda 1975, Yoshino 1975, Hollis 1975, Gregory and Walling 1973, Lindh 1972, Holland 1969, Leopold 1968).

3. Commercial and residential fertilizer applications are also sources of water quality contamination (EPA 1992, EPA 1995). Higher rates of microbial processes in lawns and the perennial nature of home lawns contribute to lower leaching of nitrogen to groundwater than reported for many agricultural crops (Gold et al. 1990). However, over-watering and excess fertilizer application coupled with the steep slopes create the potential for fertilizer to run off into the Narrow River, a problem which has not yet been documented.

4. Petroleum hydrocarbons may enter the Narrow River from recreational boating and road runoff through storm drains. Field studies indicate that, in shallow-water environments, petroleum disappears rapidly from the water column but the portion that reaches the sediments may be expected to persist for many years (Butler and Levy 1978, Mann and Clark 1978, Sanders et al. 1980). Petroleum hydrocarbons may also enter the Narrow River occasional oil spills.

5. Many commercial and residential structures in the Narrow River watershed may have underground fuel tanks storing heating oil. Nationally, of the 1.2 million federally regulated USTs, 139,000 have leaked and impacted groundwater quality (EPA 1995). In Rhode Island, of 255 active USTs, 75% involve motor fuel leaks at gasoline service stations (EPA 1995).

6. Boats may introduce petroleum hydrocarbons, solvents, antifreeze, antifouling paints, heavy metals, acids/alkalis, surfactants present in most detergents and other cleaning agents, nutrients, bacteria, floatables/plastics, and creosote from pilings (Olsen and Lee 1985, Milliken and Lee 1990).

## C. Natural Features Affecting Water Quality

1. Topography

a. The Narrow River is not truly a river. It is more accurately described as an estuary or lagoon. This combination gives the Narrow River its unique quality and character, but also hinders the natural capabilities the river system has for assimilation of increased pollutant loadings.

b. 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 till was deposited, blanketing the valley walls with stratified sand and gravel deposited over the till in the bottom of the valley (Figure 3-1). The steep walls of the watershed pose one of the more severe constraints to watershed development. The western slopes range in steepness from 20-40% (Howard-Strobel et al. 1986). There are several hills in the northwest region with greater than 15% slopes that drain directly into the upper reaches of the estuary.

c. In the southern watershed, the topography slopes steeply to the flood plain along the river which is low relief and is near sea level. The veneer of sand and gravel thins, and bedrock outcrops in various locations (i.e., Gooseberry Island, southwest shore of Pettaquamscutt Cove). Because the bedrock is close to the surface and the soil layer is thin, the depth to the water table is usually less than three feet.

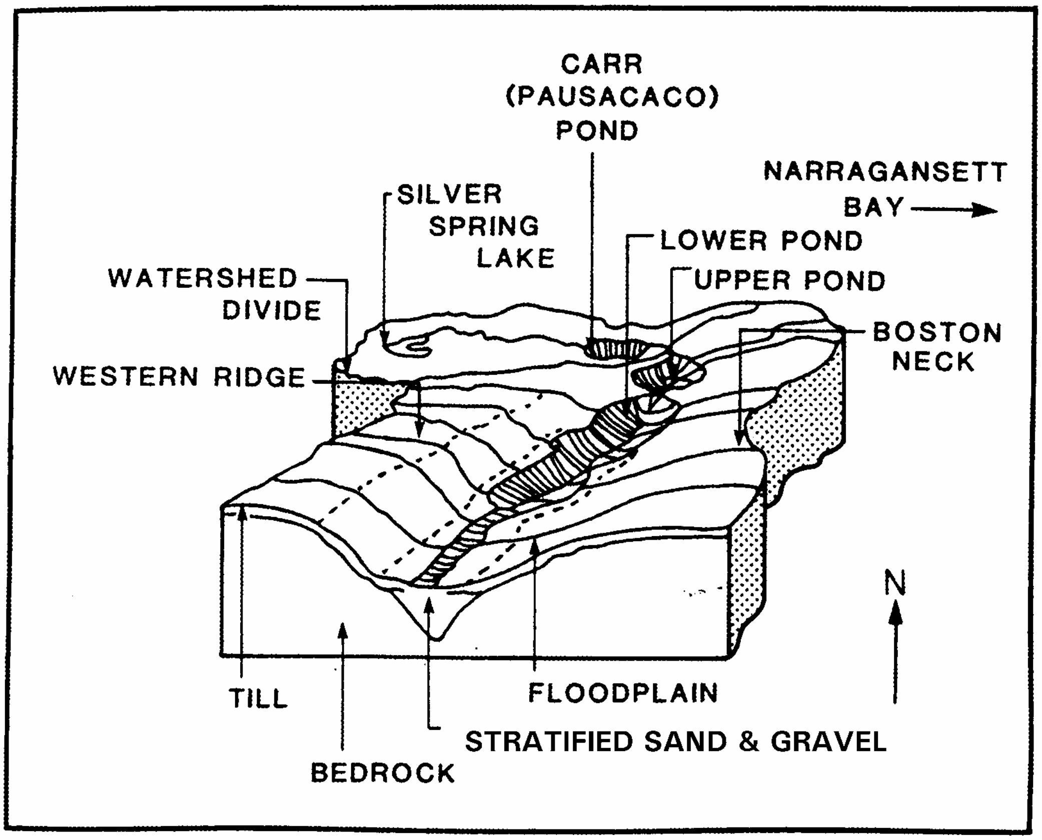



Figure 3-1. A perspective view of the topography and surficial geology of the Narrow River watershed (River Landscapes 1976).

2. Water Circulation

(a) The river is shallow (averaging 3-5 feet) except in the Upper and Lower Ponds which have maximum depths of 44.3 feet and 64 feet respectively (ASA et al. 1995). The constricted inlet channel, along with the bars and deltas in the lower portion of the Narrow River causes the nature of the tides in the estuary to change significantly along its length (ASA et al. 1995). Tides at the mouth of the Narrow River are principally semi-diurnal, with a 12.4 hour period. The range of the tidal wave at the mouth is 107cm. At the Sprague Bridge the tidal range is only 42cm. At the Lacey Bridge, the tidal wave range is reduced to 13cm, and at the head of Upper Pond, the range is less than 11cm (Gaines 1975). The time required for the tidal wave to spread along the length of the Narrow River is between 4 and 6 hours (ASA et al. 1995).

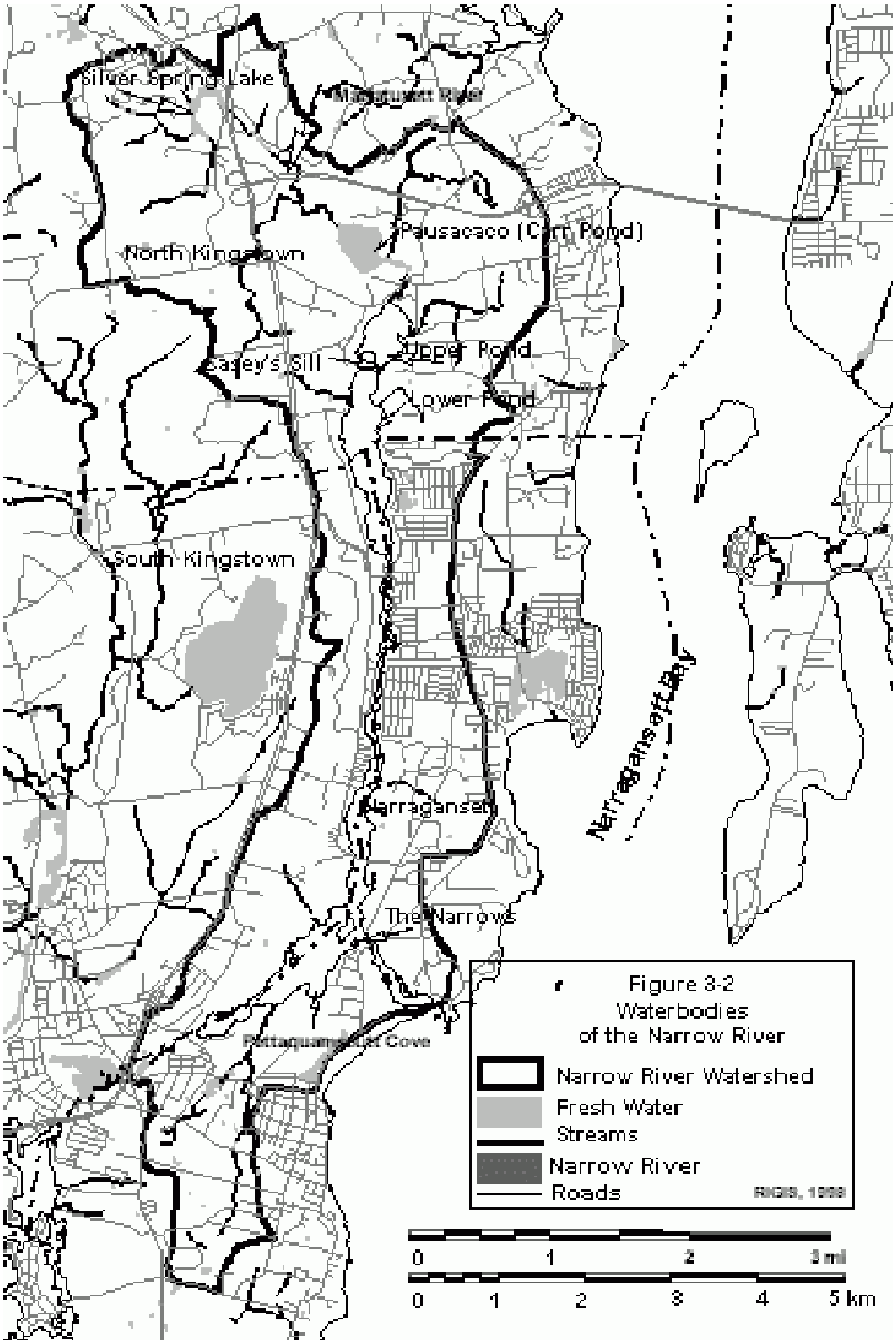
(b) Flushing time calculations were determined by ASA et al. (1995) for the Narrow River Stormwater Study. Flushing times were determined using an estuarine box model developed for Narragansett Bay at ASA, called Bay Model (Swanson and Jayko 1988). The model takes salinity values, freshwater inflows, and loads for any given pollutant, along with decay parameters and a small set of model execution parameters as input, and produces values for flushing time and concentration of pollutant (ASA et al. 1995). Under average conditions, an estimated 77 days would be required to move a contaminant introduced into Upper Pond down the estuary to the mouth off Narragansett Beach. Under drought conditions, it may take as long as a year and a half to flush the entire estuarine system. Freshwater input to the Narrow River therefore plays a significant role in pollutant behavior and potential impacts in this watershed ecosystem. Dye tests of flushing during the study indicate that flushing was slower than the model predicted, due to the complexities of the natural ecosystem and the complex interactions between different sections of the river.

**Table 3-1.** Flushing times as modeled by ASA et al. (1995) for various sections of the Narrow River during "average" conditions (e.g., normal rainfall). Flushing time is the time required, in days, to move from one river section to the next downstream section. Integrated flushing time is the time, in days, to move from the given river section out and into Rhode Island Sound. See Figure 3-2 for river section locations.

| Location | Flushing Time (days) | Integrated Flushing Time (days) |
|---|---|---|
| Upper Pond | 27.46 | 77.47 |
| Lower Pond | 47.73 | 50.01 |
| Upper River | 1.52 | 2.28 |
| Lower River | 0.65 | 0.76 |
| Pettaquamscutt Cove | 6.62 | 6.72 |
| The Narrows | 0.4 | 0.11 |

(adapted from ASA et al. (1995) Tables 4-15 and 4-16)

Figure 3.2. Water bodies of the Narrow River System.



3. Freshwater Inflow

(a) There are ten perennial streams that enter the Narrow River. The principal streams are Gilbert Stuart Stream, which discharges into Upper Pond in the north, and Crooked Brook and Mumford Brook, which discharge into Pettaquamscutt Cove in the south (Urish 1991). The other regions receive the majority of their freshwater inflow as groundwater seeping out along the coastal margin (Urish 1991). Gilbert Stuart Stream contributes about 34 percent of the total freshwater flow to the watershed, and Crooked Brook, and Mumford Brook represent about 19 percent of the total freshwater flow (Urish 1991).

(b) Studies in the Narrow River watershed (Urish 1991; ASA et al. 1995) have found that groundwater plays a significant role in watershed hydrology. Overall, 65% of the total freshwater (streamflow, groundwater, overland runoff and precipitation) flowing into the Narrow River ecosystem originates as groundwater. The influence is even greater in the central portion of the watershed where 73% of the freshwater entering the Narrow River goes through highly permeable sands and gravels (Urish 1991). This freshwater flow not only influences the flushing of the ecosystem, but is a major conduit for pollutants to the estuary, particularly nutrients leached into the groundwater from residential septic systems.

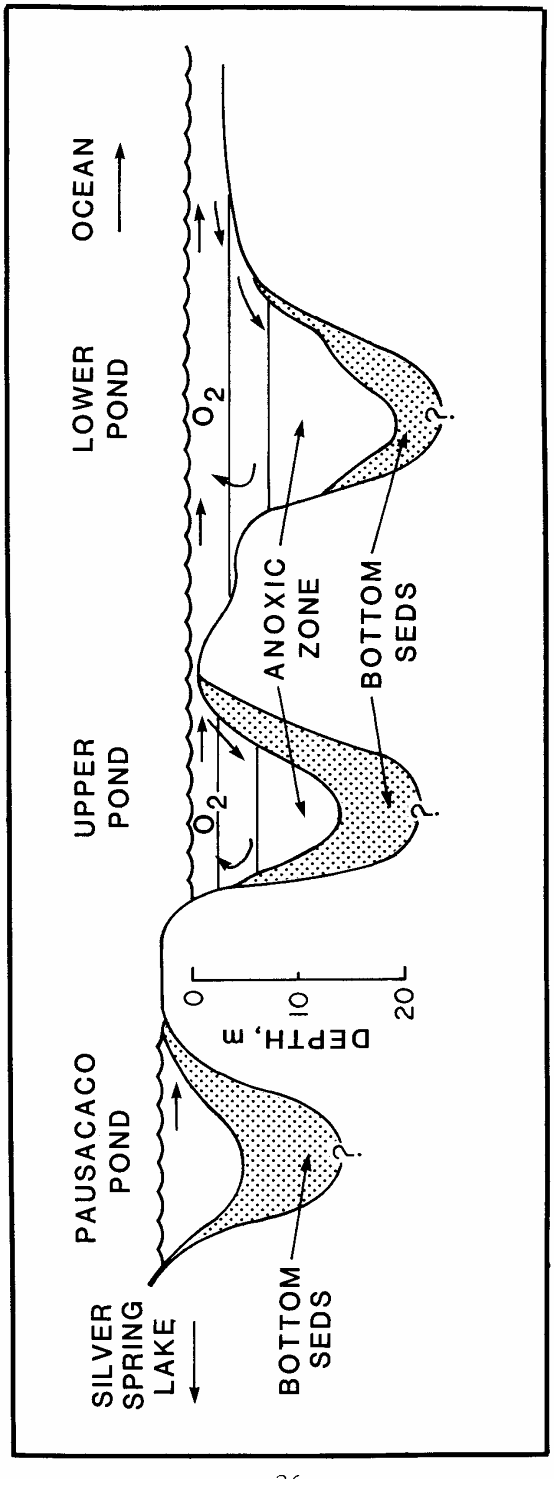
4. Anoxic Basins

(a) 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 or the headwaters region, and because of this great depth, have a separate and distinct character.

(b) The basins are characterized by strong water column stratification induced by the sinking of heavier waters on flood tide below the more buoyant fresh upper layers in a process termed density stratification (see Figure 3-3; Gaines 1975). Furthermore, the temperature of bottom waters may be several degrees cooler than surface waters, and this thermal stratification strengthens the overall stratification of the upper basins. 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 the process known commonly as “overturn”. When ambient conditions are right, generally during a major storm or excessive spring tide event (Gaines and Pilson 1972), the bottom waters are displaced to the surface, releasing accumulated nutrients and gases, most notably hydrogen sulfide. This sudden flux of nutrients and gas has been known to cause fish kills (Horton 1958). Residence time of bottom waters of the Upper Pond has been estimated to be approximately 3 to 5 years (Gaines 1975).

(c) As a consequence of this strong stratification that impedes mixing, bottom waters become anoxic or devoid of oxygen. Analysis of sediment cores show anoxic bottom waters in the upper basins occurred prior to significant human inhabitation of the area (Gaines 1990).

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



**D. Land Use and Water Quality**

1. New Technologies. Engineering designs for treatment of stormwater and sediment and innovative technologies for sewage disposal are now sufficient to allow development on lots that have steep slopes and limited area for treatment of effluent and stormwater runoff.

Consequently, development pressures in the Narrow River are a concern for the remaining undeveloped 65% of the watershed (RIGIS 1988). As the watershed is further developed, the percentage of impervious surface will increase with a corresponding increase in the amount of surface water runoff. Surface water runoff is a major pathway by which substances such as road tars and oils, trace metals, nutrients, sediments and petroleum products enter receiving waters (Hoffman and Quinn 1983). Thus, while high bacteria counts present the most immediate threat to the use of Narrow River for shellfishing and swimming, increased pollutant loading resulting from development can alter habitat characteristics resulting in long term degradation of ecological, recreational, and aesthetic qualities. When watershed imperviousness exceeds 10%, receiving waters are impacted by increased siltation, bacterial contamination and nutrient availability (Klein 1979). At present, the Narrow River watershed is estimated to be about 15% impervious within a one-half kilometer radius of the river (Desbonnet and Lee, Personal Communication 1996).

## 320. Water Quality Status

### 320.1 Bacterial Contamination

**A. Definition of the Problem**

1. In accordance with the national guidelines established by the EPA, fecal coliform bacteria are used as the primary indicator of sewage contamination, and hence indicate the potential for human pathogenic disease transmission as a result of water contact or consumption of raw shellfish. The U.S. Food and Drug Administration National Shellfish Sanitation Program established fecal coliform bacteria concentration limits for determining the safety of salt water areas for the harvesting and consumption of shellfish. The Rhode Island Department of Environmental Management (RIDEM) closes areas for the harvesting of shellfish in accordance with the National Shellfish Sanitation Program criteria listed in Table 3-2.

2. The RIDEM currently classifies the Narrow River as follows: Type SA waters from the Narrows to the landward limit of the saltwater influence at the top of Upper Pond; Type A waters from Gilbert Stuart Stream to Pausacaco Pond; and Type B waters from the start of the Mattatuxett River to Silver Spring Lake and Pendar Pond.

3. 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 (Table 3-2).

## B. Findings – Results of Bacterial Contamination Studies in the Narrow River

1. Historically, RIDEM water quality data shows that the Narrow River has consistently exceeded state standards for total coliform counts since 1959 (Howard-Strobel et al 1986). In 1974, Repaz and Hargraves (Figure 3-4) obtained samples above and below Middlebridge Bridge after late July storms and found total median coliform levels of 2799/100ml and 2863/100ml, respectively. More recently Sieburth (1983) measured high total coliform counts in 1978 and 1979 while doing a study for the Narrow River Preservation Association (Figure 3-5). The results of his study led to the closing of the Narrow River to shellfishing in August 1979. It was re-opened the following spring of 1980.

Table 3-2. State of Rhode Island Water Quality Standards for Dissolved Oxygen (mg/l) and Fecal Coliform (MPN – most probable number per 100 milliliters)(1996).

| Salt Water<br>Class - Use | Dissolved Oxygen | Fecal Coliform<br>(MPN per 100 milliliters) |
|---|---|---|
| Class SA - Shellfish harvesting for direct human consumption; bathing and primary contact recreation; fish and wildlife habitat | Not less than 6 mg/l at any place or time | Geometric mean not to exceed 14 nor shall 10% exceed 49 |
| Class SB - Shellfish harvesting for human consumption after depuration; bathing and primary contact recreation; fish and wildlife habitat | Not less than 5 mg/l at any place or time | Geometric mean not to exceed 50 nor shall 10% exceed 500 |
| Class SC - Boating and other secondary contact recreation; fish and wildlife habitat; industrial cooling; good aesthetic value | Not less than 5 mg/l at any place or time | None that impair use |
| **Fresh Water**<br>Class - Use | Dissolved Oxygen | Fecal Coliform<br>(MPN per 100 milliliters) |
| Class A - Drinking Water Supply | 75% saturation, 16 hrs/day; no concentration less than 5 mg/l at any place or time | Geometric mean not to exceed 20 nor shall 10% exceed 200 |
| Class B - Public water supply with appropriate treatment; agricultural uses, bathing; other primary contact recreational activities; fish and wildlife habitat | Minimum of 5 mg/l any place or time, except as naturally occurs | Geometric mean not to exceed 200 nor shall 20% exceed 500 |
| Class C - Boating and other secondary contact; recreational activities; fish and wildlife habitat; industrial processes and cooling | Minimum of 5 mg/l any place or time, except as naturally occurs | Not applicable |

Figure 3-4. 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 Repaz and Hargraves 1974).

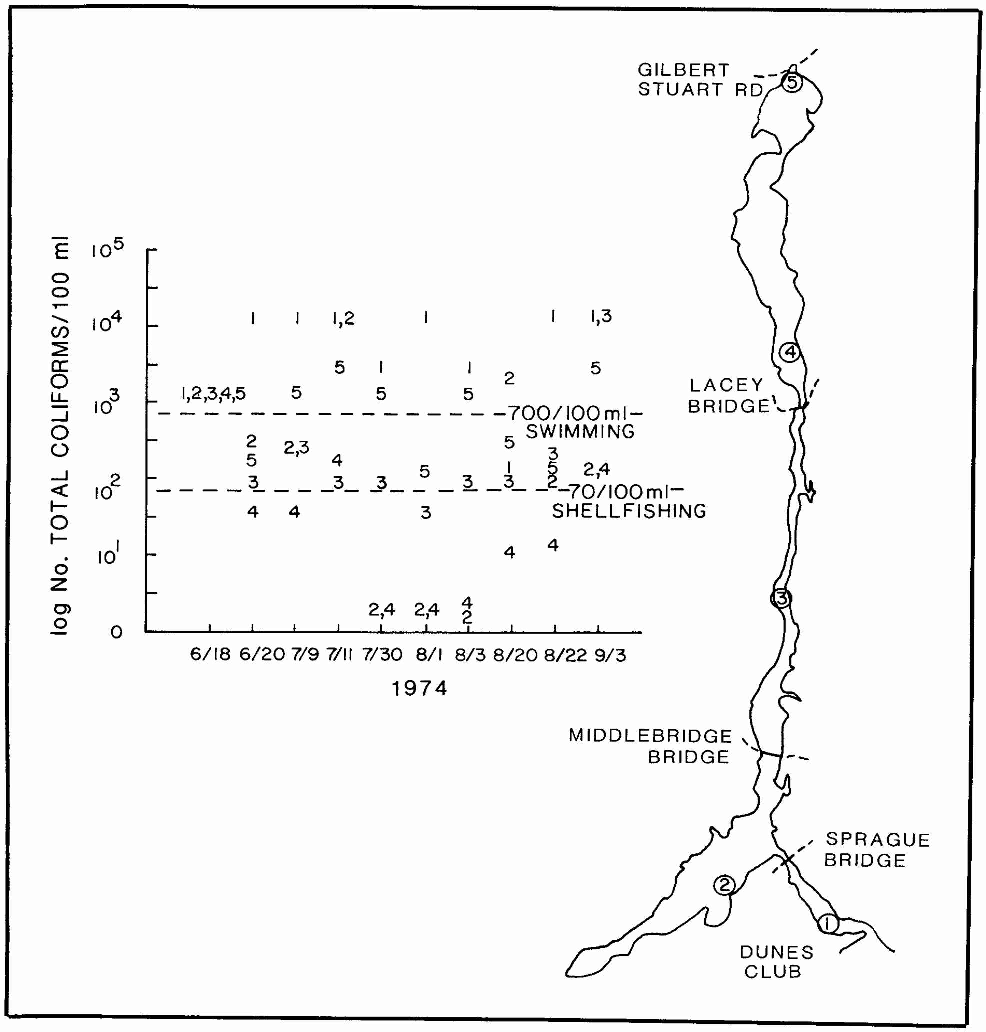
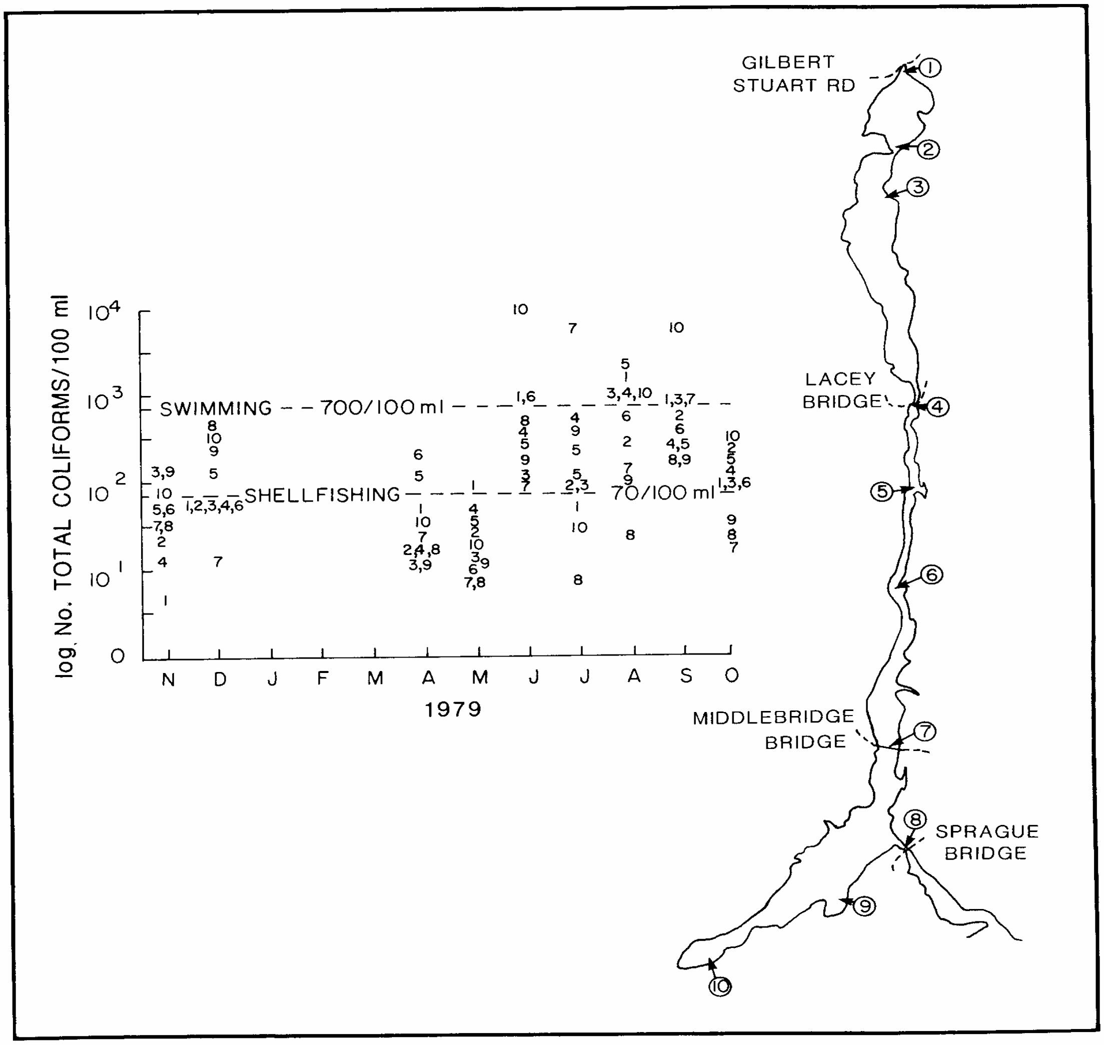


Figure 3-5. Total coliform levels measured throughout the year of 1979 along the Narrow River. Numbers plotted in the graph refer to the station numbers along the river. The two dashed lines in the graph represent the uppermost level for each standard: shellfishing and swimming (Sieberth 1983).



RIDEM monitoring data shows that of 121 samples taken from the river between 1959 and 1980, 50 (41%) were out of compliance (> 70 MPN total coliforms). Between 1980 and 1985, 24 of 48 samples taken, or 50%, were out of compliance (> 70 MPN total coliforms). Since the Narrow River was closed entirely in 1986, RIDEM samples four of the thirteen bacteria stations (Bridgetown Road Bridge, Mettatuxet Yacht Club dock, Middle Bridge, and Sprague Bridge) (Migliore, Personal Communication 1998). These stations are sampled after wet weather events four times a year. Every station has exceeded the State of Rhode Island Water Quality Standards for SA waters since 1986 (Migliore, Personal Communication 1998).

2. The URI Watershed Watch program also monitors the Narrow River for water quality trends. Station locations are identified in Figure 3-6. Fecal coliform bacteria monitoring data collected between 1992 and 1995 show a seasonal trend (Figure 3-7, middle and bottom panels), with late summer (August-September) samples being higher than earlier in the sampling season. Earlier studies by Repasz and Hargraves (1974; Figure 3-4) and Sieburth (1983; Figure 3-5) also show seasonal trends similar to those found by Watershed Watch volunteers. A trend towards increasing bacterial levels with distance down river was also noted through Watershed Watch monitoring data (Figure 3-7, top and middle panels). "Hot spots" of consistently higher bacterial counts were readily observed to occur in Gilbert Stuart Stream (Figure 3-7, Station NR-1, top and middle panels). Sampling performed as part of a major stormwater study (ASA et al. 1995) indicate that Pettaquamscutt Cove generally had bacterial levels higher than other areas of the watershed, although this is not noted in the Watershed Watch monitoring data.

Figure 3-6. Watershed Watch Narrow River Monitoring Locations (1995).

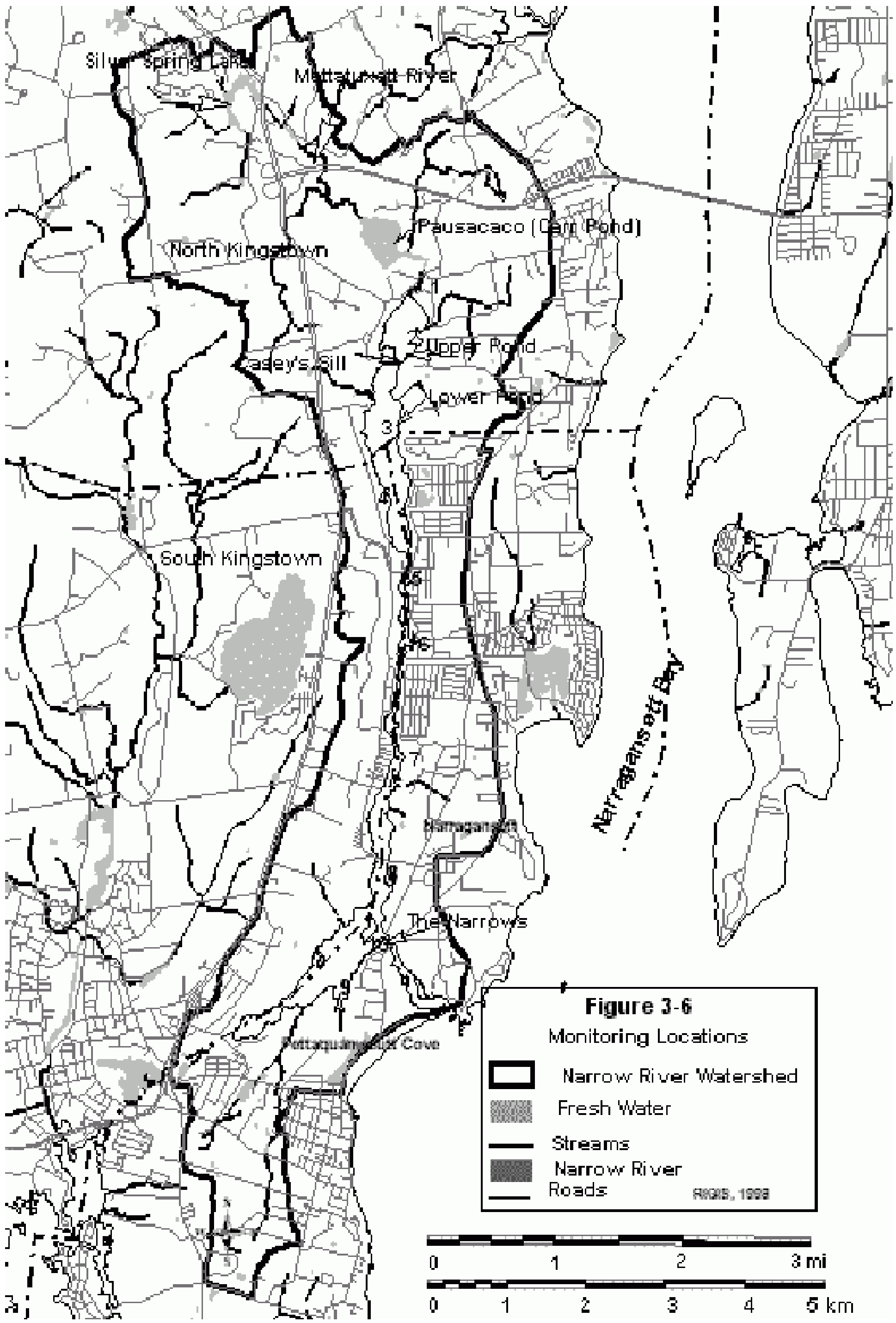
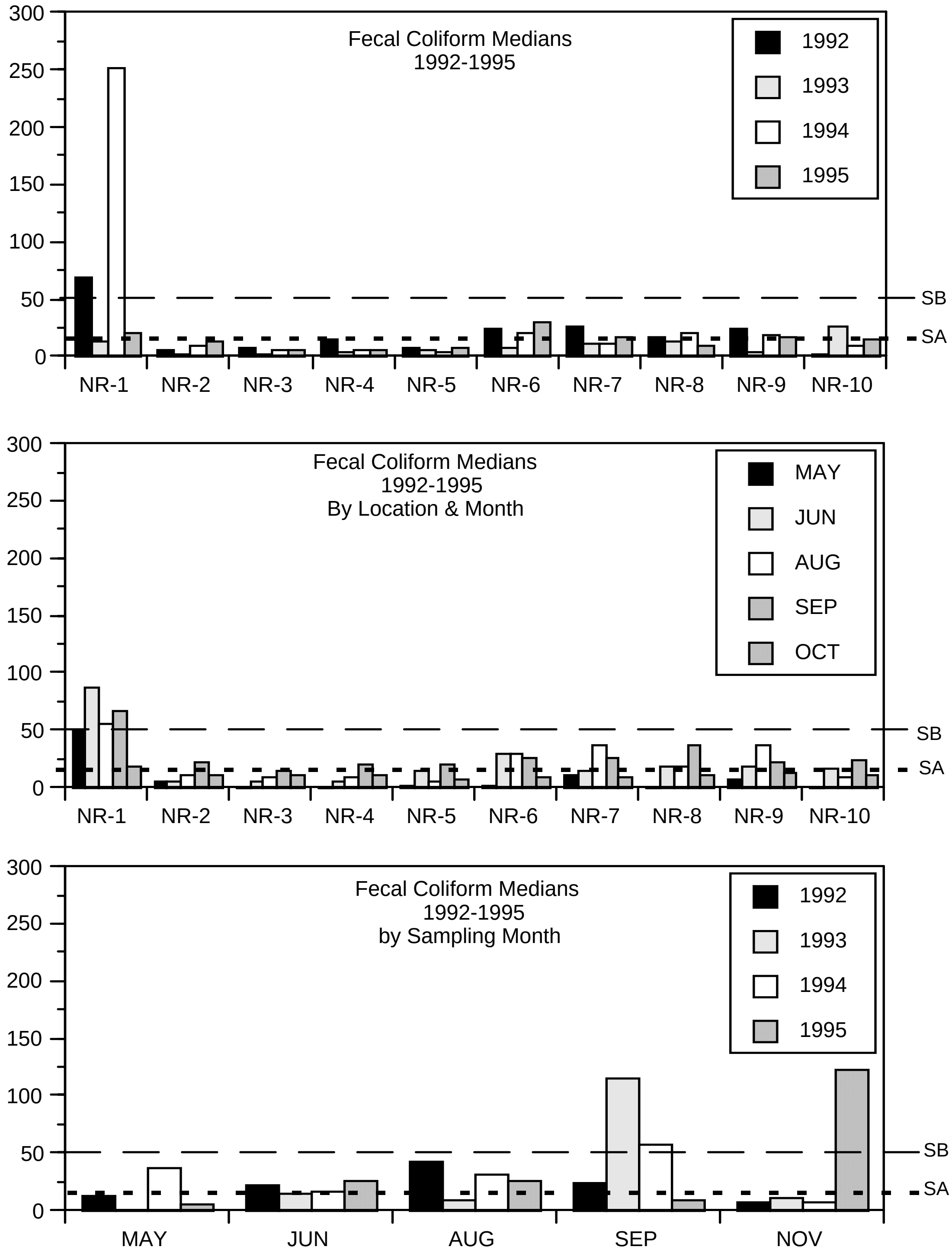


Figure 3-7. Seasonal and annual median fecal coliform concentrations in the Narrow River as measured by Watershed Watch volunteer monitors 1992-1995.



3. Water quality monitoring by Watershed Watch volunteers from 1992 through 1995, and throughout the length of the river (Herron and Green 1996), show that fecal coliform concentrations generally exceed SA criteria but not SB criteria, except occasionally in late summer months (Figure 3-5). Analysis of Watershed Watch bacterial monitoring data for the Narrow River has found that bacterial levels are closely correlated to rainfall events (Herron and Green 1996), suggesting that surface water runoff is a major source of bacterial contamination. Although the overall patterns of coliform contamination have not markedly changed over the past twenty years based on the different monitoring studies, the data are not directly comparable because of different sampling protocols and it is not possible to determine if the level of contamination has improved or gotten worse over that time frame.

4. There have been two major attempts to assess the impacts of stormwater runoff through storm drains in the Narrow River. RIDEM sampled 22 of the 33 storm drains along the Narrow River in April 1980 and June 1982 (Figure 3-9). State standards were exceeded by 3 to 3,400 times for total coliforms and by up to 3,000 times for fecal coliforms (Table 3-3). In 1993, as part of the Tri-town study for a comprehensive stormwater management plan, Applied Science Associates identified a total of 42 drainage outfalls. 23 outfalls discharge directly to the Narrow River and the other 19 discharge into detention ponds or wetlands or are directed as overland flow with no direct point of discharge to the Narrow River (ASA 1995). ASA measured coliform concentrations during periods of stormwater flow in four out of the 23 direct stormwater outfalls to the Narrow River (1995). During the four storms that were sampled, coliform concentrations exceeded DEM SA water quality criteria of 15/100 ml, and ranged from 130/100 ml to 100,000/100 ml in all 23 stormwater outfalls sampled (ASA et al. 1995). Pettaquamscutt Cove consistently showed higher in-water coliform concentrations than any other area of the river during this 1995 study, with Mumford Brook identified as the major source to the cove during both dry and wet weather.

Table 3-3. RIDEM 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 | --- |
| 23 | 2,300/230 | 75,000/4,300 | 230,000/230,000 |

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

**C. Sources of Bacterial Contamination**

1. Sources of bacterial contamination that exist within the watershed include failed septic systems, and fecal material from domestic animals and wildlife. The Tri-town stormwater study identified dry weather stream flow and stormwater flow as major pathways for fecal coliforms to travel to the Narrow River (ASA 1995).

2. ISDS are well known as a 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 lack of maintenance which tend to shorten the life, the ultimate fate of ISDS is failure due to clogging of the soil in the leachfield 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 3-4 and Figure 3-8). During or after a rainstorm, the effluent from a failed ISDS, 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 percentage of samples out of compliance with RIDEM water quality standards within three days of a rainstorm. Between 1959 and 1980 82% of samples taken under these conditions 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).

3. In the early 1980s, construction standards and field inspections became more rigorous to protect public health and the environment. The RIDEM Division of Groundwater and ISDS issues permits for ISDS to ensure that minimum standards are upheld in the siting, design and construction of such systems. RIDEM has specific standards for the siting and design of large systems designed to treat more than 2,000 gallons per day and subdivisions in critical resources areas which include the Narrow River. In accordance with state regulations, an ISDS installed in the Narrow River watershed must meet special siting standards listed below.

(a) Large Systems (>2,000 gallons)

(i) Depth to groundwater must be less than 5 feet of the original ground surface;

(ii) Large systems are not permitted in high permeable soils (perc rate faster than 3 minutes per inch) unless it can be shown that groundwater and surface water will be protected;

(iii) Horizontal separation distances from large systems to wells and surface waters must be three times that given for ISDS less than 2,000 gallons (25-200 feet).

**Table 3-4.** Summary of RIPE, Inc. Survey, 1980.

| **Neighborhood** | **Age of Homes (yrs)** | | | **Age of Septic (yrs)** | | | **% Homes with Pump Program** | **Chemical Use & Frequency** | **Septic System** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0-11** | **12-20** | **20-30** | **0-11** | **12-20** | **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 | - | - |
| Pettaquamscutt 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

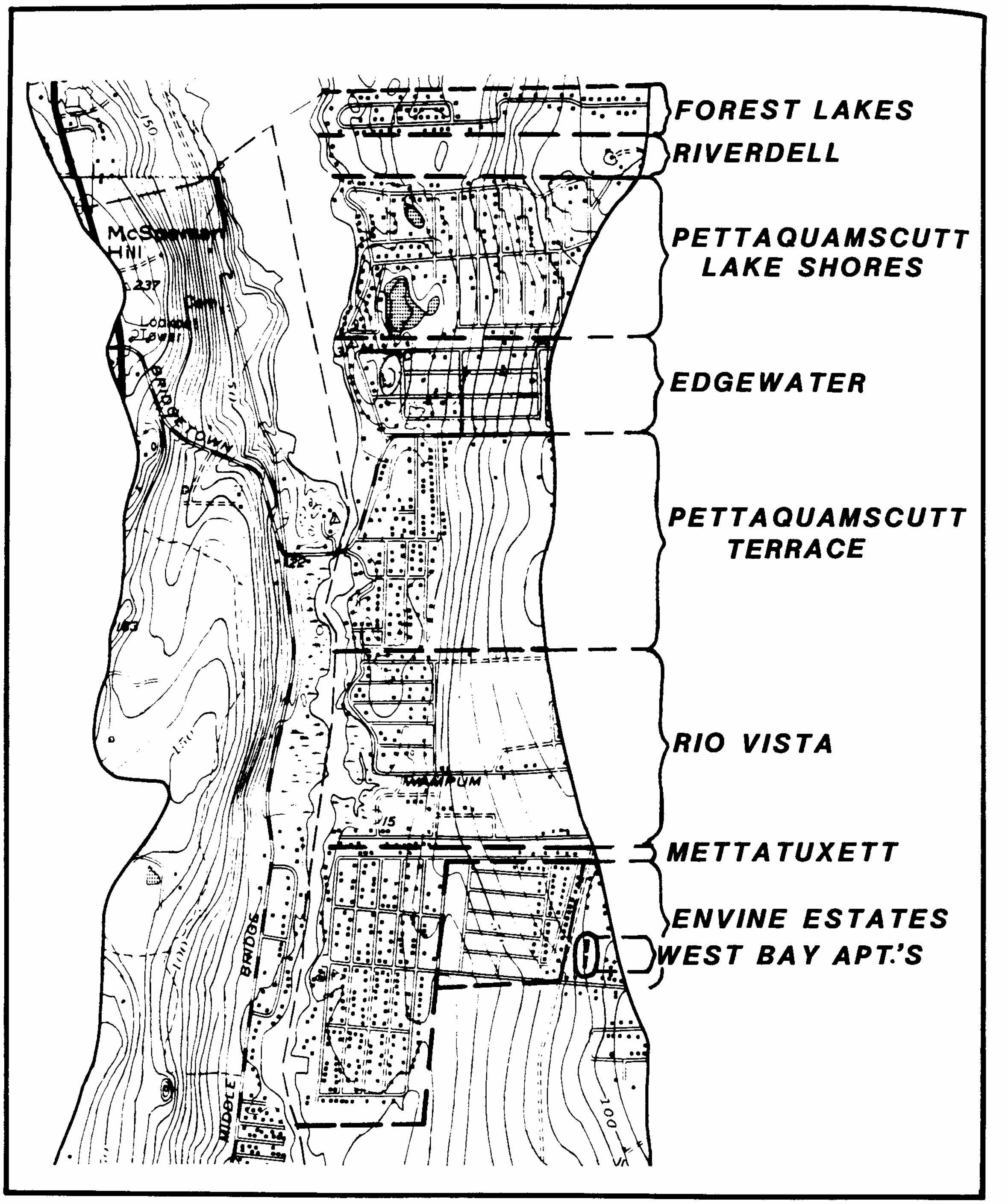



**Figure 3-8.** Location of neighborhoods surveyed by RIPE, Inc. 1980.

(b) Subdivisions

(i) Where combined flow from each system within a subdivision is 2,700 gallons per day or greater an assessment of the impact of the estimated pollutant loadings to ground and surface waters including ability of wetlands to support indigenous animal and plant life will be required. In addition, there is a 150 foot setback to critical resources areas (including the Narrow River), and a 200 foot setback to surface drinking water supply or tributary stream or drain (RIDEM 1992).

4. The CRMC manages for the potential impacts of ISDS on the coastal environment by requiring a 200' setback from the Narrow River.

5. Properly constructed and maintained ISDS are preferable to sewers in most areas because the ISDS percolate recharges the underlying groundwater whereas sewer systems carry the water outside of the watershed. Maintenance of the quality and quantity of groundwater is essential for sustainable development of the Narrow River region. Groundwater from within the watershed is a source of drinking water for North Kingstown, and parts of Narragansett.

6. Domestic animals and wildlife as a source of bacterial contamination have not been investigated in the Narrow River watershed. The RIDEM (1996) and ASA et al. (1995) suggest 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). Although the seasonal time series of counts show that winter is a period of relatively depressed coliform levels (RIDEM 1979), it is not clear if this is due to decreased levels of bacteria in the water column or if the organism is not viable in the sample taken. Mortality could result from "shocking" the organism; taking it from a state of low metabolism (colder temperatures in the winter) and then incubating it in a highly nutritive medium (Personal Communication, Gerri Miceli 1998).

## 320.2 Nutrient Loading and Eutrophication

### A. Definition of the Problem

1. Eutrophication is a process where there is an increase in the rate of supply of organic matter to an ecosystem (Nixon 1995). Eutrophication resulting from excessive nutrient loading of coastal waters has been identified as one of the major emerging problems for the coastal environment in the twenty-first century (Goldberg 1995, GESAMP 1990, Nixon 1995). In the 1994 National Water Quality Inventory, the EPA reported that more square miles of estuarine water were polluted by nutrients and bacteria than any

other pollutant or process (EPA 1995). In marine ecosystems nitrogen is the essential nutrient which stimulates plant growth, while in freshwater ecosystems phosphorus plays the controlling role. (Ryther and Dunstan 1971, Nixon and Pilson 1983, Smith 1984, Taylor et al. 1995a). Studies of nutrient impacts on ecosystems similar to the Narrow River in the northeast include Moriches and Great South Bays on Long Island, New York (Ryther 1989), Mumford Cove in Connecticut (French et al. 1989) and Waquoit and Buttermilk Bays in Massachusetts (Valiela and Costa 1988, Valiela et al. 1988).

2. Nutrients act as powerful biostimulants causing an increase of primary production of organic matter and consequent symptoms of eutrophication in coastal waters. (Nixon 1983 and 1995). Symptoms of coastal eutrophication include:

- Reduced biodiversity
- Increased seaweed biomass
- Shift from large to small phytoplankton
- Shift in species composition of phytoplankton from diatoms to flagellates (which are less desirable as a food source for shellfish and other filter feeders)
- Loss of eelgrass habitat
- Shift from filter feeding to deposit feeding benthos
- Bottom sediments become increasingly organic
- Increased disease in fish, crabs and lobsters
- Increase in aerial extent and frequency of low oxygen events resulting in the depletion of fish and shellfish populations
- Occurrence of toxic phytoplankton blooms
- Loss of aesthetic quality and recreational use

Many of these symptoms of eutrophication have been reported for the Narrow River.

3. As nutrient loading increases in enclosed bays like the Narrow River, massive growth of algae occurs and the dissolved oxygen necessary for aquatic life is depleted. During extreme low oxygen events, hypoxia (less than 3 mg oxygen per liter) or anoxia (all the dissolved oxygen is consumed) occurs with consequent fish kills, reduced biodiversity of fish and shellfish populations, mass mortality of benthic animals, bacterial slimes, foul smelling odors and in extreme cases, generation of toxic levels of hydrogen sulfide (Nixon 1995, Goldberg 1995). Eventually, fish and shellfish populations decline, waters become weed-choked and murky, the bottom accumulates organic sediments, and anoxic events occur that are toxic to aquatic life.

4. 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 largely from ISDS leachate and lawn and garden fertilizers (Koppelman 1978; Canter

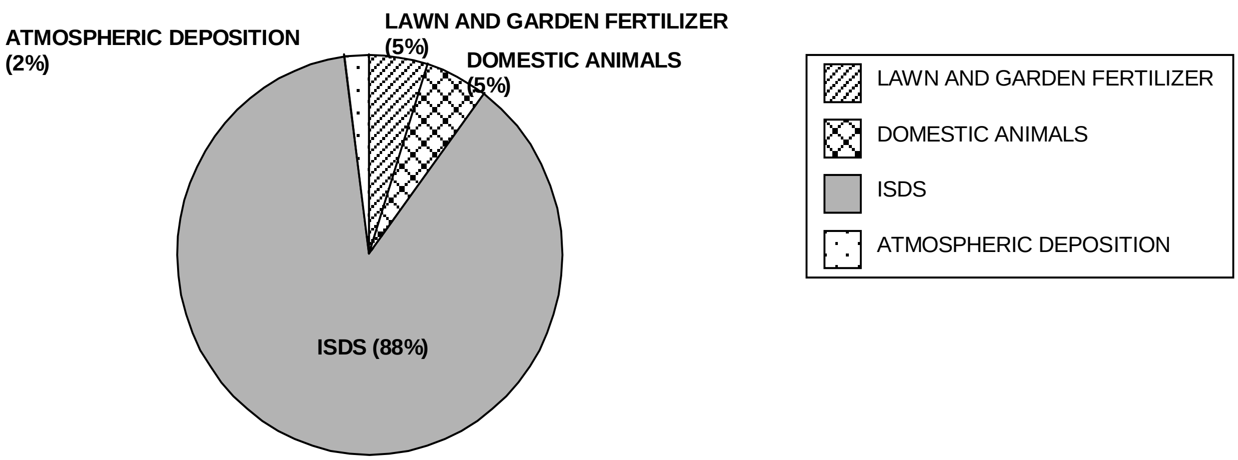
and Knox 1985). The increased population growth and high potential for failing ISDS in the watershed, suggests that the level of nutrients in the estuary could increase in the future.

## B. Findings – Sources of Nitrogen to the Narrow River

1. Individual sewage disposal systems (ISDS) are the largest contributor of nitrate-nitrogen to groundwater. In a single family residence with 2.3 people for instance, ISDS are the largest contributor of nitrate-nitrogen to groundwater (Figure 3-9).

Household water use can have implications for the transmission of nitrogen through the ISDS. Use of water control devices not only conserves water, but also reduces nitrogen loading to sensitive areas in the Narrow River. Differences in water use do contribute to the amount of nitrogen retained in the leachfield (Valiela et al. 1997). As the volume of water that is used by a household increases, effluent moves more quickly through the septic system and less nitrogen is retained.

Figure 3-9. Estimated sources of nitrate-nitrogen to groundwater from a household with 2.3 people (1990 U.S. Census Bureau data for Charlestown) on a 1394m2 lot (1/3 acre) with 464.7m2 of lawn and garden with 1.19m of rainfall and 1.04 mg/NO3-N/l (Cape Cod Commission 1992, Gold et al. 1990, Long Island 208 Plan 1978, Fraher 1991, URI Rainfall 1994-95).




2. Agriculture. Water that percolates through well drained soils in corn fields fertilized with manure can have levels as high as 10 mg/l in mid-summer and continue to be elevated throughout the fall (Gold et al. 1990). However, farmland is so sparse in the Narrow River watershed that agriculture is not a significant source of nitrogen. Even in areas around other estuaries where agriculture is a dominant land use, nitrogen loading to groundwater are less than one third of the total human loading (Jordan et al. 1997).

3. Domestic pets. Domestic pets contribute nitrogen directly to the groundwater and through stormwater runoff.

**C. Findings – Results of Nitrogen and Phosphorus Studies in the Narrow River**

1. 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.

2. Recent monitoring by Watershed Watch volunteers for nutrients indicates phosphorus increases in concentration through August in the upper and middle portions of the Narrow River (Stations 1-7), then begin to decrease (Herron and Green 1996, Figure 3-10). Another trend is increasing concentrations of phosphorus with distance traveled downriver (Figure 3-10). For nitrogen, the opposite is seen, with concentrations generally increasing with distance up the estuary (Figure 3-11), a trend noted by Herron and Green (1996) to be closely correlated to salinity of the water. However, between 1992 and 1995 no clear trend could be found in levels of phosphorus or nitrogen in the estuary (Figure 3-10 and Figure 3-11, bottom panels).

**Figure 3-10.** Seasonal and annual average total phosphorus concentrations in the Narrow River as measured by Watershed Watch volunteer monitors 1992-1995. (See Figure 3-6 for station locations) (Herron and Green 1996).

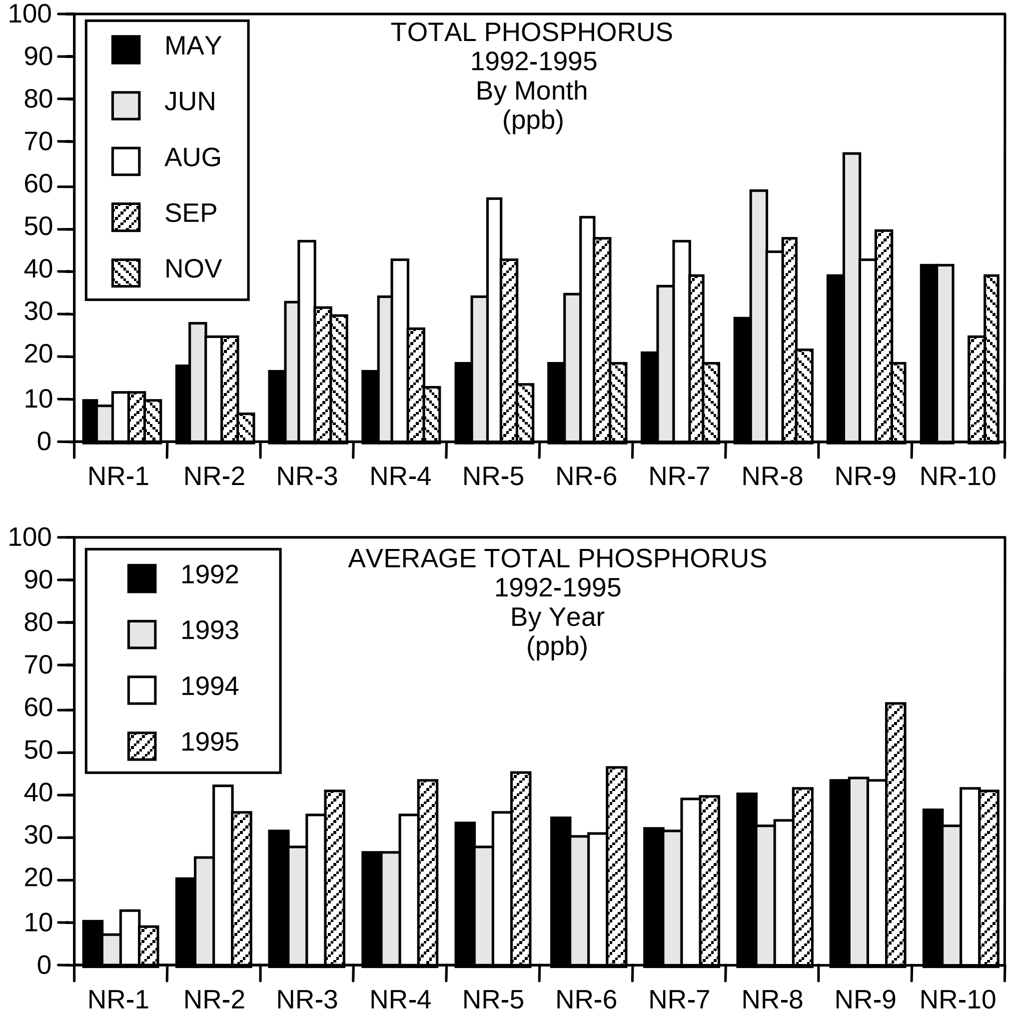
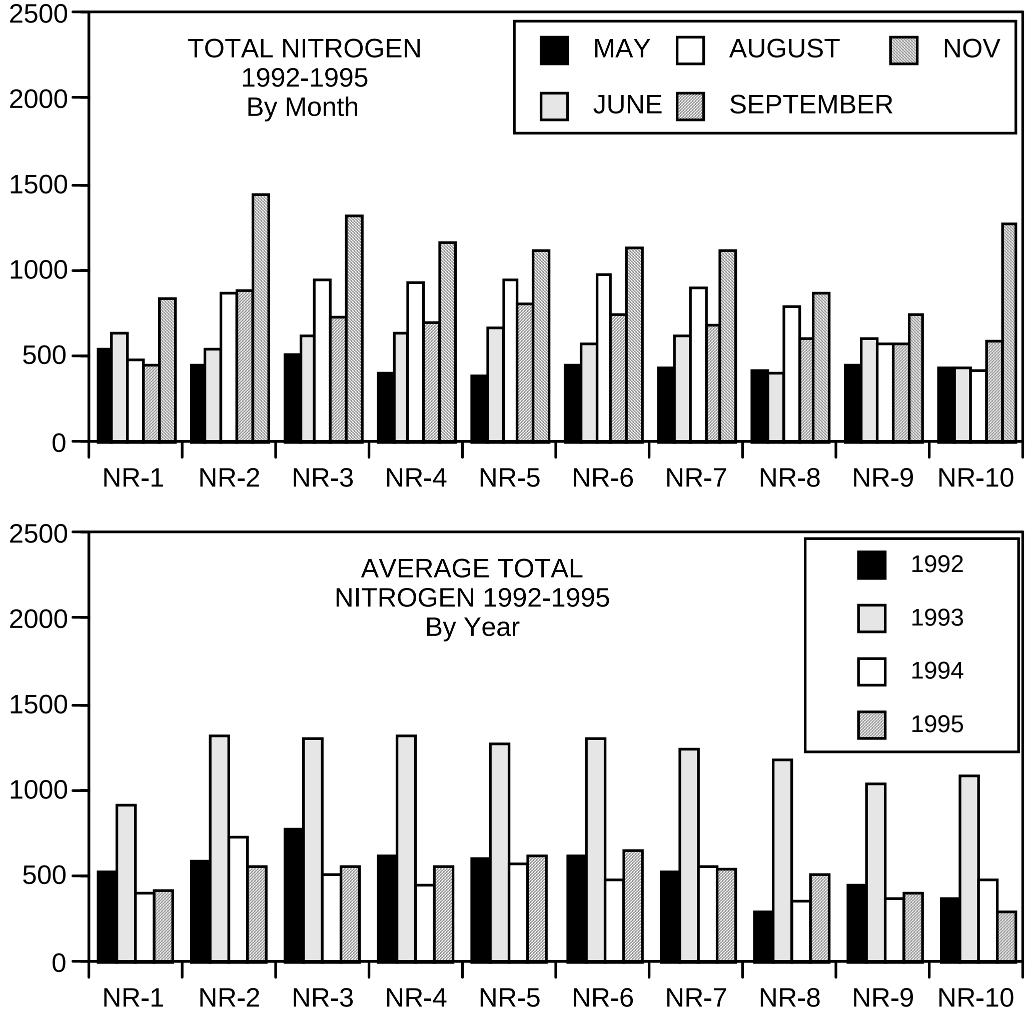


**Figure 3-11.** Seasonal and annual average total nitrogen concentrations (ppb) in the Narrow River as measured by Watershed Watch volunteer monitors 1992-1995. (See Figure 3-6 for station locations) (Herron and Green 1996).



3. Groundwater. Research in the last decade indicates that groundwater flow and transport of nutrients into shallow coastal waters is far more significant and widespread than had been previously realized (Johannes 1980, Bokuniewicz 1980, Capone and Bautista 1985, Lewis 1987, Lee and Olsen 1985, Valiela et al. 1990). Groundwater flow is especially important where underlying coastal sediments are coarse, unconsolidated sands of glacial or marine origin, typical of much of many areas around the Narrow River (Valiela et al. 1990). Groundwater was found by ASA et al. (1995) to be a major pathway for nutrient inputs, particularly for nitrogen, to the Narrow River. Groundwater concentrations vary greatly depending on land use. For instance, nitrate levels in groundwater measured during a 1988-89 Rhode Island Sea Grant Study in the Narrow River watershed were as high as 72 mg/l in residential areas with ISDS (Urish 1991), which is seven times the EPA standard for nitrate-nitrogen. In areas without development, nitrate concentrations were typically less than 0.5mg/l.

4. Applied Science Associates modeled groundwater nitrogen loading to the Narrow River as part of the Narrow River Stormwater Management Study. Nitrogen loading was determined using a mass-balance model developed by the Water Resources Office of the Cape Code Commission (Eichner and Cambareri 1992, Frimpter et al. 1988). Nitrogen loading to the Narrow River from the watershed was calculated to be 117 pounds per day or an annual nitrogen load of 43,000 pounds (21 tons) (Table 3-5) (ASA et al. 1995).

**Table 3-5.** Average daily nitrogen loading to the Narrow River. Loading is based on atmospheric input, surface water input, and groundwater input. Numbers contained in parentheses ( ) are the number of unsewered houses used in calculations. Current houses determined by counting houses on 1992 aerial photos with unsewered houses determined by comparison to existing sewer lines. Build out houses determined based on zoning and the future extent of sewer lines and soil suitability to septic system installation. Nitrogen loading is given in pounds per day.

| Region | Area (acres) | Present # Houses | Present N Loading (lbs/day) | Build Out # Houses | Build Out N Loading (lbs/day) |
|---|---|---|---|---|---|
| Upper Pond | 3699 | 534 (534) | 35.73 | 1027 (1027) | 66.59 |
| Lower Pond | 1082 | 572 (572) | 36.48 | 769 (141) | 16.81 |
| Upper River | 566 | 663 (142) | 15.31 | 768 (18) | 10.21 |
| Lower River | 956 | 653 (0) | 8.20 | 835 (108) | 15.82 |
| Pettaquamscutt Cove | 1537 | 760 (201) | 20.05 | 929 (273) | 25.68 |
| The Narrows | 241 | 31 (14) | 1.22 | 35 (14) | 1.27 |

| | | | | | |
|---|---|---|---|---|---|
| **Watershed Total** | **8081** | **3213 (1463)** | **116.98** | **4363 (1581)** | **136.38** |

(adapted from ASA et al. (1995) Table 4-12)

5. The study performed by ASA et al. (1995) also found that dry weather flows entering the river are consistent, and very significant, sources of nutrients. Dry weather flows are supported by groundwater recharge, therefore reflecting groundwater contaminant levels. Dry weather flows were estimated to input 67 pounds of nitrogen per day to the Narrow River, a total of 8,100 pounds over a four month period.

6. Surface Water. The Narrow River Stormwater Management Study completed by ASA et al. 1995 sampled four locations during four wet weather events in the central portion of the watershed in 1993 (Lakeside Drive, Wampum Road, Cananicus Road and Mettatuxet Road). Sampling results were consistent for the four sites and nitrate-nitrogen concentrations averaged between .25mg/l and .33 mg/l. These concentrations are lower than the National Urban Runoff Program (1983) concentrations for residential land use (.736mg/l) but similar to the open/nonurban land use (.545mg/l) (ASA et al. 1995).

7. Dissolved oxygen concentrations are often an indicator of excess nutrient degradation in a waterbody. As plant growth responds to increased nutrient availability by increased growth, oxygen in the water column is consumed as the rapidly reproducing plants die and decompose. In the Narrow River, bottom waters are naturally anoxic in the deep basins in the Upper and Lower Ponds, so it would not be surprising to measure exceedingly low dissolved oxygen concentrations in these bottom waters. Watershed Watch volunteers have monitored dissolved oxygen concentrations at 0.5, 1.5 and 3.0 meters below the surface of the water between 1992 and 1995. These monitoring data, when considering only minimum oxygen concentrations at each of the sampling sites, show subsurface dissolved oxygen concentrations have been recorded below 5.0 mg/l (Table 3-6) which is below the range allowable for both SA and SB quality waters. Hypoxic conditions (<3.0 mg/l) were measured at 3.0 meter depths on several occasions in Upper and Lower Ponds (Herron and Green 1996). Herron and Green (1996) note that these data were recorded during late morning to early afternoon hours (10AM - 2PM), and therefore would not be representative of presumed worst case oxygen concentrations which typically occur at dawn.

**Table 3-6.** Seasonal dissolved oxygen minima (mg/l). See Figure 3-6 for sample station locations. (Herron and Green 1996).

| **Station ID** | **1992** | **1993** | **1994** | **1995** |
|---|---|---|---|---|
| NR-1 | <5 | >6 | >6 | 5 - 6 |
| NR-2 | >6 | <5 | >6 | >6 |
| NR-3 | <5 | <5 | <5 | 5 - 6 |
| NR-4 | >6 | >6 | >6 | 5 - 6 |
| NR-5 | >6 | <5 | >6 | <5 |

| | | | | |
|---|---|---|---|---|
| NR-6 | 5 - 6 | 5 - 6 | 5 - 6 | >6 |
| NR-7 | >6 | >6 | <5 | <5 |
| NR-8 | >6 | >6 | 5 - 6 | <5 |
| NR-9 | 5 - 6 | <5 | <5 | <5 |
| NR-10 | >6 | >6 | >6 | 5 - 6 |

8. Although nitrogen loading limits to groundwater for residential and commercial land use have been adopted by several coastal and environmental management authorities (e.g., Cape Cod Commission, New Jersey Pinelands Commission, and the Town of Falmouth, MA), criteria for limiting nitrogen to shallow coastal estuaries like the salt ponds and the Narrow River have not been accepted by the broader management community. The Massachusetts Buzzard Bay Program has developed criteria for limiting nitrogen inputs to poorly flushed estuaries in Massachusetts (Buzzards Bay Program 1991), however their criteria have not yet been adapted for other waterbodies which have different flushing characteristics.

## D. Impacts of Nitrogen Pollution on Ecosystem Health

1. Increasing Anoxia. As water temperatures rise in late summer and the algae decays, the decomposition process depletes dissolved oxygen levels creating localized hypoxic or anoxic conditions (D'Avanzo and Kremer 1995). As dead plant material decomposes on the bottom it impairs the suitability of the habitat for fin and shellfish.

2. Eelgrass Habitat. Eelgrass (*Zostera marina*) habitat was mapped in the Narrow River as part of the Narragansett Bay Project Critical Resource Mapping Project (see Chapter 5, Living Resources and Critical Habitats), but groundtruthing by Save The Bay did not reveal actual eelgrass beds present. Eelgrass is important habitat for bay scallops, winter flounder, and several crab species and the loss of eelgrass beds will negatively impact these valuable fin and shellfish. Loss of aquatic grass beds due to nutrient loading is a major issue in the Chesapeake Bay where the striped bass fishery declined with the loss of this critical habitat (Kemp et al. 1983).

3. Bottom Habitat. Bottom habitat is degraded as phytoplankton and macroalgae die and decay. What were once clean gravels and sands that supported good settling surfaces for shellfish, become covered with black organic mud. As bottom sediments become more organic, the benthic organism composition will shift from desirable to less desirable food species, with a consequent impact on the fish and crabs that rely on those species for sustenance (Bagge 1969, Pearson and Rosenberg 1978, Sarda 1995). As organic matter increases in the bottom sediments, nutrient flux from the sediments will increase, adding more nitrogen to the overlying waters which will stimulate more aquatic plant growth and exacerbate the already problematic nutrient loading situation (Lee and Olsen 1985, Nowicki and Nixon 1985).

4. Well Water Contamination and Public Health Problems. In addition to the problems resulting from nutrient loading to the Narrow River, there is a very serious public health

problem associated with nitrogen contamination of groundwater in the region. As the groundwater flows toward the Narrow River, it accumulates nitrogen from fertilizers, sewage effluent discharges from ISDS and animal waste so that the concentration of nitrogen in densely developed residential areas near the Narrow River are elevated well above the EPA drinking water standards of 10 mg/l for nitrate nitrogen (USEPA 1976).

### 320.1 Soil Erosion and Sedimentation

### A. Definition of the Problem

1. Sedimentation resulting from erosion of riverbanks and surrounding slopes is a major con-tributor to water quality degradation. Sediment suspension reduces water clarity and light pene-tration, ultimately affecting the growth and development of larval fish, shellfish, and aquatic vegetation, suffocating bottom dwelling organisms, and eventually disrupting the entire food web.

### A. Sources and Physical Factors of Sedimentation in the Narrow River

1. 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 (Figure 3-12). Till is consolidated and poorly sorted, covering the upper flanks of the bounding slopes. Stratified sand and gravel, 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 (Figure 3-13). Those areas most seriously constrained are located primarily on the western side of the river where slopes reach up to 40% (Howard-Strobel et al. 1986), and in some cases climb precipitously away from the water's edge. The soil characteristics of surficial till, combined with the steep slopes, create a potential problem area requiring adequate safeguards and management.

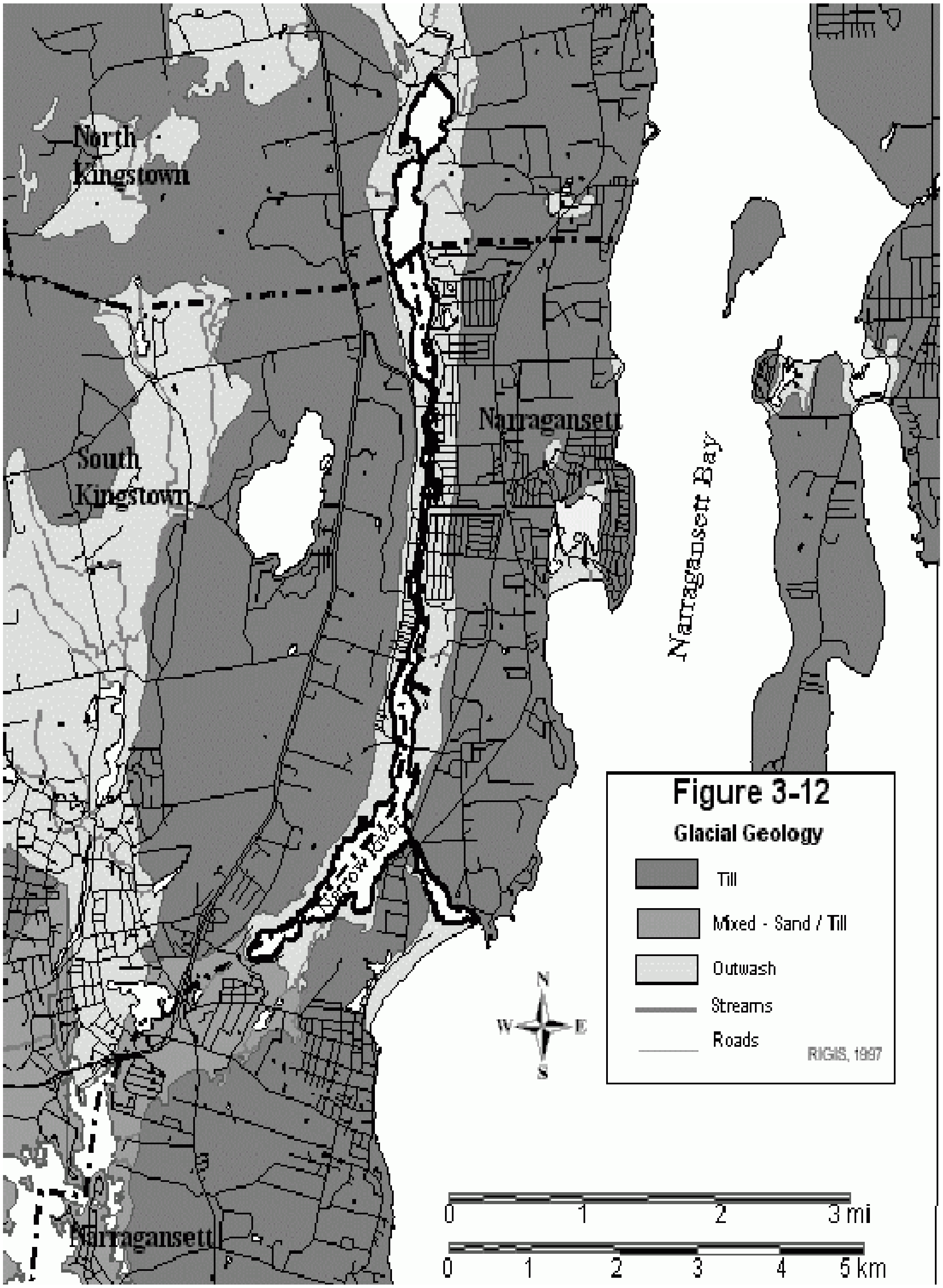
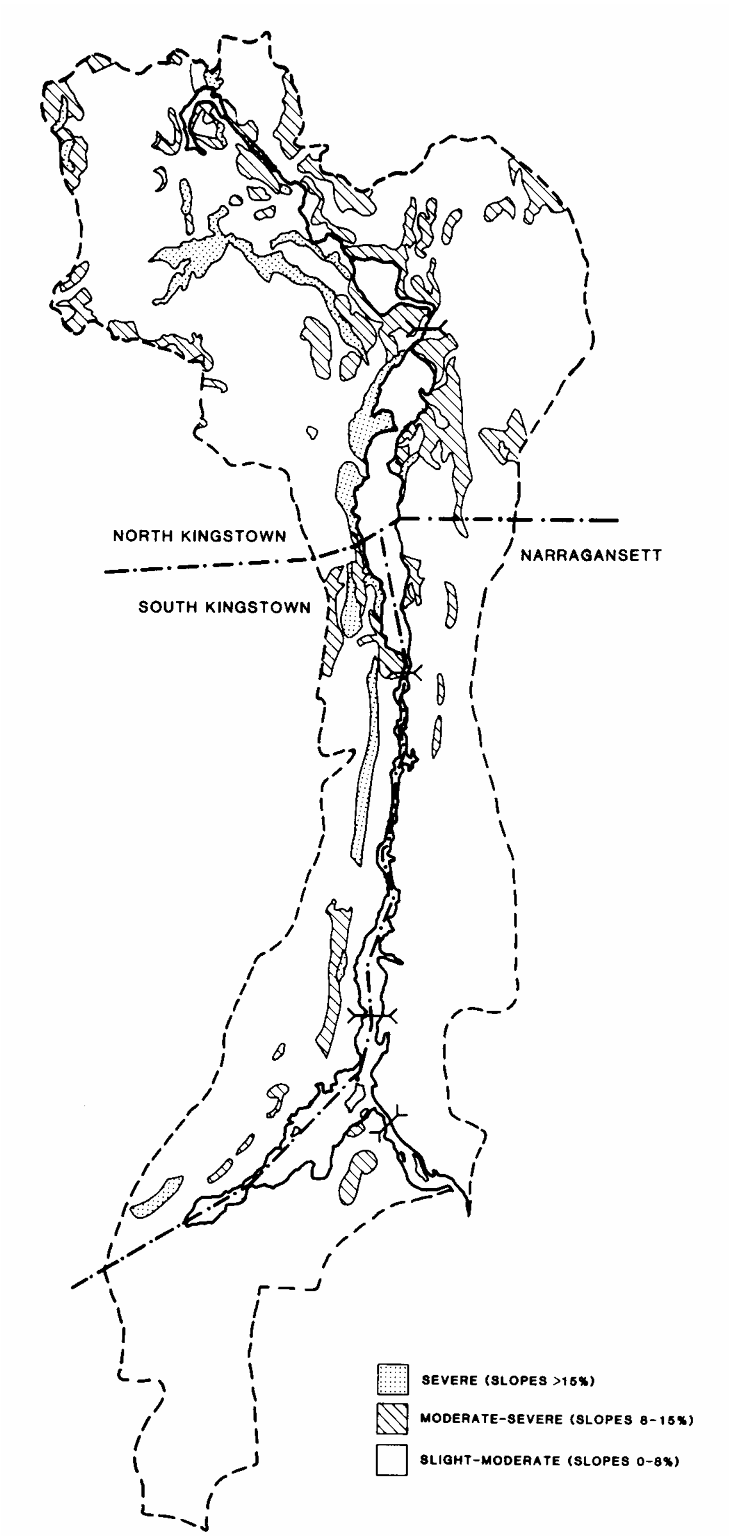



Figure 3-12
Glacial Geology
Till
Mixed - Sand / Till
Outwash
Streams
Roads

**Figure 3-13.** Erosion Potential



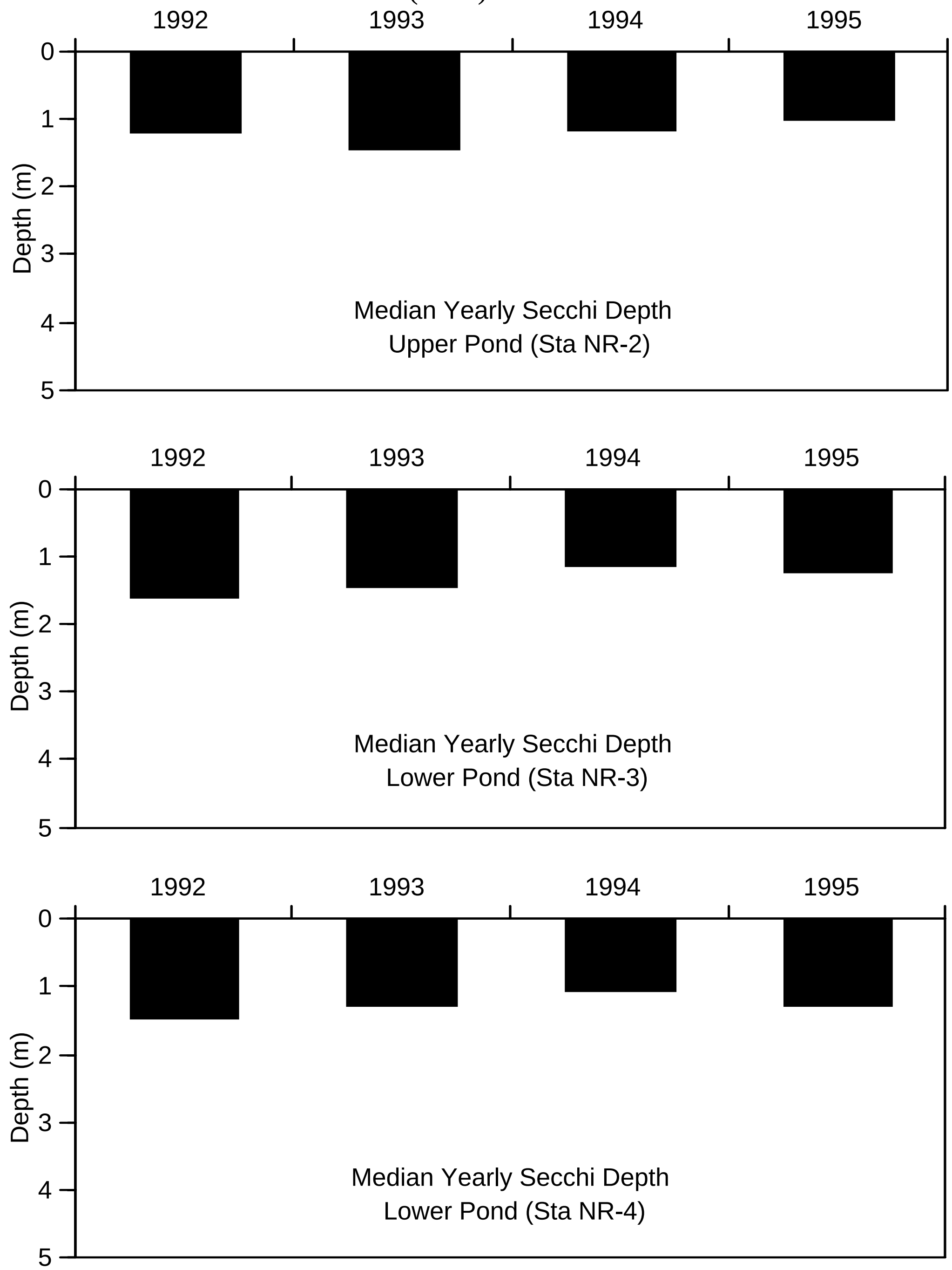
2. An analysis of sediment cores collected in the Narrow River revealed a trend from about 1900-1960 where coarse-grained sediments were deposited on the river bottom (Mecray et al. 1991). These coarse-grained sediments suggest increased erosion of soils in the watershed, probably a result of wide scale development during that time frame. Since about 1960, finer grained sediments predominate, suggesting that the rate of development, with its accompanying sediment erosion, has slowed.

3. Localized erosion spots occur where the vegetation has been cut back along the river in areas of low slope. When vegeation 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. In the past, lands with poor soils and steep slopes remained undeveloped because of these constraints. As building pressures continue, these lands become increasingly developable, particularly as sewers are expanded in the watershed.

**B. Findings – Results from Sediment Studies**

1. Reduced water clarity was noted by Watershed Watch volunteer monitoring data (Herron and Green 1996) as possibly decreasing between 1992 and 1995, and is therefore a water quality concern (Figure 3-14).

**Figure 3-14.** Average annual secchi depth measurements by Watershed Watch volunteer monitors in Upper and Lower Ponds in the Narrow River watershed. Data from Herron and Green (1996).



### 320.4 Other Contaminants

#### A. Definition of the Problem

1. Other pollutants which threaten water quality include trace metals, petroleum hydrocarbons, pesticides and herbicides, and various chemicals. These contaminants can accumulate to toxic levels in bottom sediment. They can also be taken up by aquatic organisms and passed along the food chain, where they can reach toxic levels in fish, birds, and humans. Chemical contaminants may cause reproductive problems and reduce resistance to disease.

#### B. Sources of Other Contaminants in the Watershed

1. Potential sources of these other contaminants 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, and to ensure any pollutants released to the environment are within acceptable levels and do not cause adverse environmental effects.

2. Roads and Highways. Roads and highways that drain directly to the estuary are sources of road tars, oils, trace metals, sediments, and petroleum fuels. These substances are harmful to the natural estuarine environment (Hoffman and Quinn 1985). There are three major highways traversing the watershed - Routes 1, 1A, and 138 (Figure 3-15). 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 Route 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). Other roads in the watershed that are potential sources of impacts from stormwater runoff include Shermantown Road, Congdon Hill Road, and Pendar Road. These roads are witnessing significant traffic increases from local development and, except for Pendar Road, traffic from URI commuters. Storm drains that discharge directly to the river from roads and highways are mapped in Figure 3-16.

#### C. Findings – Results of Contaminant Studies

1. Little monitoring has been performed related to these pollutants. One study noted PAHs (polycyclic aromatic hydrocarbons) in the sediments of Lower Pond (Gschuend and Hites 1980). PAHs are indicative of naturally or anthropogenically derived byproducts of combustion (i.e., car exhaust, smoke stacks, and wood burning). ASA et

al. (1995) noted that concentrations of heavy metals in receiving water, and generally in runoff water, were below a detection limit of 0.002 mg/l and therefore are not a major water quality concern at present.

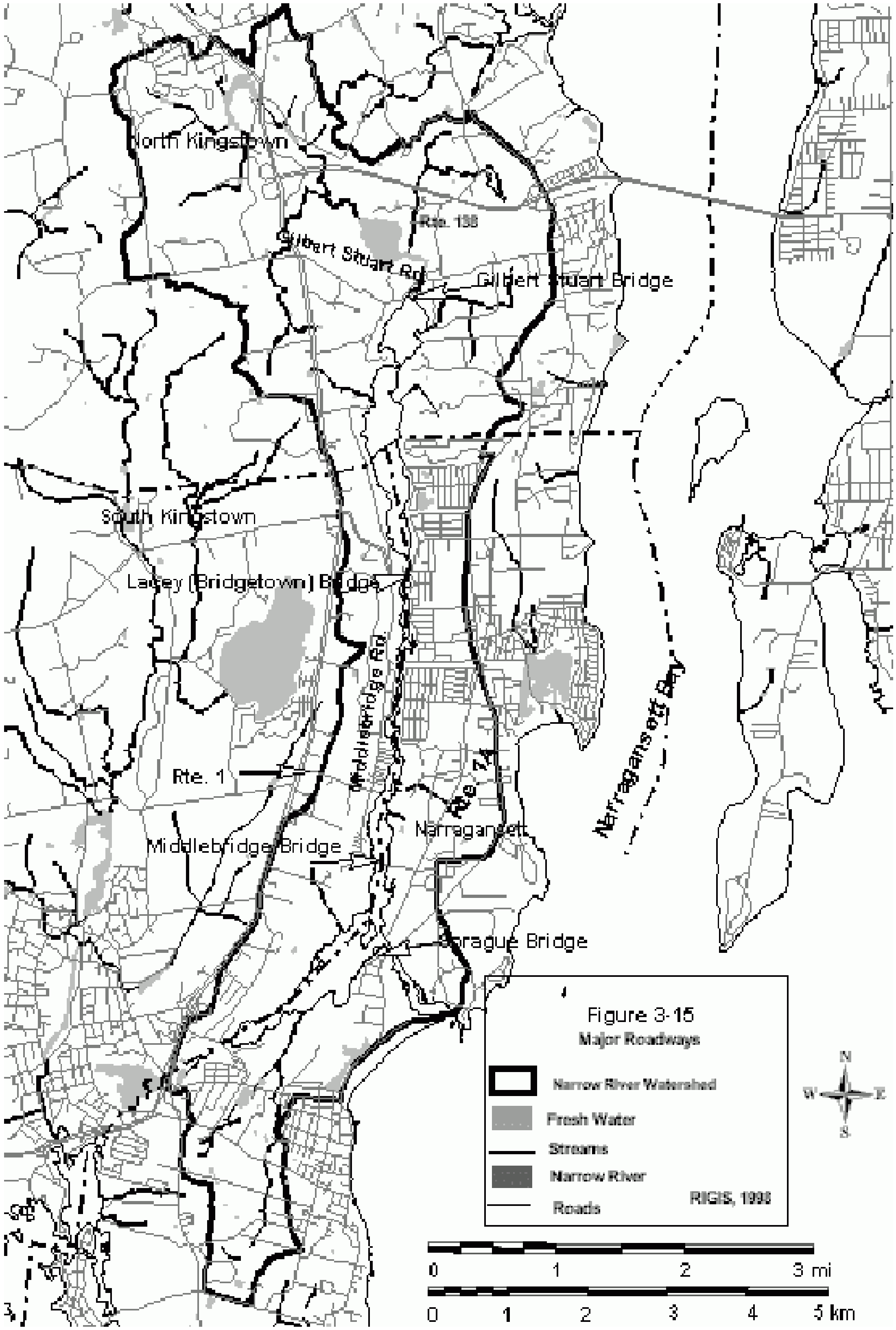
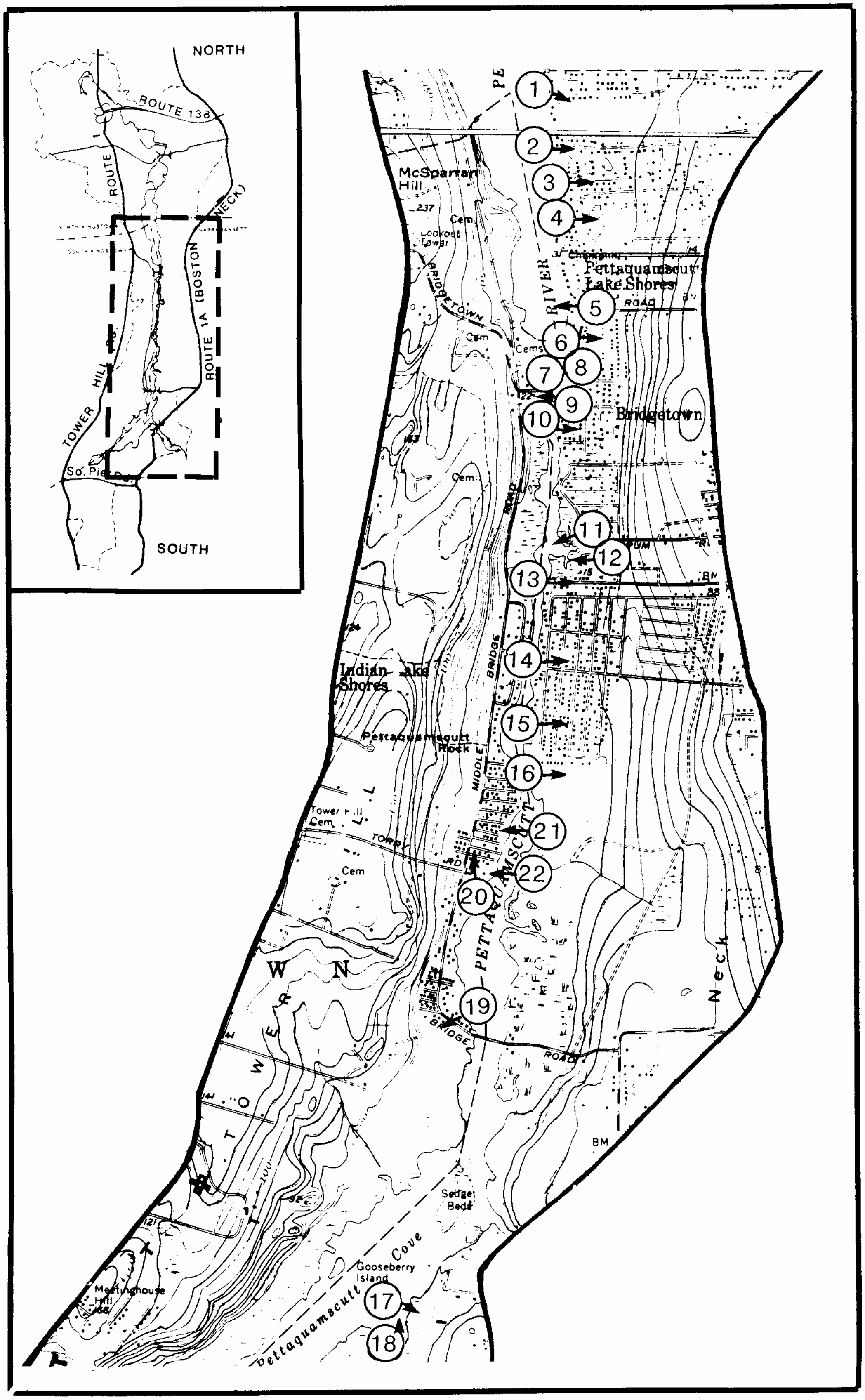



**Figure 3-15.** Location of major roadways in the watershed.

**Figure 3-16.** Location of storm drains surveyed by the RIDEM (RIPE, Inc. 1981)



## 330. Land Use in the Narrow River Watershed

### A. Current Land Use in the Narrow River Watershed.

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 accelerated growth rate has been experienced in the Town of Narragansett. The rate of development that has occurred in Narragansett has exceeded that of North Kingstown and South Kingstown by a margin greater than the two towns combined (Howard-Strobel et al. 1986).

2. Throughout the watershed, high density development is located in close proximity to the Narrow River. Along the narrowest reach of the river in South Kingstown and Narragansett, the land is divided into 1/8 and ½ acre lots. In North Kingstown, high density development occurs near Silver Spring Lake in the headwater region. The close proximity of this high density housing increases the impacts from human activities on the river water quality (EPA 1983).

3. Approximately 35% of the land area within the watershed is developed according to 1988 Rhode Island Geographic Information System (RIGIS) land use data (Figure 3-17). Undeveloped lands account for 65% of the watershed (Figure 3-17) and refer to any undeveloped land areas as well as abandoned agricultural lands reverting back to forest. Undeveloped lands include large tracts that are amenable to further subdivision as well as many small lots "grandfathered" so as to be out of conformance with existing zoning designations. Most of the undeveloped lands are located in the north-northwest region. Within the Narrow River watershed, the town of North Kingstown is 71% undeveloped, and makes up 56% of all the undeveloped land in the watershed. South Kingstown is 69% undeveloped and contains 18% of the undeveloped lands of the watershed. Narragansett is 54% undeveloped and contains 26% of the undeveloped lands of the watershed. Narragansett contains 55% of total watershed residential land and 64% of commercial and industrial land uses. North Kingstown contains 64% of watershed agricultural lands as well as 84% of the open water area of entire watershed and estuary (Figure 3-18).

4. As of 1988, approximately 10% of the total Narrow River watershed land area was designated as open space by either state, local, or private entities (RIGIS). Since then, 175 acres of land has been set aside as part of the Pettaquamscutt Cove National Wildlife Refuge and over 150 acres have been protected by the Narrow River Land Trust. This brings the percentage of designated open space in the watershed to approximately 14% of the watershed area. Most of the open space in both South Kingstown and North Kingstown, and throughout the watershed, is held in private ownership, while in Narragansett, most of the open space is held in town ownership (Figure 3-19). North Kingstown and Narragansett contain similar percentages of the total state owned open space in the watershed, with South Kingstown containing about half as much as either of these two towns (Figure 3-20). Preservation of open space is one mechanism for maintaining ecosystem integrity, as well as ensuring areas for the

enjoyment of nature within the watershed. Considering the relative abundance of undeveloped lands in the watershed, the potential to maintain the percentage of open space to total watershed area is significant, and should not be overlooked as a resource management tool.

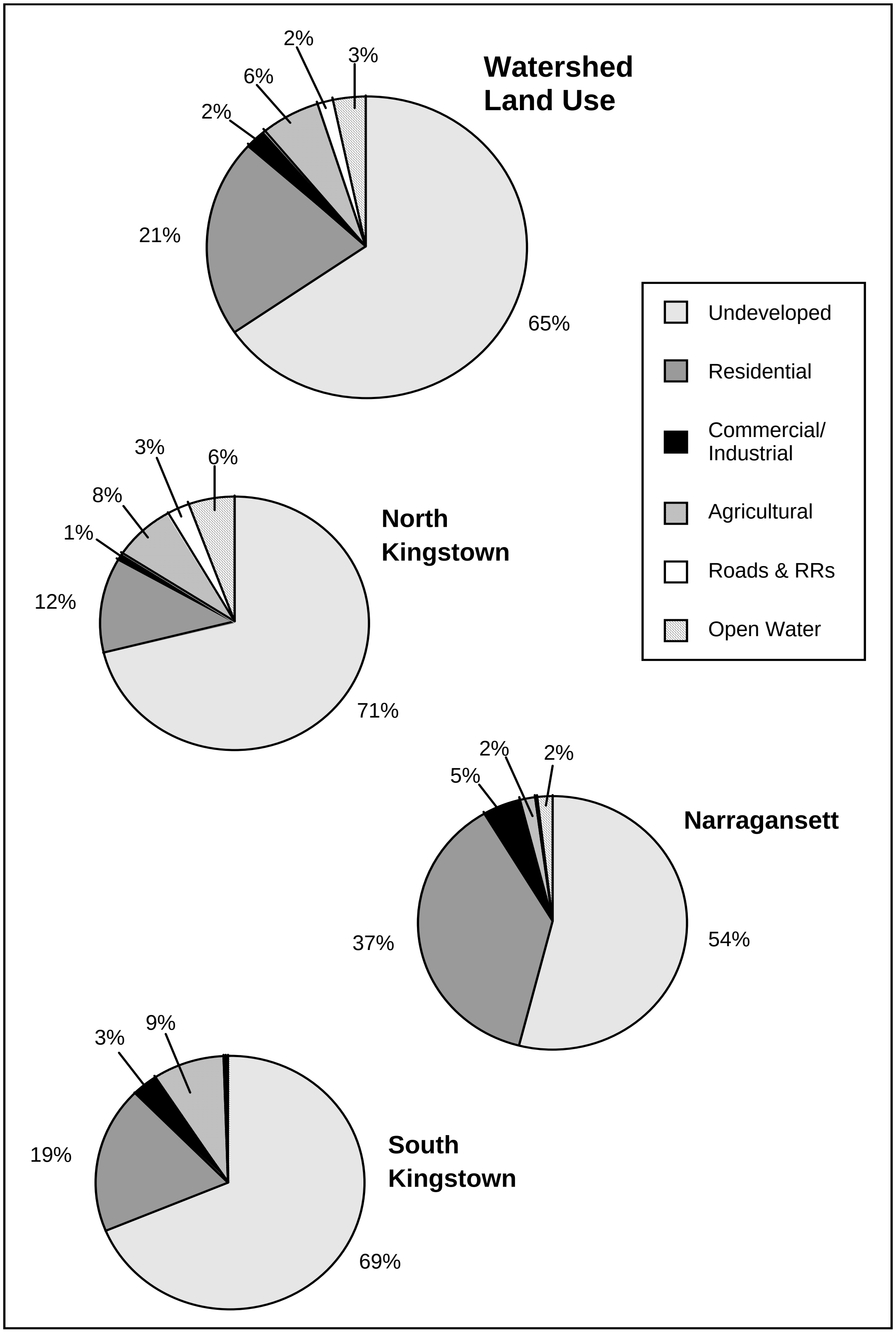



**Figure 3-17.** Land Use within the Narrow River watershed within the towns of North Kingstown, South Kingstown, Narragansett. Adapted from RIGIS 1988 Land Use data.

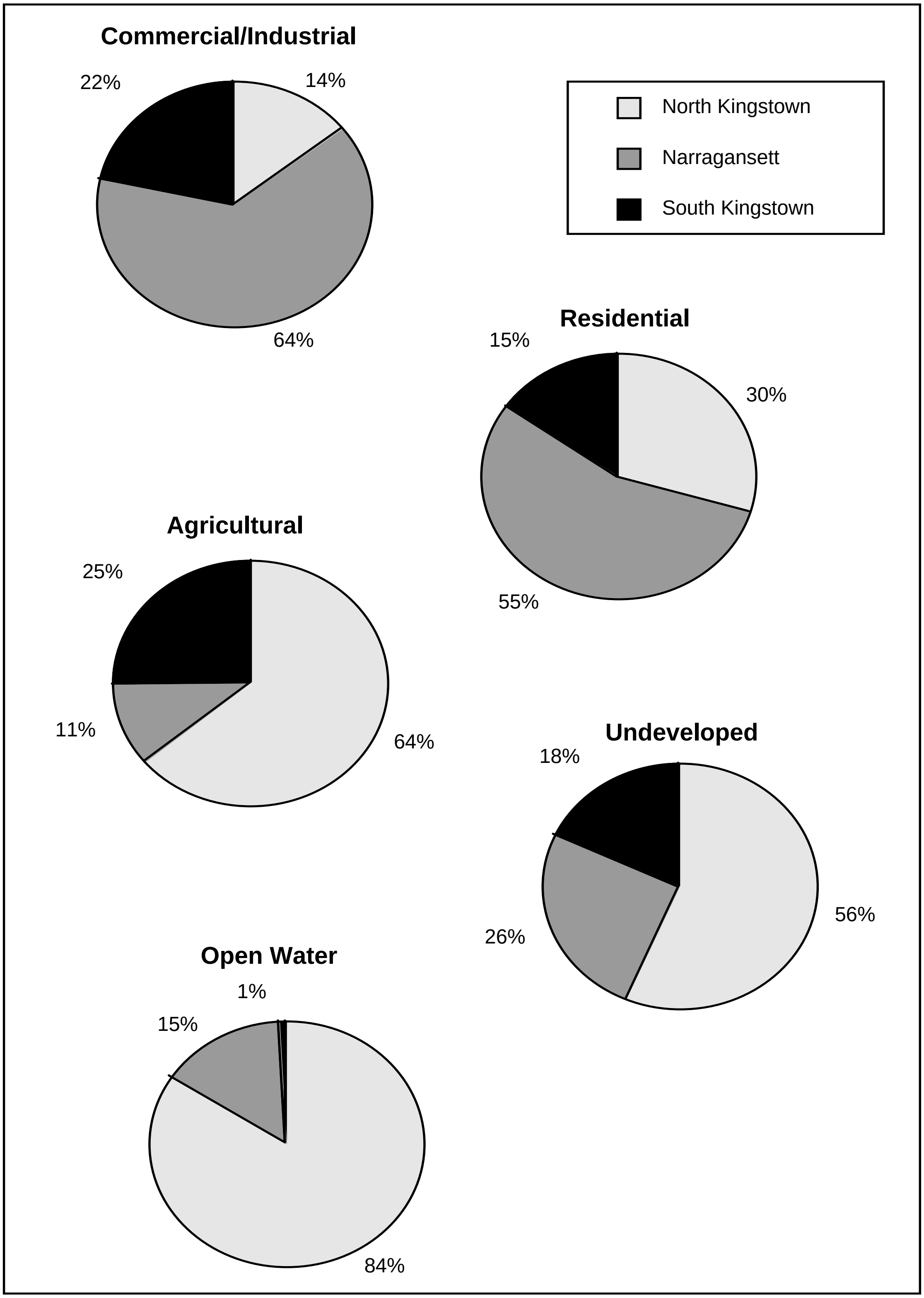



**Figure 3-18.** Land Use within the Narrow River watershed for comparative purposes. Adapted from RIGIS 1988 Land Use data.

5. Present engineering technologies and the installation of public utilities have the ability to bypass many of the natural constraints within the watershed. Based on the existing land use and present zoning ordinances for each town, there is the potential for a 36% increase in residential development (Table 3-2). This increase assumes that most of the natural constraints such as high water table, and steep slopes are overcome (excluding wetlands), and includes a number of "grandfathered" substandard lots.

**Table 3-7.** Existing and potential development in the Narrow River watershed. Present houses determined by house counts from 1992 aerial photos, build out determined by incorporating potential expansion according to zoning designations, planned sewer expansions, and site constraints such as wetland areas.

| **Region** | **Area (acres)** | **Present # Houses** | **Build Out # Houses** | **Percent Increase** |
|---|---|---|---|---|
| Upper Pond | 3699 | 534 | 1027 | 92.3 |
| Lower Pond | 1082 | 572 | 769 | 34.4 |
| Middle Estuary | 1522 | 1316 | 1603 | 21.8 |
| Pettaquamscutt Cove | 1537 | 760 | 929 | 22.2 |
| Narrows | 241 | 31 | 35 | 12.9 |
| | | | | |
| Total | 8081 | 3213 | 4363 | 35.8 |

(adapted from Table 4-12 of ASA et al. 1995)

## B. Sewer and Water Utilities

1. Public sewer lines are a key factor in determining the destiny of future development. 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, or where development will take place regardless of site constraints, 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, many areas have been sewered over the last ten years, with additional lines planned **(see map).** The Middlebridge Road area in South Kingstown is also sewered. North Kingstown is the only town not presently utilizing public sewer lines within the watershed. ASA et al. (1995) suggest that even were sewering to occur throughout the entirety of the developable watershed, a 17% increase in nitrogen entering the river would occur due to increased use of fertilizers on new residential lawns. Sewering therefore is not the complete answer to pollution control and cannot supersede competent planned growth management.

2. Public water supplies for residential and commercial use in the Narrow River watershed originate from outside of the watershed. The United Water Company provides fresh water from groundwater wells in the Mink Brook Aquifer in South Kingstown. Narragansett is almost entirely served by public water lines and South Kingstown has public water lines servicing the Middlebridge neighborhood, adjacent to the central reach of the river. Both these areas now are sewered, so the water that is

being piped in is also being piped out and discharged at the Sewer Processing Plant off Narragansett Pier. Existing development in North Kingstown that is serviced by public water lines include Polo Woods, Quail Hollow, Congdon Woods, frontage lots on Congdon Hill Road, Pendar Road and Shermantown Road, Westford Woods, Shady Lea Woods, and Holly Hills.

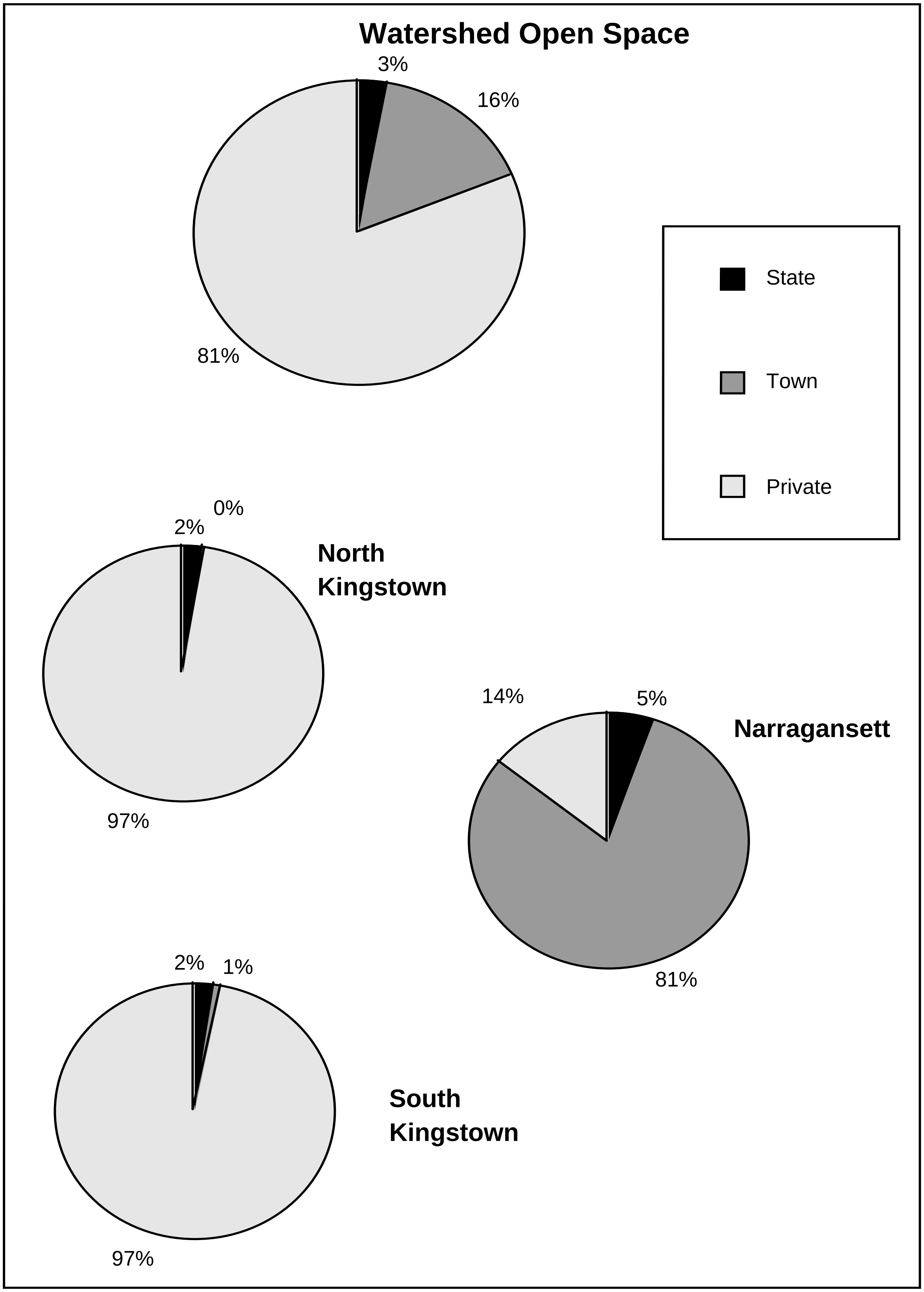



**Figure 3-19.** Open space within the Narrow River watershed within the town of North Kingstown, South Kingstown, Narragansett, and the entire watershed. Adapted from RIGIS Open Space data.

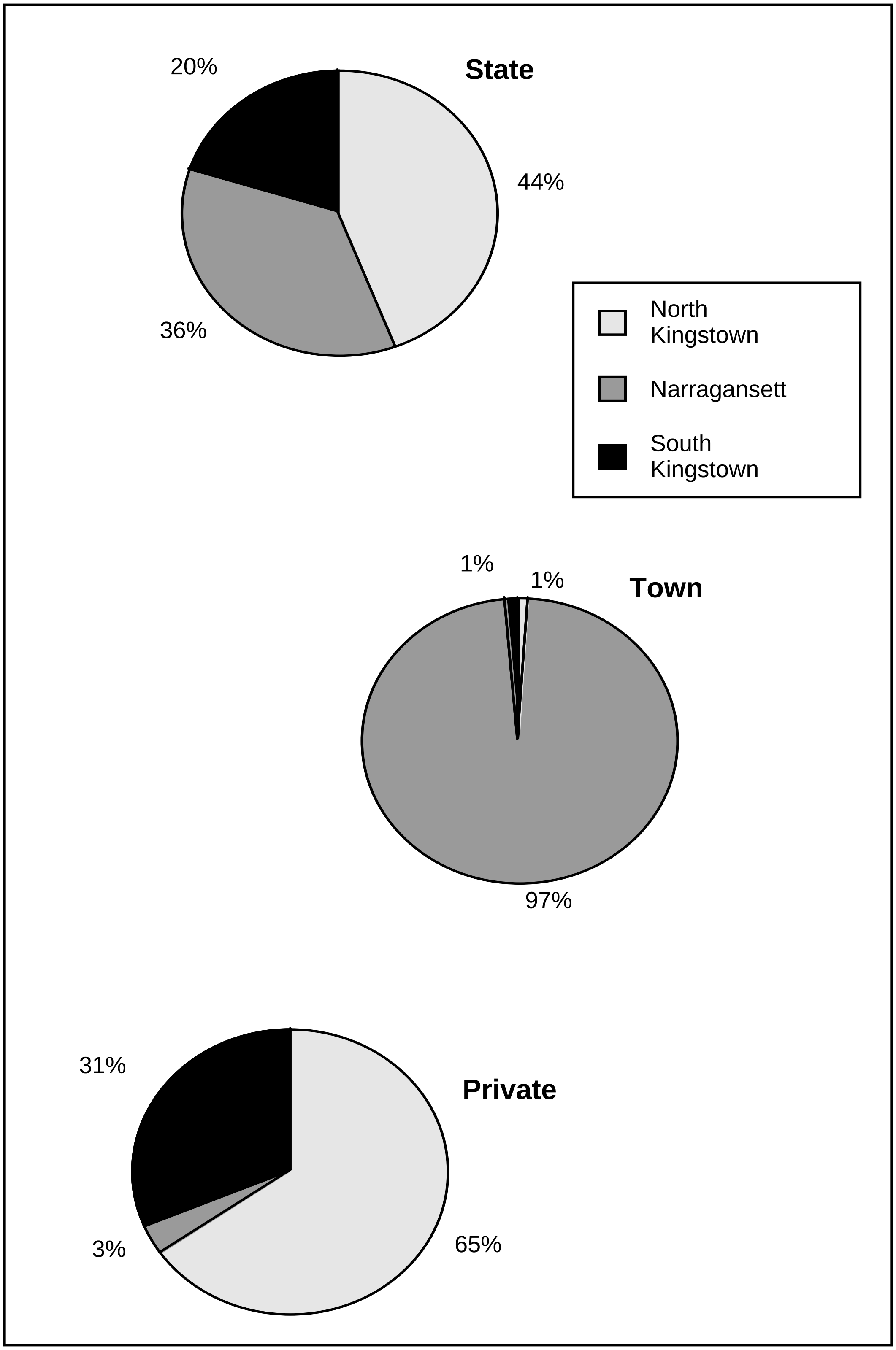



**Figure 3-20.** Open space categories within the Narrow River watershed. Adapted from RIGIS 1988 Open Space Data

Public water lines have also been proposed or requested for Quail Hollow IV, the gas company property and Westmoreland Farms. The water that serves these residential developments is entirely pumped from groundwater sources outside the Narrow River watershed, in part from the Pettaquamscutt aquifer wells. North Kingstown also pumps daily water supplies to the Town of Narragansett and provides emergency water supplies to Jamestown.

3. For those areas not serviced by water lines, the public health risk of groundwater contamination becomes a major concern. Pollutants that may enter wells include bacteria, insecticides, fertilizers such as nitrogen and phosphorus, road salts, grey water (dishwater, washing machine, sink, and shower discharges), and petroleum products. 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. Of particular concern to well owners living near an estuary or other salt water body is the threat of contamination from 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, particularly in light of trends towards increasing sea level which will force saline waters farther into coastal groundwater systems (Boothroyd 1991).

4. Of further concern to those residents serviced by well water are nitrate-nitrogen concentrations in the groundwater. Nitrate-nitrogen enters the groundwater system from septic systems in the area. The U.S. EPA has set nitrate-nitrogen levels in drinking water at 10 mg/l (EPA 1976). Urish (1991) however, reported nitrate-nitrogen levels in groundwater near residential areas serviced by septic systems in Narrow River watershed to be as high as 72 mg/l - over seven times the EPA drinking water standard.

## C. 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 3-15). 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. Private 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 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. There is also public access to the Narrow River in North Kingstown at the end of Walmsley Lane at LaFarge Point Park.

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

## D. Municipal Zoning

1. Zoning is the principal determinant of the type and density of land use, and is usually laid out in discrete districts to insure the separation of various activities. All three towns within the watershed have established zoning districts, with residential uses being the primary use designation. Residential densities range from one residence per 10,000 square feet (1/4 acre) to one per 120,000 square feet (3 acre). Narragansett generally has the highest densities, both in zoning and existing land uses (Figure 3-21). The less developed areas of North Kingstown and South Kingstown have substantial acreage devoted to low density residential uses (Figure 3-21). Industry and commercially zoned areas make up less than 1% of the total watershed land area, public use zoning makes up 4% of total watershed area, and residential uses at all zoned densities makes up over 95% of total watershed area (Figure 3-21). Residential zoning at densities of 1 unit per acre or more of land (R40, R80, R120 in Figure 3-21) comprises 86% of watershed area. Although residential zoning densities of 1 unit per acre or more of land (R10, R20 in Figure 3-21) only comprise 9% of total watershed area, these densities usually exist in areas directly on the shoreline of the Narrow River where they pose the greatest threat to water quality and habitat. Each town has approximately 50% or more of its area within the watershed zoned for residential use at densities of 1 unit per 2 acres or more of land (Figure 3-21). Highest density residential areas (R10) and commercial (Bus) and industrial zoned areas (Ind) are only found in the Narragansett portion of the watershed (Figure 3-21). North Kingstown has significant proportions (35%) of its watershed area zoned high-density residential development (R20, R40 in Figure 3-21).

## E. Future Development

1. The towns of South Kingstown, North Kingstown and Narragansett are developing groundwater overlay ordinances, wastewater management districts and large-lot zoning to protect existing groundwater supplies and other critical areas of the watershed and the Narrow River, as appropriate. Because the region supports a high quality of life for residents and visitors alike, it is under extreme development pressure. Towns are pressured by applicants and developers to reduce their existing large lot zoning and grant variances for more intense development. Because large parts of the watershed are already developed at high densities that exceed sustainable water quality for both groundwater and the Narrow River, it is critical to immediately preserve existing areas

of very low density in the watershed. A combination of actions such as large lot zoning, open space acquisition, local wastewater management programs and the application of new technologies to reduce nonpoint sources of land-based pollution is essential to protect the Narrow River ecosystem for future generations. Local and state government and private groups like land trusts and the R.I. Builders Association will need to work together for sustainable development of the Narrow River watershed.

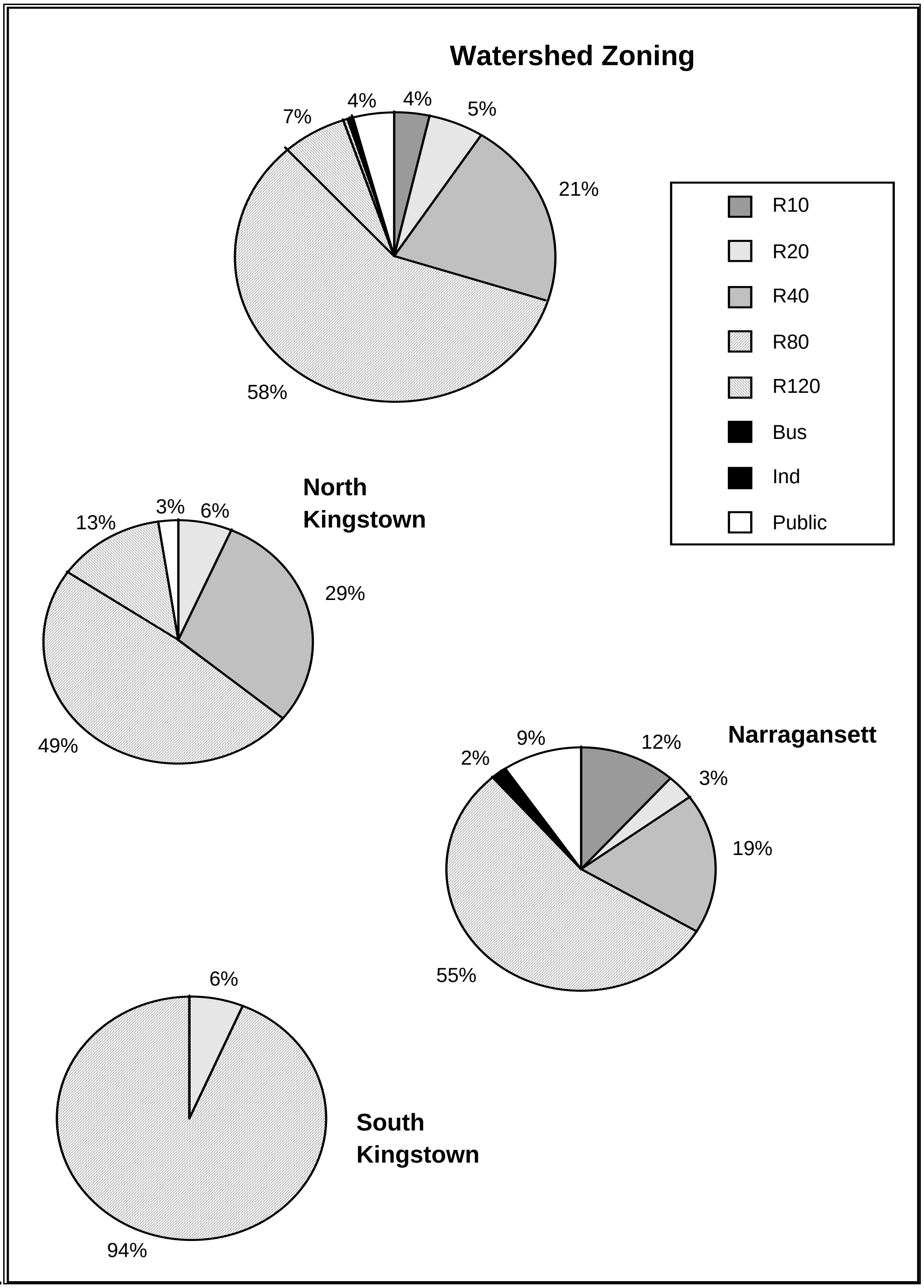



**Figure 3-21.** Zoning categories within the Narrow River watershed within North Kingstown, South Kingston, Narragansett, and the entire watershed. Adapted from CRC/RIGIS digitized zoning data. Although the other two towns seem moderate when compared to Narragansett, South Kingstown has doubled its growth rate and North Kingstown has increased by more than fourfold (Howard-Strobel et al. 1986).

2. Innovative and alternative technologies for small-scale wastewater treatment are being used successfully by communities throughout the country and within Rhode Island, particularly in the salt pond region. When these systems are properly maintained they provide important alternatives for wastewater treatment problems to reduce nutrient loading and pathogens in discharged wastewater. A variety of treatment types are available, ranging from sand filter and trickling filter technologies to extended aeration and composting toilets. Many of these technologies are featured at the On-site Wastewater Training Center (OWTC) facility located at the University of Rhode Island. The DEM Division of Groundwater and ISDS has amended the ISDS regulations to facilitate the installation of these new technologies for experimental testing in Rhode Island. DEM established a Technical Review Committee to assess the data provided by companies designing alternative systems, some of which have the capacity to reduce nitrogen loading to groundwater.

3. On-site nitrogen removal systems are effective at preventing some amount of nitrogen from reaching groundwater through denitrification. Denitrification is an anaerobic biological process which results in the transformation (reduction) of $NO_3$-N and $NO_2$-N to gaseous forms of nitrogen, mainly nitrogen gas ($N_2$). Several types of bacteria are capable of participating in the denitrification process whereby they use $O_2$, $NO_3$-N or $NO_2$-N for growth. Oxygen, if present, is preferred by the bacteria and under anaerobic conditions (without oxygen) $NO_3$-N and $NO_2$-N are substituted for $O_2$. In addition to denitrifying bacteria, there must be anaerobic conditions, a carbon source, and suitable temperature, pH and alkalinity levels (Loomis and Dow 1997).

4. The RIDEM, the CRMC and the local town governments are presently working together to respond to the need for regular maintenance, repair and replacement of ISDS in the Narrow River watershed. Theses agencies are focusing on the following actions: the delegation of authority to local governments for wastewater management programs and identification of failed or substandard systems; faster response by state agencies to reported failures; the establishment of standards for rehabilitation of substandard systems; options for community-based sewage disposal systems; and public education programs and identification of sources of funding for ISDS repairs. The Rhode Island On-site Wastewater Training Center at URI provides municipal and homeowner training regarding the proper inspection and maintenance of onsite wastewater disposal systems.

5. Based on non-proprietary systems which have been designed and installed by Dr. George Loomis and David Dow through the URI OWTC as part of an EPA Aquafund grant, nitrogen removal systems like recirculating sand filters can range in total cost for design and installation between $9,000 and $13,000 (David Dow, Personal Communication). The cost of maintenance for these systems is approximately $100 - $150 a year. Although this cost may be higher than installing a basic septic system without site constraints, nitrogen removal systems generally have much better effluent quality, reducing the possibility of drainage field failures.

6. The local communities in the Narrow River watershed are concerned about existing sources of nitrogen and bacteria which are impacting water quality in the Narrow River.

In order to encourage and assist homeowners to replace these systems, the Rhode Island Clean Water Finance Agency (RICWFA), in collaboration with RIDEM is establishing the Community Septic System Loan Program (CSSLP). Approximately 1 million dollars will be available to communities with RIDEM approved wastewater management programs. The CSSLP program will be offered to the local communities as a line of credit. Residents who need to repair or replace their septic systems will access their community's line of credit. The money is loaned to the homeowner at an interest rate of 4% with a repayment period of up to ten years. Replacement of conventional ISDS with alternative technologies to reduce pathogens and nitrogen concentrations is allowed under the program and CRMC will be working closely with local communities to identify nutrient sensitive areas within the Narrow River that will be priorities for ISDS replacement.

## 340. 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 the 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 possess 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 facilitate 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 deposited in surface water bodies and groundwater. Additionally, the intrusion of human activity and the alteration of natural habitats can adversely affect existing wildlife.

## 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 buffer 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. A review of buffer effectiveness and the many variables that affect buffer functioning can be found in "Vegetated Buffers in the Coastal Zone, A Summary Review and Bibliography" (Desbonnet et al. 1994).

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).

3. Vegetated buffer zones can also aid in the removal of nutrients such as phosphorous and nitrogen from surface water flow. Some of the nutrients are absorbed on to 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, often entering the groundwater system. Findings on the efficiency of removal of nutrients by vegetative buffers varies from 0% to 99% depending on vegetation, soil type, volume of runoff, concentration of nutrients, and slope (Desbonnet et al. 1994).

4. An undisturbed vegetated buffer zone allows for habitation by a diverse wildlife population. Without a buffer, encroachment by humans on the habitat of facultative 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).

6. Vegetated buffers also provide aesthetic appeal by providing a "screen" of natural growth between developed and undeveloped areas (Desbonnet et al. 1994). This heightens visual/sensory appeal for those enjoying the natural environment during recreational activities while at the same time providing a measure of privacy to private land-owners.

7. Vegetated buffers are very practical and cost-effective measures for implementation in the control of pollutants, and enhance habitat and visual appeal values. ASA et al. (1995) cites the implementation of vegetated buffers in the Narrow River watershed as one of only a few practical methods of better controlling nonpoint source pollutants.

## C. Buffer Zones and the Narrow River

1. Within the Narrow River watershed, establishment of buffer zones 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 (U.S. SCS 1988). 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 southern Pettaquamscutt Cove are bounded by soils having a very slow infiltration rate, permanently 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 river's 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 leach fields 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 3-22). This is essential for the 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 over the aquifer recharge zone can also reduce the potential for a continuous water supply in the future.

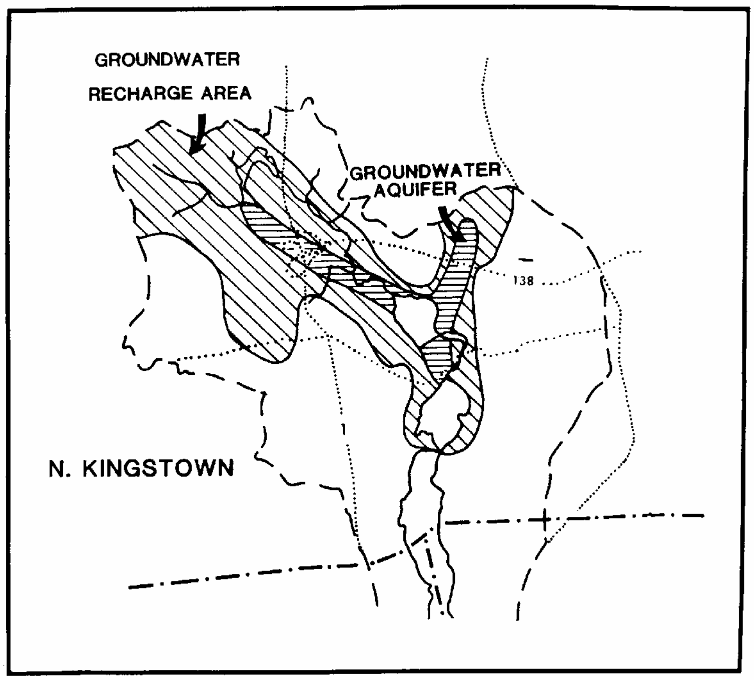



**Figure 3-22.** Location of aquifer and groundwater recharge zone.

## 350. Summary

### A. Water Quality Declines

1. 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 uses. There are still many areas of high and medium density residential communities (0.25 to 1 acre) which abut the Narrow River. 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, high water tables, and old age have 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, pooling on the surface facilitates rapid transport downslope to the river. Once in the river, the waste accumulates due to poor flushing and eventually exceeds acceptable levels, thus degrading water quality and creating a potential health hazard.

Although sewers have replaced many ISDS, vigilance with regard to proper ISDS installation and maintenance needs to be continued. Alternative technologies need to be required in areas abutting the Narrow River and wastewater management districts need to be established by the towns.

2. While fecal coliform bacteria are an immediate and well known problem, the same circumstances and conditions that promote bacterial degradation of the estuary also apply to excess nutrient inputs to the Narrow River. Water quality problems associated with nutrients, particularly nitrogen, are further exacerbated by groundwater flows recharged to the river, which move the nitrogen from residential septic systems directly into the estuary. Nutrient impacts have been noted as early as 1972 and, in consideration of the potential for future development, even when factoring in the extension of sewer services, nitrogen loading to the estuary can increase significantly. As the ecosystem is poorly flushed and therefore prone to long retention time for anthropogenic inputs, the control of nitrogen should be a priority management issue.

3. 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 its high aesthetic quality and unique resource value, imposes significant constraints on the continued uses of the watershed.

4. Buffer zones provide an undisturbed zone around critical areas and serve many functions that help to mitigate the impacts from upland human activities (i.e., construction, lawn fertilization, etc.). Specific functions include slowing the rate of 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.

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# Chapter 4
# Geologic Processes

## 400 Geology of the Narrow River

### 400.1 The Geologic History of Narrow River

### A. Early History

1. Rhode Island began as a series of volcanic islands that formed along the coast of Africa before 600 million years ago (Late Precambrian time). These volcanic islands were on a tectonic plate that collided with Africa (during an event called the Avalonian Orogeny). The granite in parts of the upper watershed of Narrow River formed at this time. Between 600 and 300 million years ago, a small slice of continental rock drifted away from Africa, much as Madagascar is doing today. This slice (the Avalon tectonic plate) existed in the early Atlantic Ocean (the Iapetus Ocean). Pulling apart of this slice led to the formation of the Narragansett Basin and the sedimentary rocks that underlie most of the Narrow River watershed.

2. The Avalon tectonic plate moved away from Africa because of several processes. The Iapetus Ocean first grew larger and then began to close as the ocean basin was consumed by a subduction zone along the North American tectonic plate. Eventually, Rhode Island collided with New England about 375 million years ago. The continent of Africa followed and further crunched Rhode Island in a scraping motion. Granite formed during this event now borders the Narrows and the south side of Petaquamscutt Cove. At the end of this series of collisions (called the Alleghanian Orogeny), Rhode Island was probably a rugged mountainous barrier separating Africa from North America.

3. The high mountains were eroded to lowlands by the time the opening of the present Atlantic Ocean began between 220 and 150 million years ago. The lowlands were uplifted several times in response to complicated plate motions. The last time was probably 20 million years ago. Sediment deposited in ancient lowlands during these episodes is now missing on mainland Rhode Island but can be seen in isolated bluffs on Block Island and Martha’s Vineyard. The valley that contains Narrow River probably came into existence when erosion lowered the landscape following the last uplift.

4. Narrow River proper and the upper ponds are underlain by sedimentary rocks that have been changed by heat and pressure. These schists, phyllites, and slates contain some interbedded graphite that originated as coal. Several small mines were established during colonial times to obtain graphite for use in the manufacture of gunpowder, as a lubricant and as a refactory material in smelting and casting. Bedrock, including older

granitic rock, is near or at the surface of much of the steeply sloping watershed, and the resistant granite of the Narragansett Pier Formation forms the entrance to Narrow River at Cormorant Point. The Narragansett Pier granite also pokes up through the Narragansett Basin rocks at Pettaquamscutt Rock.

5. An ancestral river coursed through the present location of Narrow River, eroding a valley in the bedrock and depositing sediment on a river flood plain. All evidence of this earlier river sediment has been removed by subsequent glaciation during the last one to two million years.

**B. Glacial History**

1. The glacial history of Narrow River began one to two million years ago with the first advance of a continental ice sheet. Ice covered Rhode Island and then retreated and advanced several times as the climate warmed and cooled. Each time the ice advanced, it removed the original river sediment and later glacial sediment, and redeposited it as a thin layer of till on the uplands, and as thicker river and lake deposits in the lower areas. Thus we see only the record of the last glacial advance and retreat. However, it is this last glacial episode (the Wisconsinan Stage) that truly dominates the landscape of Narrow River.

2. The glacial sediment now in the Narrow River valley began to be deposited about 18,000 BP (years before present). A glacial river and lake deposit (called the Saugatucket morphosequence) filled the lowermost Pettaquamscutt valley and created a sediment dam in the area between the present Silver Lake and Sprague Park in Narragansett. With the retreat of the glacier up the valley, a glacial lake formed behind the dam. Ice blocks, detached from the active ice front, water later buried by a delta, that advanced southward into the lake filling the Narrow River valley. This interpretation of delta sedimentation is different that shown on published surficial or glacial geologic maps (Schafer 1961); cores recovered from the middle River area show glacial delta and lake floor sediment at depths of three to seven meters between present mean sea level (MSL). This shows that a lake did occupy the valley even through the maps show only river deposits.

3. The gently sloping, glacial delta plain dips below present sea level south of Middle Bridge, thus the glacial lake level was lower than present sea level. The lake probably drained through low areas in the till-covered uplands, perhaps into a larger lake, that is now overlain by Narragansett Beach. Glacial deposition in the Pettaquamscutt valley ceased when meltwater from the glacier was directed elsewhere by ice retreat from the northern topographic divide of the valley. The meltwater was then directed toward the present Narragansett Bay through Hamilton and Bissel Coves.

**C. Most Recent History**

1. Melting of ice blocks created depositions where organic sedimentation in freshwater wetlands or ponds was initiated by 11,300 BP according to work by Arthur Gaines (1975). These wetlands and ponds were probably connected by a series of small streams, much like Gilbert Stuart Stream, at the head of the valley, does today. Saltwater incursion into the valley occurred between 4,750 BP and 1,700 BP, based on work by McMaster (1958), when rising sea level overtopped the low bedrock sill in the vicinity of the Narrows. The present system of flood-tidal delta shoals, tidal flat, and salt marsh became active at that time.

**D. The Present System**

1. The Pettaquamscutt or Narrow River estuary, trending north-south, is 10km long and ranges from 100-700m in width. A separate, 1.25km long segment (the Narrows) forks from the main estuary and serves as the present tidal inlet. Tidal range in the lower estuary is 45 cm, decreasing to 20 cm at the head. The present estuary occupies ice block depressions at the northern end, but at the southern end, marine sediment has filled the depressions and extended laterally over the glacial delta plain.

2. Narragansett Beach, a 1.6km long, 200m wide barrier spit, is anchored to a till bluff on the southwest and extends northeast to restrict the entrance of the Narrow River estuary. Mean tidal range in the open Rhode Island Sound is 1.2 m. The beach fronting the barrier spit was eroding at the rate of 0.4 to 0.7 m per year between 1939 and 1985 (Dein 1981, Harwood 1993). The direction of sediment transport on the beach is to the northeast, thus the beach serves as a source of sediment for the Narrow River estuary.

3. The lower Narrow River is geologically complex. The seaward portion of the tidal inlet (the Narrows) is filled by a flood-tidal delta and various other sandy intertidal-to-subtidal shoals. A second, more complex, flood-tidal delta is present at the junction of the Narrows with the main body of the estuary. This tidal delta, with many lobes, has moved across the estuary to separate the southern deeper-water area (Pettaquamscutt Cove) from the rest of the estuary. Most of the flood-tidal deltas is subtidal, but less than 1 m below MSL. The tidal delta extends northward to Middle Bridge, where construction of the causeway and resulting narrow constriction has allowed a series of subtidal shoals to form north of the bridge. Salt marsh is moving outward over these tidal flats, gradually constricting the river.

4. Sea level is presently rising at a rate of 27 cm per century as measured at the Newport tide gauge. The present rate of rise is matched by the upward growth of salt marsh peat so that the high marsh surface is level with spring high water. However, the present rate of sea level rise is raising the ground water table in the glacial river sediment along the

river. This elevated water table adds to the problem of failing septic systems.

5. Future sea-level rise will gradually inundate, from south to north, the gently sloping glacial delta plain particularly in the Middlebridge Road area of South Kingstown. Accelerated sea level rise due to global warming will, of course, hasten this process.

## 410.1 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. Federal 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, and again 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, sinuous 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 bedrocks near the entrance are visible only 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 Pettasquamscutt Cove region, although very wide, is extremely shallow; navigation is restricted to the tidal channels around and across the flood-tidal delta. 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 traveling upriver.

## B. Dredging Impacts

1. 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 project boundaries. The re-suspension of sediment increases turbidity which degrades water quality and primary productivity (Ingle 1952, Kaplan et al. 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).

2. Estuarine sediments can act as a trap for a variety of pollutants, nutrients, trace metals and pesticides, adsorbing them onto individual particles which settle and eventually are buried with time. Dredging can re-suspend 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 associates hazards (Biggs 1968, Sabba Rao 1975, LaRoe 1977). Re-suspensions of reduced (low oxygen) sediments can also deplete the ambient oxygen supply available to other organisms (USACOE 1971, LaRoe 1977). Increased turbidity, re-suspension 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.

3. 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 invertebrate species (Chapter IV).

## C. Dredging Perceptions and Usefulness

1. The Inlet Entrance - Wave action during storms erodes sand from Narragansett Beach and transports it offshore and along the shore to the northeast. A certain volume of sand eroded from the Beach is transported to the mouth of the Narrow River where it forms flood and ebb-tidal deltas adjacent to the inlet. The flood-tidal delta is the best developed and varies in size with the severity of storms within the past 5 years. The perception is that the flood-tidal delta effectively retards flushing for the Narrow River. While it may

have a minor effect, the channel system and tidal currents adjust to pass the same volume of water over and around the flood-tidal delta.
However, it would not harm the River if this flood-tidal delta was dredged periodically and the sand replaced on Narragansett Beach. Boat navigation in the lower Narrows would be enhanced and no habitat changes would occur north of Sprague Bridge, a major choke point. Narragansett Town Beach would be the logical site for beach replenishment using the flood-tidal delta sand.

2. Flood-Tidal Delta System between Sprague and Middle Bridges - The large system of shoals filling the northeast end of Pettasquamscutt Cove is the major tidal-delta system in the Narrow River. Many of the tidal flats are exposed at low tide. These intertidal flats and subtidal shoals retard the flooding tide as it passes up the River resulting in a reduction in tidal range between Sprague and Middle Bridges. Dredging of a portion of the this tidal delta may result in an increase in tidal range and a greater volume of water available at Middle Bridge and would aid the passage of boats up the River. However, the natural habitat of the flats and shoals would be altered, thus a balance between potentially enhanced flushing of the River and destruction of habitat must be considered.

A dredging plan in place in the salt ponds (Lee and Olsen 1984) allows dredging of narrow, shallow navigation channels through the flood-tidal deltas with the placement of dredged material to replenish a nearby beach. Such a plan may be feasible for the Narrow River.

3. Middle Bridge - The restricted opening at Middle Bridge has resulted in the buildup of a small flood-tidal delta just upstream of the Bridge. The subtidal shoals are extremely shallow, less than 0.5 m deep at low tide, and are an impediment to navigation. This tidal delta can be dredged and the sand placed on Narragansett Beach with no alteration to the habitat of the River. The shoals will be redeposited in a few years with the present configuration of the Bridge opening. Widening the Bridge opening will slow down the rate of deposition of the tidal delta (see discussion below).

## 410.2 Road and Bridge Alterations

### A. 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. Expansion of the tidal-current flow, particularly the flood-tidal current flow north of the bridge, results in sediment deposition in the form of a small flood-tidal delta.

2. Suggestions have been made regarding reconstruction of the bridge, particularly, the elimination of the causeways which extend into the river. It is popularly 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, a recent study on flushing characteristics (ASA 1995) indicates that a wider bridge opening will have no influence on flushing. This is because the restrictions in the River below ("downstream") Middle Bridge control the volume of water delivered by tidal action to the Middle Bridge opening. The ASA study indicates that the present bridge opening is adequate to handle the volume of tidal water available with no restriction in flow. Increasing the cross-sectional area, by removal of the causeway, will decrease the current speeds in the immediate vicinity and retard the buildup of the flood-tidal delta. The net flushing from the river will not change at all, since these rates are primarily a function of the influx of water to the system.

3. A study on storm-surge flooding in the Middle Bridge area by the U.S. Army Corps of Engineers (USACOE 1994) concluded that the bridge opening did not retard storm-surge waters because a sufficiently severe event that would carry a large water volume would have a surge elevation that would overtop the approaches to the Bridge, thus allowing the surge water to travel up the estuary unimpeded by the bridge and causeway.

## 410.3 Sea Level Rise

### A. Introduction

1. Gasses, such as carbon dioxide, chlorofluorocarbons, and methane, which reside in the atmosphere block some of the sun's infrared radiation from returning to space. The excess infrared radiation warms the earth's atmosphere. Heat transfer from the atmosphere warms the surface ocean waters, and causes increased melting of glacier ice. The larger the percentage of infrared radiation blocked by "greenhouse" gases, 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 Whord 1982) of global warming will continue. As temperatures rise, thermal expansion of sea water, accelerated melting of mountain glaciers, and increased melting of the Greenland and Antarctica ice caps will cause sea level to rise (Hoffman et al. 1983, Meier 1984, Revelle 1983, Thomas 1985).

## B. Worldwide Trends

1. Based on worldwide tide gauge records dating back to the 1800s, the level of the global ocean has been rising at a rate of approximately 10 to 12 cm per century (3.0 to 4.7 in per 100 yrs) (Gornitz and Lebedeff 1987). Since continents also rise and fall from regional and global tectonic forces, the relative rate of sea level rise at a given location may be greater or lesser than the global average. Estimates of future sea level rise are based on complex climate models that contain the assumption that the atmospheric concentration of $CO_2$ (carbon dioxide) and other "greenhouse" gases will double within the next century (Charney et al. 1979, Smagorinsk 1982). This increased concentration of greenhouse gases in the atmosphere is predicted to cause increased absorption of infrared radiation leaving the surface of the earth, and re-radiation of this energy back to the surface, enhancing surface warming. Two results of increased surface warming would be an increase in the volume of surface ocean waters from thermal expansion, and increased melting of glacier ice. The global sea level rise estimates for the year 2100 derived from the model developed by the Environmental Protection Agency (Hoffman et al. 1983, Hoffman 1984) range from a conservative 56 cm (1.8 ft) above the 1980 level to a high projection of 345 cm (11.3 ft). More recent work reported by the Intergovernmental Panel on Climate Change (IPCC) (Houghton et al. 1990) project a slower rise rate of 25 to 40 cms (0.8 to 1.3 ft) by the year 2050.

## C. Trends in Rhode Island

1. In Rhode Island the land is subsiding at a rate of approximately 15 cm per century (6 in) perhaps in response to readjustments of the underlying bedrock to release of load from the continental ice sheet (Douglas 1991). When a subsidence rate of 15 cm per century is added to a global sea level rise rate of 10 cm per century, the rate of relative sea level rise in Rhode Island is 25 cm per century (10.4 in per 100 yrs). If this historic trend continues to the year 2100, sea level in Rhode Island will have risen approximately 45 cm (approximately 18 in) above NGVD (National Geodetic Vertical Datum - the zero elevation on government topographic maps). Many scientists predict a more rapid rise of sea level in the future.

## D. Effect of Sea-Level Rise

1. The effect of any amount of future sea level rise will be an increased rate of coastal erosion as waves will break higher on bluffs and dunes along the open shoreline for any given storm intensity. Bathing pavilions, hotels, and other buildings now protected by coastal enginneering structures will subject to increased wave attack as the protection structures are overtopped by smaller and smaller storms. Low-lying areas adjacent to the shore front will be subject to "in-place drowning", i.e., increased flooding during storms. Water tables will rise causing failure of ISDS systems. Given the range of sea level rise

estimates it is difficult to plan for a specific scenario, however it would be prudent to be aware of the impact of sea level rise. As the rate of sea-level rise estimates are refined, the responses needed can be more finely tuned.

2. The rise in sea level is expected to produce a variety of adverse impacts. As seawater encroaches on the coastline, beaches will be displaced landward and coastal marshes will be drowned, flooding problems will increase, particularly as vulnerable inland areas are approached; freshwater marshes will move up and inland; and saltwater intrusions will extend further inland, contaminating groundwater aquifers and private wells. Many communities are ignoring potential groundwater impacts by continuing to build in coastal flood prone areas and near marshlands (Titus 1984). It is possible, through adequate planning and timely decisions, to alleviate adverse impacts of sea level rise (Hoffman et al. 1983). The rise in groundwater table produced by rising sea level is particularly important along the low-lying fringe of glacial delta plain between Lacey Bridge and Middle Bridge.

## 410.4 Summary

### A. Narrow River Environment

1. The Narrow River for the most part, is a shallow estuary and is configured such that tidal deltas and points of constriction on the river minimize the amount of water flow that travels up the estuary. The estuary has a sharp flood tidal velocity, with less of an ebb-tidal current which fosters tidal delta formation. The bulkheading that has been done at Middlebridge contributes to creating a sediment sink to the north of the bridge, but also to creating sheltered winter flounder habitat to the south of the bridge. Pettasquamscutt Cove diverts a lot of water flow from the river, and has abundant habitat utilized by both migrating and local waterfowl. At the river inlet the Narragansett Beach extends to restrict the entrance, and provides a source of sediment to the estuary.

2. The CRMC water type designations limit the level of activity that can occur on the river, to areas of low intensity use and conservation areas. Dredging has been previously prohibited throughout the estuary, but may be appropriate in specific CRMC identified areas to support the current recreational uses of the river. Intensified recreational use is not consistent with the goals of this plan and the RICRMP.

3. 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, storm surges, and consequent flooding. Steady growth within the flood zone areas of the river has occurred over the past 45 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.

4. Because the flood zone areas of the lower and middle regions of the river have 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.

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# Chapter 5
# Living Resources and Critical Habitats

## 510. Findings of Fact

### 510.1 Narrow River Ecosystem

#### A. Introduction

1. The Narrow River estuary consists of a thriving ecosystem with inter-related habitats throughout its watershed which support many animal and plant communities. Habitats found in the estuary and its watershed include tidal open waters, fresh water, mud flats, salt marsh, rivers, streams and seeps, red maple swamps and oak-maple woodlands. These habitats form the basis for a highly productive and diverse ecosystem establishing the watershed as a valuable natural resource.

2. The viability and natural function of the ecosystem depend on the careful stewardship by human populations. Stewardship by the surrounding communities will help to preserve the tremendous natural resource values of the watershed. Some of these resource values include abundant and diverse fish and wildlife populations, recreational water uses, and a high aesthetic quality. These are characteristics that often attract more development activities, placing further stress on ecosystem function.

### 510.2 Wetland Habitats

#### A. Description

1. Wetlands are among the most productive ecosystems found anywhere on the planet (Figure 5-1). In terms of gross and net primary productivity, salt marshes rank high, nearly as high as subsidized agriculture (Mitsch and Gosselink 1986). The causes of such high productivity in salt marshes are subsidies in terms of tides, nutrient import and water abundance which offset stresses associated with extremes in salinity, temperature, flooding and drying. Twenty-five metric tons per hectare of plant material (2,500 $g/m^2/yr$) can be produced annually in the southern Atlantic Coastal Plain of North America (Niering and Warren 1977). In Rhode Island, measured net primary productivity (above ground portion only) of cordgrass *Spartina alterniflora* low marsh was 840g dry wt./$m^2/yr$ and of *Spartina patens* high marsh was 430g dry wt/$m^2/yr$ (Nixon and Oviatt 1973).

2. Miller and Egler (1950) described the vegetation found in tidal salt marshes as typically occurring in four or five zones arranged roughly according to elevation in the marsh. Although relatively low in diversity of higher plants (Teal 1962), the vegetative

productivity of the tidal salt marsh supports high production of detrital material (decaying organic matter) which in turn is important to the marsh and adjacent estuary as a nutrient source for consumer organisms. The major path of energy utilization in a tidal marsh system is through detrital decomposition (Mitsch and Gosselink 1986). In some cases, detrital material export from the marsh to the adjacent estuary is greater than the phytoplankton-based production and, is a major reason (combined with the shelter provided by the edge of the marsh), salt marshes are important nursery areas for many commercially important fish and shellfish (Mitsch and Gosselink 1986).

3. The vegetation of the tidal marsh 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 filter, maintaining the water quality of the open water habitat. With rising sea level, the filtering and accretion of sediments facilitates growth of the marsh, ensuring continued productivity.

4. Wetlands provide a host of functions and values which are important to society and which provide ecosystem benefits and both consumptive and non-consumptive values to humans. Tiner (1989) categorized the benefits wetlands provide in three groups: (a) fish and wildlife values, (b) environmental quality values, and (c) socio-economic values

(a) Fish and wildlife values of wetlands vary depending on the type of organism. Certain fish, shellfish, birds, and mammals are wetland dependent, spending their entire lives in wetland areas. Waterfowl, wading birds, shorebirds and other migratory birds utilize wetlands for feeding areas, resting areas during migration, courtship, breeding, and raising young. Upland terrestrial animals may use wetlands as feeding areas, for drinking water or as refuge when displaced by development (Tiner 1989). Wetlands are also essential habitats for many rare or endangered animals and plants.

(b) Wetlands provide ecosystem benefits by improving water quality, recharge/discharge to the water table and contributing to the stability of global levels of available nitrogen, atmospheric sulfur, carbon dioxide and methane (Mitsch and Gosselink 1993).

(c) Numerous socio-economic values are also associated with wetlands including flood control functions, wave damage protection, hunting, trapping, fishing and shellfishing, aesthetics, education and research.

These natural functions and values associated with wetlands represent attributes which dramatically affect the quality of life for the communities and residents within the Narrow River watershed. Table 5-1 summarizes several of these values and associated hazards that arise when natural functions of the wetlands are ignored.

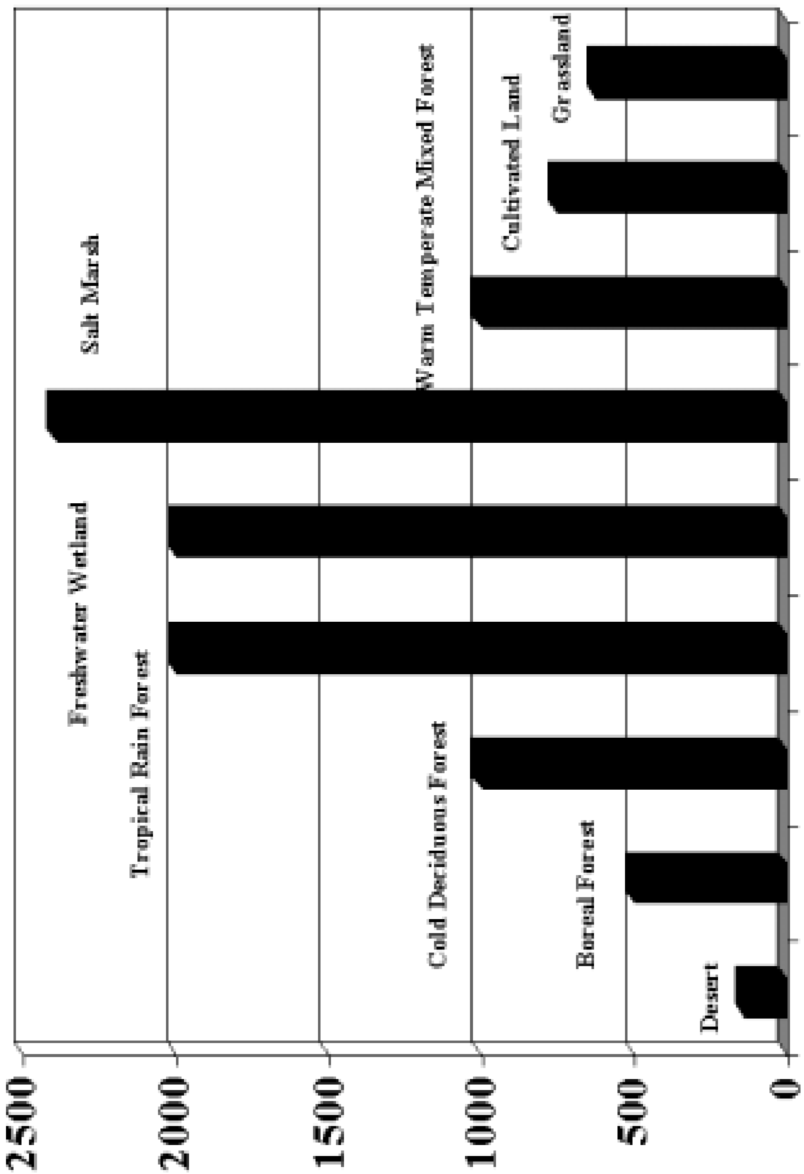


Figure 5-1. Net Primary Productivity of Selected Ecosystems ($g/m^2/yr$) (Adapted from Tiner 1985)

**Table 5-1.** Values and hazards associated with the various wetlands found within the Narrow River watershed (Kusler and Harwood 1977).

| Isolated Wetlands | |
|---|---|
| Values | Hazards |
| • Waterfowl feeding and nesting habitat<br>• Habitat for both upland and wetland species of wildlife<br>• Flood water retention area<br>• Sediment and nutrient retention area<br>• Area of special scenic beauty<br>• Permanently high groundwater levels due to discharge and drainage | • Flooding and drainage problems for roads and buildings due, in some instances, to widely fluctuating surface and groundwater elevations<br>• Serious limitations for on-site waste disposal<br>• Limited structure bearing capacity of soils for roads and buildings due to high content of organic materials |
| **Lake Margin Wetlands** | |
| Values | Hazards |
| • See values for isolated wetlands above<br>• Removal of sediment and nutrients from inflowing waters<br>• Fish spawning areas | • See hazards for isolated wetlands above |
| **Riverine Wetlands** | |
| Values | Hazards |
| • See values for isolated wetlands above<br>• Sediment control, stabilization of river banks<br>• Flood conveyance area | • See hazards for isolated wetlands above<br>• Flood conveyance area subject to deep inundation<br>• Sometimes erosion areas |
| **Estuarine and Coastal Wetlands** | |
| Values | Hazards |
| • See values for isolated wetlands above<br>• Fish and shellfish habitat and spawning areas<br>• Nutrient source for marine fisheries<br>• Protection from erosion and storm surges<br>• Feeding and roosting areas for shorebirds and water birds | • See hazards for isolated wetlands above<br>• Often severe flood hazard due to tidal action, riverine flooding, storm surges, and wave action<br>• Sometimes severe erosion area in major flood due to wave action |

5. In Rhode Island, coastal wetlands include salt marshes and freshwater or brackish wetlands contiguous to salt marshes (Olsen and Seavey 1983). Figure 5-2 shows the areal extent of freshwater and salt marshes in the Narrow River watershed. Most of the salt marshes are located in the southern portion of Pettaquamscutt Cove. Pettaquamscutt Cove is almost completely surrounded by broad expanses of salt marsh with several marsh islands present in the shallow waters. Smaller salt marsh patches ffringing marshes extend up the river, on both sides, as far north as Middlebridge.

6. Freshwater wetlands contiguous to the salt marshes which surround the estuary, account for almost half of the freshwater systems within the watershed. The remaining freshwater wetlands can be found along the Mettatuxet 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 supports high productivity levels.

7. Tributary wetlands are freshwater wetlands within the CRMC jurisdiction that are connected via a watercourse to a coastal wetland and/or tidal waters. Because of their hydrologic relationship with coastal resources, tributary wetlands require particular protection and management and must be evaluated on a case-by-case basis.

**B. Vegetation**

1. Aerial photographs have been used to classify the salt marshes surrounding Pettaquamscutt Cove as estuarine emergent wetlands (Kenenski 1986). Two forms of salt marsh are generally recognized dependent on the tidal flooding regime present. The low marsh is regularly flooded by tides, at least once daily, and occurs along the edges of the marsh and along the banks of tidal creeks. The low marsh is dominated by the tall form of smooth cordgrass (*Spartina alterniflora).* The high marsh zone occurs above the low marsh and is flooded less often than daily, forming a more complex and diverse plant community (Tiner 1989). Plant species typical of these communities and wetlands within the watershed are listed in Table 5-2. The cord grasses (*Spartina sp.)* 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).

2. Vegetation type within the estuary changes with salinity and tidal inundation. Salt pannes, depressions in the high marsh, present in the lower estuary are hyper-saline and partially submerged. Such an environment is almost exclusively inhabited by *Salicornia* sp., a saltwort.

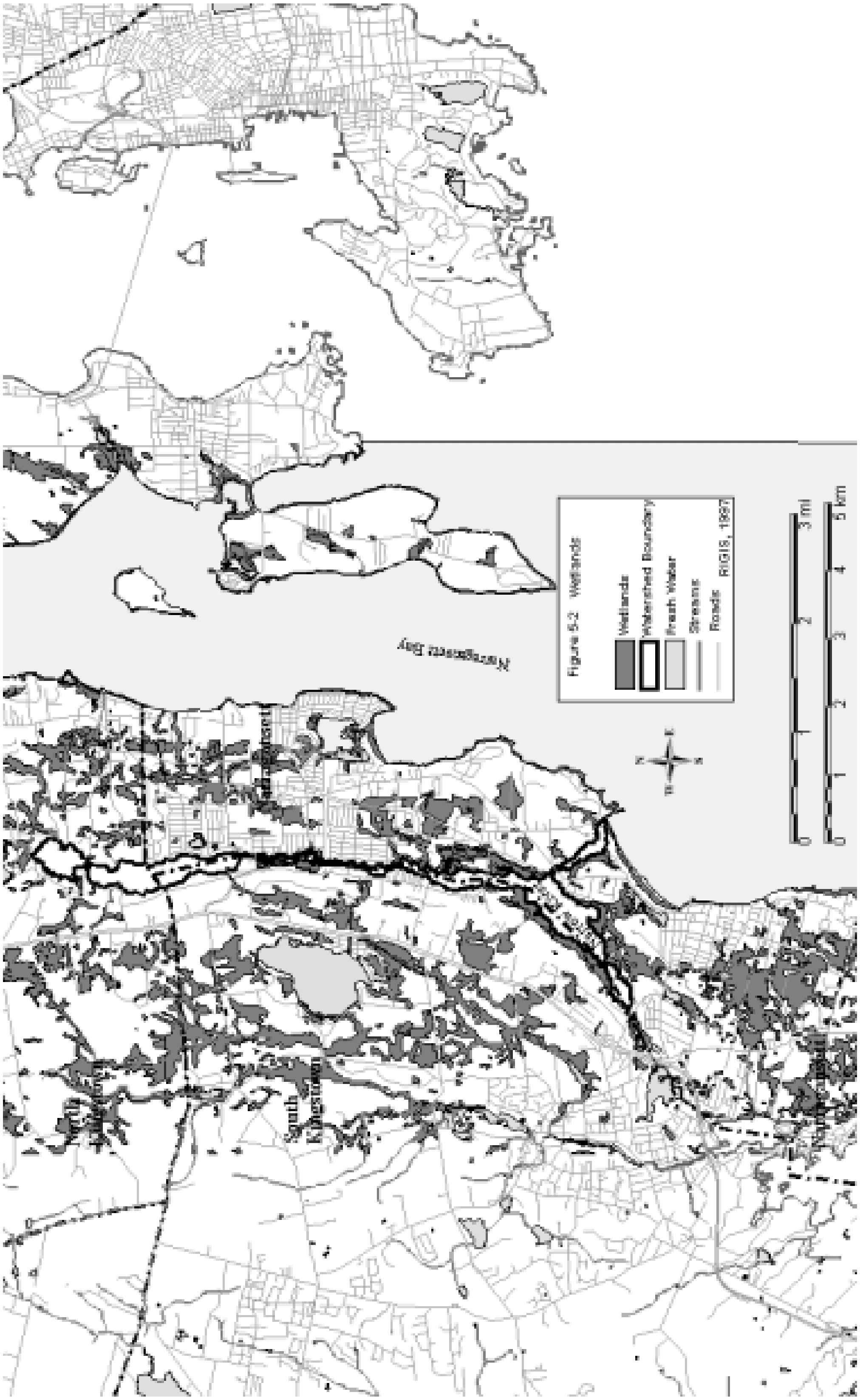
Figure 5-2 Wetlands
Wetlands
Watershed Boundary
Fresh Water
Streams
Roads
RIGIS, 1997
3 mi
5 km
Narragansett Bay
South Kingstown

**Table 5-2** Predominant wetlands vegetation of the Narrow River Watershed

| Common Name | Scientific Name | Type | Location |
|---|---|---|---|
| Salt marsh cordgrass | Spartina alterniflora | sw | lower estuary |
| Salt meadow grass | Spartina patens | sw | lower estuary |
| Spike grass | Distichlis spicata | sw | lower estuary |
| Saltwort | Salicornia sp. | sw | low/mid estuary |
| Sea lavender | Limonium carolinianum | sw | lower estuary |
| Cattails | Typha augustifolia | bw | cove/headwaters |
| Cattails | Typha latifolia | fw | headwaters |
| Reedgrass (Tall Reed) | Phragmites australis | bw | cove/mid estuary |
| Sedge grass | Scirpus sp. | bw, fw | mid estuary |
| Rushes | Juncus sp. | bw, fw | 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

3. The presence of the reed grass *Phragmites australis* is an indicator of disturbed estuarine wetlands, particularly where natural flushing by saltwater has been altered, or sediment loading is occurring (Neiring and Warren 1977). Regular tidal flooding which allows the level of soil water salinity to reach 20 parts per thousand is necessary to eliminate reed grass in favor of more desirable salt marsh vegetation (Howard et. al. 1978). *Phragmites* is most often considered a nuisance plant species due to its habit of growing in impenetrable monotypic stands, providing little overall food and cover for waterfowl, and generally out-competing and subsequently replacing more desirable vegetation (Cross and Fleming 1989).

## C. Wildlife

1. The Narrow River estuary and surrounding watershed support a variety of habitats which supply food, cover, feeding and breeding sites for a diverse animal community. The Narrow River water-shed includes many if not all of the common wildlife present throughout the state. Also present are many species dependent upon specialized habitats, such as salt marsh or brackish wetlands, for one or more of their requirements. Vertebrate (with backbone) animals comprise the following groups: fishes, amphibians, reptiles, birds and mammals which are described in the following sections.

2. Amphibians are often found in or adjacent to freshwater wetlands and are dependent on these habitats at least for breeding. Freshwater marshes, vernal ponds, seeps and small streams within the watershed provide critical habitat for these species. Typical examples of these animals include many of the common frogs, toads and salamanders found throughout the state. Common frogs and toads include American toad, spring peeper, grey treefrog, bullfrog, green frog, wood frog and pickerel frog. Common salamanders found within the watershed include spotted, two-lined and redback salamander. Amphibians generally do not occur within the tidal portion of the estuary due to the drying effects of salt water upon their highly permeable skin (Chabreck 1988).

3. Reptiles include turtles and snakes and are common inhabitants of the watershed area. Turtles are common in freshwater ponds and marshes many of which are found within the upper reaches of the watershed. Turtles found within the watershed region include the common snapping turtle, stinkpot, spotted turtle, eastern painted turtle, wood turtle and eastern box turtle. Snapping, spotted and eastern painted turtles are found within fresh as well as brackish portions of the estuary and may range into salt marsh habitats (DeGraff and Rudis 1986). One uncommon species in Rhode Island is the wood turtle (*Clemmys insculpta)* which may occur within the upper reaches of the watershed along the Mattatuxet River and which is susceptible to illegal collection and habitat loss (Raithel 1995). The diamondback terrapin, an estuarine turtle found in some parts of Rhode Island, is not found within the Narrow River.

Snakes commonly found within the watershed region include the eastern garter snake, hognose snake, northern water snake, northern brown snake, eastern ribbon snake, and northern ringneck snake. Most of these species inhabit terrestrial sites in near proximity to water, only the northern water snake inhabits primarily aquatic and semi-aquatic sites in fresh or salt water (DeGraaf and Rudis 1986).

4. The diversity of habitats found within the watershed give rise to a variety of birds found within the region. Both year round resident and migratory species inhabit this area and consist of such diverse groups as perching birds, birds of prey and waterfowl. The Breeding Bird Atlas Project (Enser 1992) has documented the nesting status of birds in Rhode Island. Because of habitat diversity, the list of species found within the entire Narrow River watershed includes many of the species found throughout the entire state.

(a) The watershed region of the Narrow River provides habitat for numerous bird species beyond those mentioned in this chapter. The wild turkey is a large native game bird which historically inhabited the upland habitats of the watershed but which became extinct from the state in the late 1700s. Restoration of turkey populations in Rhode Island began in 1980 and today wild turkeys can be found roaming within the vast woodlands of the watershed area (Tefft 1995).

(b) Focusing on wetland habitats within the Narrow River watershed, Table 5-3 lists those breeding species which may be found in open water, periodically exposed mud flats, and associated salt and brackish marshes fringing the river and within coves and bays. Table 5-4 lists those migratory bird species, which occur during spring, fall and winter, within wetland habitats associated with the Narrow River. This list is derived from observations of species expected to occur annually from the "Field Notes of Rhode Island Birds" (published monthly) and the "Checklist of Rhode Island Birds (1900-1985)" published by the Audubon Society of R.I. (Enser 1995).

**Table 5-3** Breeding bird species of wetlands habitat on the Narrow River (Enser 1992).

| | |
|---|---|
| Green-backed Heron | Sharp-tailed Sparrow |
| Belted Kingfisher | Song Sparrow |
| Least Tern | Red-winged Blackbird |
| Common Yellowthroat | Mute Swan |
| Marsh Wren | Swamp Sparrow |
| Seaside Sparrow (possible) | Mallard |
| Canada Goose | American Black Duck |
| Osprey | Clapper Rail |
| Virginia Rail | Killdeer |
| Spotted Sandpiper | |

**Table 5-4** Migrant Bird Species of wetlands habitat on the Narrow River (Enser 1995).

| | | |
|---|---|---|
| American Bittern | Common Merganser | Semipalmated Sandpiper |
| Great Blue Heron | Red-breasted Merganser | Western Sandpiper |
| Great Egret | Ruddy Duck | Least Sandpiper |
| Snowy Egret | Sora | White-rumped Sandpiper Pectoral |
| Little Blue Heron | American Coot | Sandpiper |
| Black-crowned Night Heron | Black-bellied Plover | Dunlin |
| Glossy Ibis | Pied-billed Grebe | Stilt Sandpiper |
| Snow Goose | Double-crested Cormorant | Short-billed Dowitcher |
| Green-winged Teal | Lesser Golden-Plover | Common Snipe |
| Gadwall | Semipalmated Plover | Laughing Gull |
| American Wigeon | Piping Plover | Bonaparte's Gull |
| Canvasback | Greater Yellowlegs | Ring-billed Gull |
| Ring-necked Duck | Lesser Yellowlegs | Herring Gull |
| Greater Scaup | Solitary Sandpiper | Great Black-backed Gull |
| Lesser Scaup | Willet | Common Tern |
| Common Goldeneye | Whimbrel | Least Tern |
| Bufflehead | Ruddy Turnstone | Horned Lark |
| Hooded Merganser | Red Knot | Sanderling |

(c) The open water, exposed flats, salt and brackish marshes of the Narrow River are particularly important to waterfowl, ducks and geese. The Atlantic Coast Joint Venture Plan (ACJVP) was established in 1986 in conjunction with the North American Waterfowl Management Plan, an international plan with the purpose to protect and restore the continents' waterfowl populations and their habitats. The goal of the ACJVP is to protect and manage priority habitats for migration, wintering and production of waterfowl, with special consideration to black ducks (ACJVP 1991). "Focus Areas" were identified in each state which consist of important wetland habitats to the objectives of the plan. In Rhode Island, the Narrow River was identified as a Focus Area containing at least 330 acres of salt and brackish marsh and open water habitats of critical importance to black ducks and other waterfowl (Allin 1989).

(d) The black duck is considered a species of international concern by the ACJVP and the Black Duck Joint Venture was designed to reverse declines in this important species caused by habitat loss, competition with mallards and changes in nesting and brood rearing success. Midwinter waterfowl counts, conducted annually by the state since the late 1950s, have documented the Narrow River as an important wintering habitat for black ducks and other waterfowl including mallards, canvasbacks, bufflehead, mergansers, Canada Geese, and mute swan (Allin 1995). The mute swan is common during winter in Narrow River and is an exotic species introduced from Europe sometime prior to 1938 (Willey and Halla 1972). These aggressive birds compete with native waterfowl and are suspected of interfering with and adversely affecting native species.

(e) The osprey (Pandion haliaetus) is a large, fish-eating hawk generally found along seacoasts, bays, rivers, lakes and marshes. Adult osprey can have a wingspan of up to 74 inches and can be easily identified in flight by their white underparts, barred brown and white tail and flight feathers and long wings which have a conspicuous bend at the wrist. Osprey construct large nests near water, consisting of sticks and often up to four feet in diameter. Osprey utilize tall, isolated dead trees for nesting and with increasing frequency man-made structures such as utility poles and communications towers. In Rhode Island osprey nest from April to July and exhibit strong nest fidelity, often returning to the same nest site for many years. Osprey suffered a dramatic decline in numbers during DDT (Dichloro Diphenyl Trichloroethane) accumulation. Since the reduction of pesticide use and proper management, osprey numbers have increased significantly range wide. In 1998, there were 61 active nests in Rhode Island with a record 104 birds fledged. In 1998, there were three known nesting pairs in the Narrow River watershed with additional pairs and individual birds utilizing the estuary and associated ponds and river systems as foraging areas.

4. Many species of mammals can be found within the diverse habitats of the Narrow River watershed (Cronan and Brooks 1968). Small mammals such as meadow voles and white footed mice are ubiquitous and are found from the salt marsh to the upland woodland. Other

common small mammals include masked shrew, short-tailed shrew, star nosed mole, rabbits, chipmunk, woodchuck, red, gray and southern flying squirrel, opossum and skunk. Many common species of bats, including the little brown myotis and big brown bat, can be observed foraging on insects over the estuary during the twilight hours on warm summer nights.

(a) Many of the economically important fur-bearing mammals common to the state live and feed in close proximity to aquatic habitats along the Narrow River. These species would include red and gray fox, raccoon, muskrat, mink, ermine, and river otter. Large mammals such as the white-tailed deer are abundant throughout the watershed from the salt marshes of the river to the upland forest and can be observed crossing or feeding along the edges of road and fields. Recently the coyote has dramatically increased in numbers throughout the State and is common within the Narrow River watershed.

**D. Rare Species**

1. Within the Narrow River estuary and watershed a few species of flora are listed as rare according to the RIDEM Natural Heritage Program. The Piping Plover is the only known federally threatened species in the watershed, and has only recently returned to nest at the mouth of the Narrow River. In 1998, there was one Plover pair nesting at the mouth of the Narrow River on a wide sandy point which has formed and 3 fledglings were produced. Two state listed plant species are known to occur within the area. The sea pink *(Sabatia stellaris)* is found within the Narrow River estuary, one of only 6 confirmed sites in Rhode Island. Olney's sedge (*Scirpus olneyi)* also occurs in the estuary, one of 3 sites statewide, and is indicative of a high quality brackish water system.

2. The beach at the mouth of the Narrow River has been a perennial attractant for Least Terns and Piping Plovers. For decades the birds have arrived and occupied territories on the beach near the outlet of Narrow River (Ferren and Myers 1998). Although most accounts of nesting activity report limited success because of recreational activities, 60 Adults were recorded by Ferren and Myers for 1996 (Ferren and Myers 1998) and 24 Least Tern pairs were recorded in 1998 (USFWS 1999, Personal Communication). The clapper rail is another rare species which has not been identified in the estuary marshes recently, although its habitat is present.

**510.3 Open Water and Aquatic Habitats**

**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 (Clark 1977). Typical inhabitants of this community include submerged seagrasses, shellfish and finfish, mudworms, and many planktonic (microscopic 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 quantities of nutrients to be produced and exchanged between wetlands and open-water 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 fishermen, and loss of recreational revenue to municipalities due to reduction in sportfish populations. These effects have already been felt in the salt pond region of southern Rhode Island (Olsen and Lee 1984).

**B. Plankton**

1. Plankton are microscopic organisms (bacteria, diatoms, uni- and multicellular algae and animals) 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 1974). Typical zooplankton 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 3) and are important in that they are indicators of sewage waste material.

**C. Submerged Aquatic Vegetation**

1. Submerged aquatic vegetation (SAV) 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. Wood et al. (1969) characterized some of the more important functions of SAV as:

- 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

2. Six species of SAV have been documented in the Narrow River by Wright et al. (1949) and are presented in Table 5-5. As part of the Narragansett Bay Critical Resource Mapping project, the RIDEM Narragansett Bay Project and Save The Bay are cooperating with the University of Massachusetts to map SAV in Narragansett Bay, including the Narrow River (EPA 1997). An aerial overflight was conducted in the summer of 1996 utilizing the NOAA Coastal Change and Analysis Program (C-CAP) guidelines to produce true color aerial photographs at scales of 1:12,000 and 1:40,000. The UMASS Natural Resource Assessment Group was contracted to interpret the aerial photographs to identify, delineate, and classify SAV (primarily eelgrass (*Zostera marina*), salt marshes, barrier beaches, cobble beaches, spits, bars, mud flats, oyster reefs, and coastal banks. This

information was then transferred to mylar U.S. Geologic Survey 7.5 minute series quadrangle base maps to be digitized and incorporated into the state GIS in order to produce resource maps. The data is still being finalized and will be included as part of the SAMP once it is completed.

**Table 5-5.** Submerged Aquatic Vegetation observed in the Narrow River (Wright et al. 1949).

| Common Name | **Scientific Name** | Mode of Occurrence | Observed Location |
|---|---|---|---|
| Narrowleaf Pondweed | *Potamogeton berchtoldi* | Infrequent | Cove in the upper basin |
| Sago Pondweed | *Potamogeton pectinatus* | Infrequent-Moderate | Sporadically in the upper basins |
| Claspingleaf Pondweed | *Potamogeton perfoliatus* | Infrequent | Northern basins |
| Wigeongrass | *Ruppia maritima* | Infrequent | Shallow coves |
| Horned Pondweed | *Zannichellia palustris* | Infrequent | Easter shore, north of Middlebridge |
| Eelgrass | *Zostera marina* | Infrequent-Moderate | South and north of Middlebridge, patches in the Pettaquamscutt Cove |

**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 1700s:

> "...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 1950s 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. Seventy-five 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 the use of the river is presented in Table 5-6. 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, American pollock, 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). From data collected during 1992 and the data reported by other investigators it appears that the species diversity in Narrow River has varied little during the past 30 years although it is probable that seasonal and annual variations in air temperature, water temperature, salinity, dissolved oxygen and transparency have resulted in short term changes in species occurrence (Satchwill et al. 1993).

A total of thirty-eight species from twenty-four families were collected during 1992. The most abundant species in the collections occurred as juveniles and adults of menhaden, winter flounder, silversides, alewives, sheepshead minnow and mummichogs. Fresh water species including smallmouth bass and bluegill were collected in upper river stations during the study. In addition to fresh water species, samples contained important anadromous species such as alewives, American shad, striped bass and white perch (Satchwill et al. 1993). Most of the remaining species are commonly collected in the nearshore coastal waters of Rhode Island (Lynch 1993).

Variations in total monthly catches were influenced by the dominant species; silversides, mummichogs, 4-spine stickleback, alewives and sheepshead. Menhaden appeared at irregular intervals, and because of their characteristic schooling behavior became a major component of the catch at various times during the year. Major species with recreational and commercial value ranked by abundance over the entire year were winter flounder, white perch, striped bass, bluefish, tautog, scup and summer flounder.

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 most 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 co-habitating within the extremes of their preferred natural environments.

5. The Narrow River is renowned 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 (Durbin et al. 1979). Resident fish in Carr Pond have growth rates considered much higher than the statewide

| Common Name | Scientific Name | Location | Spawning/Breeding | Resident | Wintering | Migrant | Transient/Rare |
|---|---|---|---|---|---|---|---|
| Atlantic Silversides | Menidia menidia | L,M,U | | * | | | |
| Blue runner | Caranx crysos | U | | | | * | |
| Inland Silversides | Menidia beryllina | L,M | | | | | |
| Sheepshead minnow | Cyprinodon variegatus | L,M | | * | | | |
| Striped mummichog | Fundulus majalis | L,M,U | | | | | * |
| Common mummichog | Fundulus heteroclitus | L,M,U | | | * | | |
| Silver gar | Strongylura marina | L,M,U | * | * | | | |
| Anchovy | Anchoa mitchilli | U | | | | | |
| Striped anchovy | Anchoa hepsetus | U | | * | | | |
| Pipefish | Syngnathus 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 lance | Ammodytes americanus | L,M | | | | | * |
| Short horned sculpin | Myoxocephalus aeneus | L,M | | | | | |
| Winter flounder | Pleuronectes americanus | L,M,U | | * | * | | |
| Atlantic sea herring | Clupea harengus | M,U | | * | | | |
| Tautog | Tautoga onitis | L,M,U | | | | | |
| Pollack | Pollachius virens | L,M,U | | | | | * |
| White Perch | Morone americana | L,M,U | | | | * | |
| Striped bass | Morone saxatilis | L,M,U | | | * | | |
| Tomcod | Microgadus tomcod | L,M,U | | | | | |
| Halfbeak | Hyporhamphus unifasciatus | U | | | | | * |
| Atlantic Cod | Gadus morhua | M,U | | | | | |
| Hake | Urophycis sp. | U | * | * | | | |
| Hogchoker | Trinectes maculatus | U | | | | | |
| Mullet | Mugil cephalus | U | | | | | * |
| N. Barracuda | Sphyraena borealis | U | | | | | * |
| Bardtail | Caranx crysos | U | * | | * | | * |
| Lookdown | Selene vomer | U | | | | | |
| Rudderfish | Seriola zonata | U | | * | | | |
| Threadfin | Alectis ciliaris | U | | | | * | |
| Round pompano | Trachinotus carolinus | U | | | | | |
| Common pompano | Trachinotus carolinus | U | | * | | | |
| Bluefish | Pomatus saltatrix | U | | | | * | |
| Common bigeye | Priacanthus arenatus | U | | | | | |
| Naked goby | Gobiosoma bosc | U | | | | | * |
| Toadfish | Opsanus tau | U | | | | | |
| Grubby | Myoxocephalus aenaeus | L | | * | | | |

| Common Name | Scientific Name | Location | Spawning/Breeding | Resident | Wintering | Migrant | Transient/Rare |
|---|---|---|---|---|---|---|---|
| Cunner | Tautogolabrus adspersus | | | * | | | |
| Rainwater killifish | Lucania parva | L | | * | | | |
| Permit | Trachinotus falcatus | U | | | | * | |
| Crevalle jack | Caranx hippos | L,U | | | | * | |
| Darter goby | Gobionellus boleosoma | L | | | | * | |
| Summer flounder | Paralichthys dentatus | L,U | | | | * | |
| A. Croaker | Micropogonias undulatus | U | | | | * | |
| **Anadromous Species:** | | | | | | | |
| Alewife | Alosa psuedoharengus | L,M,U | * | | | | |
| American shad | Alosa sapidissima | U | | | | * | |
| Blueback herring | Alosa aestivalis | U | * | | | | |
| **Catadromous Species:** | | | | | | | |
| American eel | Anguilla rostrata | L,M,U | | | | * | |
| Conger eel | Conger oceanicus | L | | | | * | |
| **Freshwater:** | | | | | | | |
| Large mouth bass | Micropterus salmoides | L,M,U | | | | * | |
| Brown bullhead | Ameiurus nebulosus | U | | | | * | |
| Chain pickerel | Esox niger | U | 0 | | | * | |
| E. Banded killifish | Fundulus cingulatus | U | | | | | |
| Yellow perch | Perca flavescens | U | | | | * | |
| Bluegill | Lepomis macrochirus | U | | | | * | |
| Small Bass | Micropterus dolomieu | U | | | | * | |
| Gizzard shad | Dorosoma cepedianum | U | | | | * | |

**Table 5-6. Finfish of the Narrow River** 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, Bengston 1982, Satchwill et al. 1993, Gray 1994.

average which is also attributed to the alewife migration (Guthrie and Stolgitis 1977).

(a) The Narrow River herring (consisting of alewife and blueback herring) run at the Gilbert Stuart Birthplace, has been monitored by the Rhode Island Division of Fish and Wildlife (RIDFW) since the mid 1970s. In the early 1990s, to augment a declining population, the RIDFW stocked an additional 7,000 river herring into Carr Pond. Between 1990 and 1993 the Narrow River herring runs yearly average was approximately 22,600 upstream migrants (Powell 1994). As of May 1995, the number of upstream migrants exceeded 70,000 (Chris Powell, Personal Communication 1995).

(b) Improved water quality, more conservative fishing regulations and fine tuning of the outflow from the Gilbert Stuart Birthplace dam have contributed to the improvements of this run. The continued "pristine" nature of this system is important, as the monitoring of this river herring population is used as a barometer for the condition of other runs around the state. It is important that this water quality system be protected from undesirable land use development or eutrophication (Powell 1995).

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 shellfish species encountered in the Narrow River include quahaugs, mussels, razor clams, and soft shell clams. The blue crab is able to move freely through the estuary and is commonly encountered near the shore searching for food (Campbell 1958).

2. It is interesting to note that Campbell's 1957 survey found almost no soft shell clams within the Narrow River. The following year, Wright (1958) surveyed the beds and determined that the Narrow River had been over-exploited, eventually leading to special catch and enforcement regulations enacted by the RIDEM (Table 5-7). Results from Baczenski and Ganz's 1980 survey indicate several dense softshell clam beds (Ganz, Personal Communication 1997). Thus, it is clear that the shellfish populations fluctuate;

whether or not this is the result of natural cycles or the RIDEM's catch regulations has not been determined.

3. The location and mean densities of shellfish species found in the Narrow River have changed dramatically since Baczenski and Ganzs' 1980 survey (James Boyd Personal Communication 1997). An updated survey is nearing completion and should be published in the Fall of 1997. These investigators found that the oyster population was wide-spread throughout the gravel periphery of the upper ponds. No major oyster clusters were found in mud areas below the

gravel periphery. The upper ponds, the southernmost in particular, have the optimal salinity range for oyster propagation.

(a) In the 1980 survey, sand, silty sand and firm mud substrates through the lower Narrow River supported clams and quahaugs. Soft mud areas in lower Pettaquamscutt Cove, in the mid-river areas and in the deep waters of the upper ponds did not supported clams and quahaugs. Clams and quahaugs were less numerous in readily accessible areas, primarily in the immediate vicinity of Middle Bridge. Areas that were only accessible by small boat or considerable wading exhibited denser concentrations of shellfish. Delta sands along the lower river adjacent to and below Sprague Bridge did not support clam and quahaug populations. However, a large mussel bed did develop in that area. Some razor clams were observed in the delta sands. No bay scallops were observed in the survey. Recruitment in soft shell clam and quahaug populations appears to exist as evidenced by the large proportion of juveniles. The lack of large soft shell clams does raise overfishing questions.

4. The Narrow River, in its entirety, was closed for shellfishing due to pollution in 1987. Although, the Narrow River has been declared a special Shellfish Management Area in its entirety for a period of five years as of November 1992, this is superseded by pollution. The Shellfish Management Area status will expire five years from the filing date unless renewed by subsequent RI Marine Fisheries Council actions. The following daily catch limits have been established for the following species and will be in effect when the pollution closure is terminated: quahaugs, soft-shelled clams, sea clams and oysters.

**Table 5-7.** Minimum Size and Catch for Shellfish (RIDEM 1985 & 1986).

MAXIMUM DAILY TAKE*
RI Resident................................................................1 peck each/day/person
Licensed Non_Resident.............................................½ peck/day/each/license
Commercial...............................................................3 bu/day/each/license
*Oysters_season open from September 15_May 15.

| Species | Size | Catch: Commercial/Resident |
|---|---|---|
| Quahaug | 1" smallest diameter | ½ bu/day, 1 peck/day |
| Clam | 1½” maximum diameter | ½ bu/day, 1 peck/day |
| Mussel | 1½” maximum diameter | ½ bu/day, 1 peck/day |
| Oyster | 3" longest axis | ½ bu/day, 1 peck/day |
| Blue Crab | 4 1/8" tip to tip | ½ bu/day, 1 peck/day |

## F. Rare and Uncommon Species

A sea cucumber has been collected from the southern portion of the estuary, near the Cove, the only location in the state where this species has been documented (Seavey 1975). Several uncommon fish species have also been known to inadvertently enter the estuary. These species include the Atlantic Sturgeon (Enser 1986), Northern barracuda (Gordon 1960), moonfish (preserved at the URI Bay Campus), shortfin squid (Gray 1994) flying gurnard (Gray 1994) and the tilefish (Satchwill et al. 1993).

**G. Human Impacts to Wetlands and Open Water Habitats**

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 wetlands habitats, severely effecting the productivity of the ecosystem. This, in turn, can lower the resource value to the community and threaten future use (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, recreation, scientific, and aesthetic qualities are additional benefits 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).

## 510.4 The Terrestrial Habitat

**A. Description**

1. Terrestrial uplands within the Narrow River watershed are comprised of a continuum of successional habitats ranging from abandoned fields to mature forest. The uplands are interspersed with and surround smaller sub-watersheds which drain small streams, rivers, swamps and other freshwater wetlands that comprise the entire watershed basin. The land use policies and practices employed within the terrestrial habitats have a direct affect on the overall quality of the watershed ecosystem. Land use practices which abuse or over develop the land within the watershed will diminish the quality and function of the Narrow River estuary.

2. Forest land covers about 400,000 acres or 60% of the state, commercial forestry operates on a very small scale in the state, with commercial holdings owning approximately 1% of Rhode Island's forest lands.

(a) Trees of the red oak group are the dominant species in Rhode Island making up 42% of the growing stock of all species. Red maple is the second most dominant tree species accounting for 22% of the growing stock of tree species. The most common understory woody stem shrubs in Rhode Island are the blueberries (*Vaccinium sp.)*. A total of 25 hardwood species and 6 softwood species are found in the state, many of which are common to the watershed of the Narrow River (Dickson and McAfee 1988).

3. Vegetation helps to prevent the impacts associated with sudden discharges of freshwater, such as increased sediment loads and erosion due to storm events. 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).

4. Trees and woody shrubs are an essential component of wildlife habitat producing much of vegetative materials in the form of nuts, seeds, fruits, twigs, buds and foliage consumed by herbivorous wildlife. In addition, trees and shrubs provide habitat for insects and other prey animals that are consumed by other forms of wildlife. The diversity and pattern of forests is one of the primary determining factors of which types and where wildlife live in the terrestrial environment. The structure and form of the vegetation in the forest and other early successional habitats is the critical component of habitat for wildlife.

**B. Flora and Fauna**

1. A diverse assemblage of wildlife species inhabit the terrestrial uplands within the watershed. Few wildlife species live exclusively in terrestrial upland but utilize adjacent wetlands in some small way that may include a source of drinking water, a travel corridor or an escape cover when disturbed by predators. Many forms of animal life, ranging from insects to vertebrate animals (amphibians, reptiles, birds and mammals) are found in great abundance throughout the watershed. Many of the common wildlife found throughout the state are found within the watershed region. These would include many of the species which are described in this chapter.
2. 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, destroys vegetation resulting in increased velocity and quantity of surface water runoff. This is extremely important in those portions of the watershed characterized by steep slopes with potentially erodible soils. The runoff generated by developed surfaces constitutes a form of water pollution, known as non-point, which cumulatively degrades the water quality within the watershed.

2. The degradation of water quality directly affects the species and diversity of flora and fauna living in the region. Increased discharges of freshwater to the wetland and river, due to lack of

attenuation of flow by vegetation, can eventually disturb the natural salinity and hydrology of the estuarine habitat, in turn, affecting the faunal communities (Daiber 1986).

### 510.5 Summary

#### A. Significant Habitats

1. The wetlands, fresh and tidal, of the watershed are highly productive and supplement the productivity of the adjacent estuary. The vegetation forms the basis of this productivity, serving as food and habitat for fish and wildlife. The wetlands also provide several significant functions which are beneficial to the surrounding residential communities. These include fish and wildlife habitat, environmental quality and socio-economic values. Destruction of wetlands reduces these functions and the overall value of the watershed as a natural resource.

2. The aquatic habitat supports a diverse community with several unique species. In the upper basins of the Narrow River, rare microorganisms flourish, phytoplankton populations simulate those found in Norwegian climes, and freshwater and marine fish intermingle. The best known alewife 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 was collected 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 Narrow River by supporting many recreational and sport fishing activities, as well as a few small commercial operations.

3. The uplands surrounding the wetlands and aquatic environments form the majority of the watershed area and contribute to the overall productivity of the ecosystem. They provide structurally diverse habitats which increase wildlife species abundance and diversity. Upland vegetation aids in the maintenance of water quality and in mitigating runoff, the impact of which can be devastating to the wetland and aquatic communities.

4. The ecological processes of the Narrow River watershed make it a complex support system for a very diverse floral and faunal communities utilizing several different habitats. Inextricable ties have developed which contribute to the overall productivity of the estuary and consequently to the abundance and diversity of animal populations which inhabit the watershed. Keeping the natural resource value of the Narrow River high requires keen stewardship and protection of each component of the ecosystem. The watershed's viability is highly subject to human proclivities and the manner in which human impacts are managed, now and in the future, will determine the degree to which the Narrow River ecosystem can be maintained.

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# Chapter 6
# Storm Hazards

## 600 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 Federal Emergency Management Authority (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 watershed 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 emergency official in each town and reported to the Governor's office. FEMA, in conjunction with Rhode Island Emergency Management Authority (RIEMA) and the Governor's office, will survey and designate those areas severely affected and help coordinate federal disaster assistant 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 and CRMC.

2. Presently, the CRMC is mandated to set policy and permitting activities in the coastal zone. Municipalities, in conjunction with RIEMA, have their own emergency response plans which include evacuation information, locations of shelters, sites for debris removal,

priorities for the replacement of public and private facilities, and mechanisms for FEMA intervention post-storm. Local officials are responsible for determining the local permits necessary for rebuilding, as well as implementing the required flood construction standards dictated by the location of the structures within flood zones. State and local coordination after such an event is imperative. The CRMC has its own emergency post-storm response procedures (see Section 180 of the RICRMP) including emergency permitting, and works to stay involved with the FEMA, RIEMA, and local officials to ensure that immediate intervention occurs and haphazard re-development within flood prone areas does not take place.

## 600.1 Emergency Preparedness Information

### A. Preparations

1. In addition to the obvious preparations of educating the public, training of emergency personnel, acquisition of adequate emergency equipment, and the installation of warning systems, there are other planning tasks communities can undertake in advance of a storm, that will minimize damage and speed recovery from a storm event. Hazard mitigation and post storm redevelopment planning are two very important steps in preparing for a major storm. Land use controls and appropriate construction standards can be applied to new construction and post storm reconstruction. As of 1995, RIEMA and local municipalities in conjunction with the U.S. Federal Government are attempting to develop regulations to apply setbacks, new construction standards, mitigation measures, such as relocation and acquisition of unbuildable property, etc., for redevelopment after disasters.

In September of 1995, Governor Almond signed a Partnership Performance Agreement (PPA) between the RIEMA and the federal government for emergency management. The PPA is part of the National Mitigation Strategy which has two principal goals:

(a) To substantially increase public awareness of natural hazard risk so that the public demands safer communities in which to live and work; and

(b) To significantly reduce the risk of loss of life, injuries, economic costs, and destruction of natural and cultural resources that result from natural hazards.

2. Goals and objectives established for Rhode Island are consistent with the national strategy. RIEMA has made a significant investment in developing and promoting a pro-active approach to hazard mitigation. Mitigation is becoming a key focus area for the organization and is highlighted by the goals of the PPA which states that within five years they expect to have achieved the following:

- Improve the sustained hazard mitigation capability of state and local jurisdictions.

- C In partnership with state and local jurisdictions, improve building codes, zoning ordinances, and infrastructure design standards, and develop adequate enforcement capability to minimize risks associated with known hazards.
- C Establish for state and local jurisdictions a public and private sector partnership to promote, plan, and coordinate activities that enhance mitigation.
- C Develop an all-hazard multi-objective mitigation plan.

3. The goal of the PPA is to increase the ability of the state to respond to and recover from emergencies and disasters and ultimately reduce the need for federal assistance. This goal is scheduled to be accomplished through a coordinated plan of mitigation, preparedness, response and recovery (Lee et al. 1996). During the end of 1995 and early 1996, RIEMA participated with RI Sea Grant, the URI Coastal Resource Center, and various municipalities including representatives from the Salt Pond Region in South County, to address issues and formulate a foundation for work to begin on these multi-objective mitigation plans. The document**,** "Integrated Multi-Hazard Mitigation in Rhode Island" was released in March of 1996.

Lives and property can be saved through appropriate planning and mitigation techniques. Proper placement, construction, or retrofit of residential and other structures will reduce the threat to the inhabitants and to the physical property within the Narrow River watershed. Mitigation planning will provide an opportunity for local and state government to work together to ensure the proper placement, construction or retrofit of residential and commercial structures (Lee et al. 1996).

**B. Evacuation**

1. An evaluation of a number of factors affecting evacuation of the Narrow River watershed, including the roadway system, likely evacuation destinations, traffic, seasonal population, severity of storm, etc., was conducted by the ACOE for the Hurricane Evacuation Study (ACOE 1995). This transportation analysis was utilized to compose an evacuation route map that illustrates evacuation zones and shelters for each affected community. Municipal and state emergency management officials have the Inundation Map Atlas and the Evacuation Map Atlas, both products of this study, for each community. This information would be most useful if it resulted in municipal signs posting appropriate evacuation routes on roadways. It is recommended by FEMA that coastal communities use an 8 hour clearance time estimate for well-publicized daytime evacuations.

In addition to the actual evacuation time, officials must add the time required for dissemination of information to the public, which can vary from community to community. It is a community decision to conduct an evacuation based on information made available to municipal officials. The ACOE recommends that the evacuation be complete before the arrival of gale-force winds. The ACOE, under a weak hurricane scenario, estimates 86,000 people in affected inundation areas for the state. In the Narrow River Area, estimates are 18,080 people in vulnerable areas, with an estimated population of 17,240 likely to evacuate the three towns under a weak hurricane scenario. Strong hurricane scenarios estimate 24,160 people in the Narrow River region are vulnerable, with 23,260 likely to evacuate. Any regional hazard mitigation plan that may be accomplished under the FEMA/RIEMA partnership should (and would likely) address this issue in a coordinated manner for the Narrow River.

**C. Shelters**

1. Due to the difficulties in keeping this information current, refer to the local emergency management plan and shelter listing held by municipal emergency management officers, and their copy of the U.S. Army Corps of Engineers (ACOE) Draft Hurricane Evacuation Study Technical Report (ACOE 1995).

**D. Disaster Assistance**

1. Federal disaster assistance provides opportunities for post disaster hazard mitigation through funding options and technical assistance. Although most disaster assistance for public facilities is funded 75 % by the federal government for a restoration to pre-disaster conditions, some flexibility in funding is available that permits facilities to be rebuilt or relocated so that future vulnerability to flooding is reduced. Most of this financial assistance comes through FEMA. In Rhode Island, RIEMA is responsible to the Governor for carrying out the emergency management programs in the state and for coordinating disaster response and recovery activities of state agencies and municipalities with FEMA. Their basic responsibilities are:

(a) Pre-Disaster: Organization, planning, coordination, education, and training for emergency preparedness and management, including the Emergency Operations Plan (EOP).

(b) Post-Disaster: Coordinating disaster response and recovery of state agencies and municipalities with FEMA and any other necessary federal agencies, including:

1. Initial damage assessment from municipalities to assess needs and magnitude of damage.
2. Detailed damage assessment for the Governor's request for major disaster declaration by President, if necessary.
3. Requests for federal and state disaster assistance funds.

## 600.2 The Flood Zones Along the Narrow River

### A. Areas of Flood Zones

1. The character of the Narrow River drainage system is related to the interaction of several factors, including climate, topography, geology, vegetation, and soil.

2. Flooding problems have become apparent in the Middlebridge area where, during storms, the water level 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. Areas that have been classified by FEMA as flood potential zones are delineated on FEMA's flood insurance maps. These maps 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). Many building regulations are determined by what zone a structure is in. In addition to these areas, there also exists within the watershed, a proportional amount of land subject to flood elevations from 100-year to 500-year flood events. The A and V zones for the Narrow River watershed are shown in Figure 6-1.

### B. Threats to Development in Flood Zones

1. Several factors controlling flood damages include land use within the flood prone areas and the magnitude and duration of a flooding event. Land clearing and the associated development increase runoff, erosion, and the occurrence of flood hazards in the individual sub-basins of the watershed. 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 do not greatly increase the flood hazard above its present level in general, but can have a large impact in any specific sub-basin.

2. Concern over flooding in the largely undeveloped northern area is related chiefly to rainfall-runoff events along Gilbert Stuart Stream and tributaries. Flood effects in the lower and middle estuarine areas are related to storm 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 6-1). The majority of the houses located in the A zone are in the middle estuarine region, adjacent to the Narrow 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 6-1.** Lots of Record Located within the Narrow River Flood-zones (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 within one year (FIAC 1985). Planning for such hazardous events is tenuous, at best.

4. In the Narrow River watershed, much of the A zone has been developed for residential use. This situation creates the potential for a host of problems in the event of flooding. For example, many ISDS commonly used throughout the watershed, are located within these flood prone areas. In the event of inundation by storm-surge flood waters, effluent from the ISDS, along with other pollutants, could flush to the surface, thus contaminating the Narrow River. The threat of such an occurrence compounds the existing concern over water quality problems.

## 600.3 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 Narrow River is subject to periodic flooding events.

2. Data compiled in the ACOE 1995 Draft Rhode Island Hurricane Study calculates the recurrence interval (1886 to present) at one hurricane every 5.4 years, and a tropical storm at one every 1.7 years. They count 29 hurricanes and 67 tropical storms in the Ocean State since 1886 (ACOE 1995). There is, however, no regularity to their occurrence; while no major hurricanes swept across the state in the 30 years spanning 1954-1984, four hurricanes struck Rhode Island in the decade from 1944 to 1954. Since 1984 there have been two; Hurricane Gloria in 1985, and Hurricane Bob in 1991.

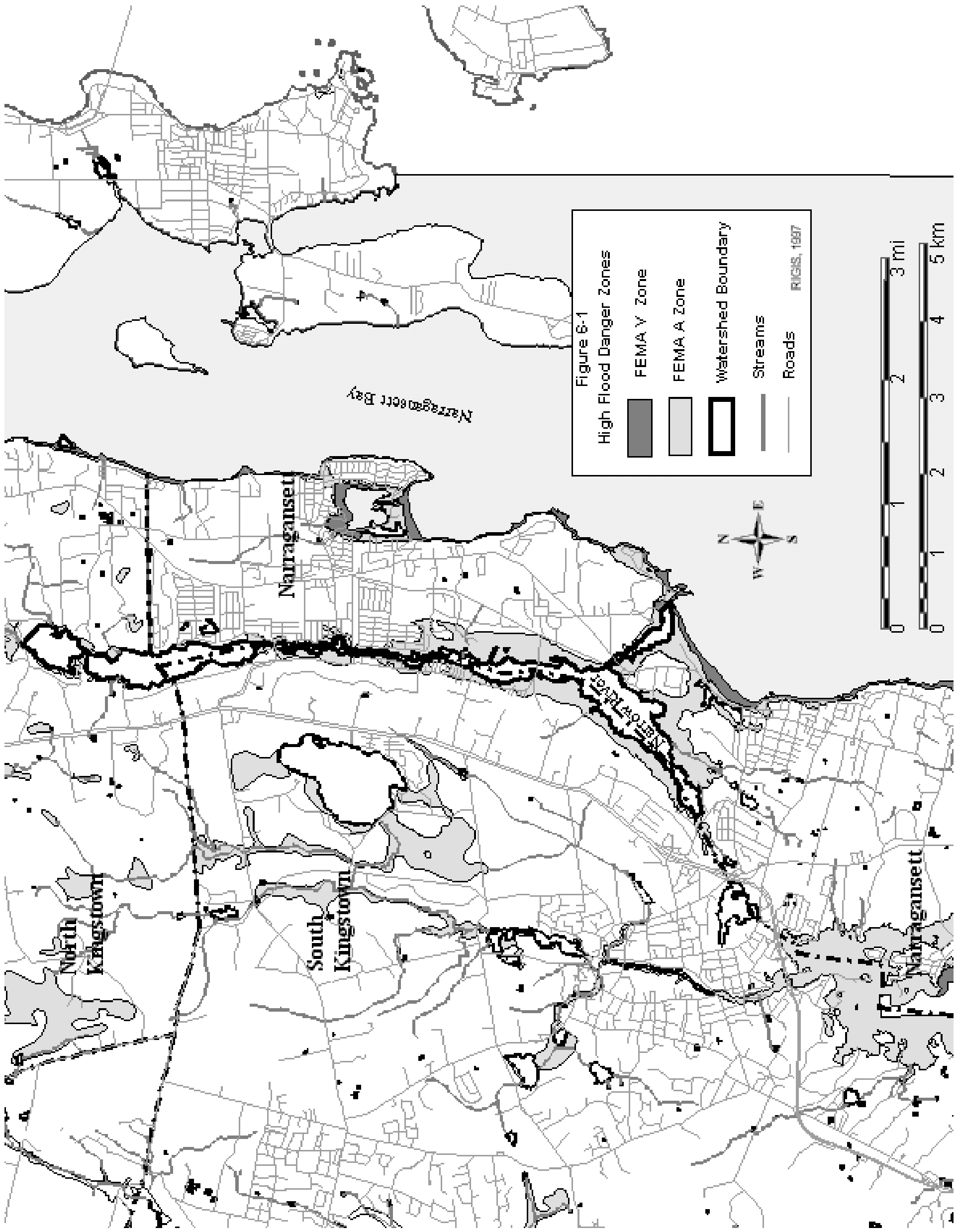
Figure 6-1
High Flood Danger Zones
FEMA V Zone
FEMA A Zone
Watershed Boundary
Streams
Roads
RIGIS, 1997
0 1 2 3 mi
0 1 2 3 4 5 km
N
E
S
W
Narragansett Bay
Narragansett
North Kingstown
South Kingstown
Narragansett

Descriptions of how past storms have affected the Narrow River area are found in Table 6-2. Damages from such storms are caused most often from storm surges, flooding from heavy rain, action of storm driven waves, and high velocity winds (Keller 1975). The location of the Narrow River, within the lower reaches of Narragansett Bay and behind the Narragansett Beach area, reduces its exposure to the direct force of hurricanes and coastal storms approaching the south coast.

**Table 6-2**. Hurricane Events Impacting the Narrow River Watershed (data from archives of the Narragansett Times)

3. Officially the hurricane season extends from June through November, however, hurricanes most frequently occur during the months of August, September, and October.

**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 storm-surge flooding. 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” (ACOE 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 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 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 (ACOE 1960). The sediment deposition that occurs during such severe events can cause changes to an estuary not only by creating shoals such as those that now exist in the Narrows and Pettaquamscutt Cove, but also by altering circulation patterns and the aquatic habitat (Olsen and Lee 1984).

3. The most threatening element associated with hurricanes is the storm 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 Narrow River channel serve to slow the storm surge and, thus, to protect this area somewhat from the full force of the surge during severe hurricane events.

4. The 1938 and 1954 hurricanes, both arriving within one hour of high tide, produced storm-surge levels of 13.8 and 12.8 feet, respectively, indicating that tidal stage is another important factor of storm events (ACOE 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). 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 in flat low-lying areas.

5. Coastal winter storms, known as Nor’easters, are usually large, cyclonic storms representing the same hazards present for hurricanes with the exception of severe rainfall

(Gordon 1980). Nor'easters appear in the winter and spring on an even more regular basis than hurricanes, and cause severe flooding and erosion. The degree of damage is dependent upon the duration of the storm and when it occurs in the tidal cycle (R.I. Office of State Planning 1986). Although waves from these storms are comparable to those of a hurricane, wind speeds are lesser, usually gale force (40 mph and greater). As with hurricanes, the stage of the tide influences the reach of the ocean and the resulting damages.

## 600.4 Vulnerability of Flood Zones

### A. Damages from Past Storms

1. According to archives of the Narragansett Times, the Middlebridge wooden bridge was swept away for the second time by the storm surge from the 1938 hurricane (the first washout occurred during the "Great Gale of 1815"). Hurricane Carol in 1954 produced tidal flood losses to 10 cottages and 2 commercial establishments amounting to approximately $112,000 within the Middlebridge and Bridgetown sections of Narrow River (ACOE 1960). Damage to docks and retaining walls affected nearly 60 summer properties.

2. Throughout Rhode Island's history, hurricane-driven storm surges and tidal flooding have caused enormous destruction, killing hundreds of people and causing millions of dollars in property damage along the coastline. In the Great Atlantic hurricane of 1938, 262 lives were lost and $100 million in property damage was sustained statewide. After many of the coastal areas had been rebuilt, another major hurricane in 1954 (Carol) again swept over the barriers, took the lives of 19 people, cut back the headlands, and caused $90 million dollars in property damage (Providence Journal 1979). Hurricane Gloria, forecast to pass directly through southern Rhode Island, picked up speed and changed direction to strike Connecticut, some 60 miles to the west in September of 1985. High winds caused one of the worst power outages in history, with a total of 334,700 homes and businesses affected. Power was not completely restored statewide for ten days. Though wind damage was severe, the storm hit at low tide, therefore minimizing the flood/storm surge damage despite the water level peaking at six feet above the normal tidal cycle. This storm displayed several similar characteristics to the 1938 and 1954 hurricanes, but luckily, factors such as a changing path direction, and early warning systems combined to lessen the overall blow to Rhode Island. Property damage was estimated at $19 million dollars (RIEMA 1986). The most recent hurricane to hit Rhode Island was Hurricane Bob in 1991. The storm path of Bob was quite similar to the destructive 1954 Hurricane Carol. Though the storm hit at high tide as a Category 2 hurricane, its center passed over Massachusetts. Nevertheless, the state suffered over $115 million dollars in damage, with spillage of 100 million gallons of untreated sewage into Narragansett Bay and a resulting nine- day shellfish bed closing (RIEMA 1993-94).

3. 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). Since the 1954 hurricane, many new houses have been built within this high risk zone, most notably in Narragansett. Many were built before the implementation of the National Flood Insurance Program in 1968, 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 flood zone. Approximately two thirds of Rhode Island's one million residents are concentrated in its 21 coastal communities (ACOE 1995). Even though storm surge areas appear relatively small, they hold a disproportionate number of residents in their boundaries.

4. Of particular concern when considering flood zone management is the natural storage capacity of flood waters 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 (Figure 5-2). 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 in the lower reaches of the estuary by trapping and temporarily storing rainfall and surge waters from major storms. During flooding events, water covers the marsh in a broad sheet flow through the vegetation, attenuating the effects of waves. Gradual release of flood waters from these areas reduces flood heights and the subsequent damages (Burby and French 1985). Also, shrubbery along the periphery of marshes serves 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 1960). Once lost, these areas cannot be regained, therefore, in the undeveloped flood zones, preservation is a high priority and strong protective measures should be implemented.

## B. Potential Damages to the Developed Areas in Flood Zones

1. Lands along the shoreline of the Narrow River, including those susceptible to flooding, continue to command a high price; an average home with shore frontage is valued in the $200,000 dollar range, and homes just inland within the Middlebridge and Mettatuxet areas are currently valued at more than $100,000. Within the 100-year flood zone, major damages to homes and commercial establishments can be expected from storm-surge flooding and wind-blown debris. Public properties are also at risk and include roads, bridges, and water and sewer lines. The damage could be lessened if hurricane warnings are heeded early, such that boats and other loose objects could be secured. Because the area located in the high hazard zone is small and does not include structures,

it is expected that dollar damages here will be low, though there is apparently degradation occurring to salt marsh areas and gradual property loss along the Narrow River's's edge where speed limits and wake restrictions do not exist.

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 closure of local landfills makes the removal and subsequent disposal of debris 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 phenomenon and its consequences are discussed in Chapter 4, Geological Processes.

4. In addition to the FEMA Flood Insurance Maps, the ACOE, in cooperation with FEMA, modeled 536 hypothetical hurricanes and their maximum potential surge inundation to produce a useful planning and evacuation guide for Rhode Island entitled "Rhode Island Hurricane and Evacuation Study: Technical Data Report (ACOE 1995). This hazards analysis attempted to predict likely surge scenarios, identify the vulnerable population, and examine factors of evacuation such as route, method, and time needed. This study employed the National Hurricane Center's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) computerized model. Accompanying the study is the Inundation Map Atlas, and the Evacuation Route Map Atlas. These maps estimate 80,000 residents effected by a weak hurricane surge scenario, and over 120,000 from a strong surge scenario. To emphasize the need for adequate warning and evacuation procedures, the study cites the average 12 hour hurricane forecast error to be approximately 60 miles. Much of Rhode Island is also at risk with landfall predictions in eastern Connecticut, or southern Massachusetts (ACOE 1995).

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# Chapter 7
# Cultural and Historical Resources

## 710. Findings of Fact

### 710.1 Introduction

### A. Archeological Significance

1. The Rhode Island coastal zone has a long, rich history. This region contains numerous archaeological sites dating back 10,000 years, including Native American settlements, fortifications, and sacred places, as well as historical resources ranging from 17th century trading posts to 19th century industrial sites. Both prehistoric and historic cultural resources are extremely valuable to the state's citizens and visitors alike for educational, recreational, and economic reasons. They contribute not only to our knowledge of the region's history, but also to the aesthetic qualities of the watershed.

2. The Narrow River is an area of particular archaeological importance and interest. Unlike other coastal rivers, the Narrow River was not significantly affected by sea level rise for most of the prehistoric period. This means that prehistoric sites dating back thousands of years still can be found along its banks. Surveys sponsored by the Rhode Island Historical Preservation and Heritage Commission (RIHPHC) have identified numerous archaeological sites in the Narrow River watershed. Although incomplete, these surveys have allowed archaeologists to study the land use patterns of the region as a whole, instead of having to rely only on isolated sites. They have shown that the spatial and temporal patterns of prehistoric land use along this river are different from any reported or predicted for New England.

3. Archeological research around the Narrow River has revealed the history of the resources of the Narrow River. Pollen cores taken around the Narrow River indicate that salt water did not move into the Narrow River until about 2,000 years ago and that the Narrow River's modern salt marsh conditions were not established until 600 years ago, much later than most other locations around the bay (RIHPHC in prep.).

The archaeological evidence reflects the lateness of the formation of estuarine conditions. Of the fifteen sites located by the Public Archaeology Laboratory, only the Freeman site contains evidence that estuarine resources were used. A shell midden found at the site contained remains of whelk, periwinkle, quahaug, grapes, acorns, deer, birds and fish.

4. Although many sites in the Narrow River watershed have been located, not all of the area has been systematically surveyed. Environmental models developed by the RIHPHC are based on factors including distance to salt and fresh water, degree of slope, and a high probability of archaeological resources. These include the area around Silver Spring Lake, the Mattatuxet River, and the north-western shores of Carr Pond. Little Neck and the area around the Narrows have also never been systematically surveyed. The RIHPHC considers survey of these potentially sensitive areas a high priority.

5. Significant historical resources within the watershed include most notably the Gilbert Stuart Birthplace, a National Historic Landmark, the Jireh Bull Blockhouse site, dating to the seventeenth century, the original Governor Sprague Bridge, the McSparran site, an eighteenth-century plantation, and the Silas Casey Farm, the oldest working farm in the U.S. These sites are all important to Rhode Island's history and culture, as well as having aesthetic value. The protection of these sites is a priority of the RIHPHC.

6. Unfortunately, many of the historical and archaeological sites in the region have been altered or destroyed. These fragile and nonrenewable resources are vital links to the past of 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 resources provide a unique and educational quality to the resource value of the Narrow River and thus deserve consideration for protective measures. Increased public interpretation and educational programs can help to stimulate interest and assure long term appreciation and protection for these fragile resources.

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# Chapter 8
# Cumulative and Secondary Impacts

## 810. Findings of Fact

### 810.1 Introduction

### A. Cumulative Impact Management

1. One of the criticisms of state and local coastal resource regulatory and management programs is that they are unable to protect coastal resources from incremental degradation due to a willingness to accept a little degradation with each action, the absence of a holistic ecosystem perspective, and the use of "halfway measures" that "simply forestall the inevitable" (Odum 1982, Houck 1988). The concept of cumulative impact management has been a part of our national environmental policy since 1978 when the Council on Environmental Quality (CEQ) Guidelines (40 C.F.R. §1508.9 et seq. 1978) mandated federal agencies to identify the cumulative impacts of major federal actions. Since the Coastal Zone Management Act is required to be consistent with the National Environmental Policy Act and the CEQ Guidelines, all state coastal programs are mandated to consider cumulative impacts. The 1990 amendments of the Coastal Zone Management Act of 1972 created a Coastal Zone Enhancement Program to encourage states to strengthen their coastal zone management programs in the area of cumulative and secondary impacts of development. As part of this initiative the Rhode Island CRMC undertook a Cumulative and Secondary Impact Study of Development in the Salt Pond Region and the Narrow River watersheds. Based on the findings of the Council, land use classifications, management practices, innovative technologies, and coastal ecosystem planning methods were developed as part of revisions to the SAMPs.

### 810.2 State Cumulative Impact Management

### A. Mechanisms for Managing Cumulative Impacts

1. At least ten coastal states are involved in the process of managing and regulating for cumulative impacts through mechanisms like "mini" National Environmental Policy Acts which evaluate the environmental effects of a proposed action (Vestal and Rieser 1995). Other states like Connecticut depend on state Coastal Management Acts which contain specific policies, standards and adverse impact criteria used to evaluate direct, cumulative and secondary effects on sensitive coastal resources (Vestal and Rieser 1995). State land use planning is also used to control incremental coastal environmental impacts. Development of resource goals and long-range comprehensive plans allow communities to establish a broader context for site-specific regulatory decisions; and comprehensive plans guide development to those areas where the least ecological damage will occur (Vestal and Rieser 1995).

**B. Managing Cumulative Impacts in Rhode Island**

1. The Rhode Island Land Development and Subdivision Review Enabling Act of 1992 (Act) implies consideration of cumulative impacts by requiring each city and town to develop land development and subdivision regulations in accordance with the community comprehensive plan, capital improvement plan, and zoning ordinance; and to ensure the consistency of all local development regulations with state agency regulations. The Act also requires that local regulations address the protection of the existing natural and built environment and the mitigation of all significant negative impacts of any proposed development on the existing environment. Each city and town in Rhode Island has the same procedure for integrating the approval of state regulatory agencies into the local review and approval process for land development and subdivision, allowing for review of potential cumulative impacts by CRMC and RIDEM. In addition, municipal Comprehensive Plans must be consistent with state agency regulations, including the CRMC Coastal Resources Management Program.

**810.3 Recognizing Cumulative Impacts**

**A. Definition**

1. Cumulative impacts can be defined as the total effect on the environment of development activities and/or natural events taking place within a geographic area over a particular period of time. They are not restricted to on-site impacts, but may include off-site impacts which exist or are going to exist based on current land use planning. Cumulative impacts can result from traditionally unregulated changes in land and water uses. For example, actions such as incremental changes in the intensity of use of a site, post-development failure to maintain septic systems, or excessive use of fertilizers may have greater impact than the original regulated activity (Vestal and Rieser 1995).

**B. Cumulative Impacts in the Narrow River**

1. In the Narrow River, there may be many different actions occurring which can have a cumulative impact on both land and water resources. For instance, roads, driveways, decks and roofs from residential development all contribute to storm-water runoff in the Narrow River across the entire watershed. Individually minor alterations in impervious surfaces can be associated with sedimentation and runoff of bacteria and nitrogen to the ponds. High density development and traditional subdivisions can obscure scenic vistas and public access to the Narrow River. These changes within the Narrow River watershed impact the long-term value of the land and its ability to sustain human, fish and wildlife populations.

2. In order to quantify the cumulative environmental impact of any single action within a group of similar or dissimilar activities it is necessary to determine the relationships between spatial and/or temporal modification of habitat and identifiable living resource losses (Ludwig et al. 1995). Other effects can spill over and complicate an evaluation of cumulative impacts; for instance, sedimentation from stabilization of the breachways covers valuable fishery habitat in the Narrow River, making it difficult to determine how much of a problem sedimentation from stormwater runoff is in the Narrow River. Cumulative impacts are the result of an action and can

be directly associated to that action. Cumulative effects are the physical, biological or chemical outcome of the action on the environment. For instance, the cumulative impact of many ISDS in the Narrow River watershed is an increase in the amount of nitrogen to groundwater and to the Narrow River. The cumulative effects of more nitrogen in the groundwater and to the Narrow River are increases in nitrogen available to phytoplankton and macroalgae which can grow in mass quantities and shade out other aquatic vegetation. Blooms of nuisance algae can result in anoxic or hypoxic conditions where oxygen levels are completely removed or lowered resulting in lowered survival of larval fish, mortality of some species of benthic invertebrates, and loss of habitat for some mobile species of fish and shellfish that require higher concentrations of oxygen, such as lobster and codfish (EPA 1993).

**810.4 Examples of Cumulative Impacts**

**A. Cumulative Impact Scenarios**

1. Multiple small-scale, unrelated land development changes can have even greater harmful effects on natural processes than larger-scale projects. For instance, ten single-family residences located on one acre lots with their own water hook-up, driveway, septic system and private dock can have more of an impact than a ten unit condominium project located in one large structure on a ten acre shore lot with public water, community waste-water treatment and a community dock. Area of imperviousness is decreased, less habitat is fragmented, the dock utilizes less shoreline, and the potential for shading aquatic vegetation is minimized (Vestal and Rieser 1995).

2. The effects of development projects, both large and small, often go far beyond the obvious direct impacts of a project. For instance, the direct effect of dredging the tidal deltas and wash-over fans in the Narrow River might be removing bottom-dwelling organisms and vegetation, and suspending sediment in the water column. Yet the indirect and secondary effects include increased suspended loads of nutrients, a temporary reduction in phytoplankton production due to increased turbidity, and increased commercial and recreational boat traffic in the harbor. Increased boat use may, in turn, lead to longer term reductions in water quality due to the discharge of oil, sewage and debris from the vessels (Vestal and Rieser 1995).

**810.5 Cumulative Impact Research in the Narrow River Watershed**

**A. Cumulative Impact Concerns**

1. There are many direct actions related to human development which occur site specifically within the Narrow River watershed. These actions were monitored over the last ten years through the development of the 1984 Narrow River SAMP and the 1997 Narrow River Cumulative and Secondary Impact Study. Findings of both these studies indicate existing development has already resulted in cumulative impacts with serious implications for the health of the water resources and habitat of the Narrow River. Development in the Narrow River watershed over the last forty years has resulted in an overall increase in impervious areas, ISDS, population, domestic pets, and lawn fertilizers, and a decrease in vegetated buffer zones for riparian and coastal waters. The cumulative impacts of these changes are increases in the source and greater transmission of pollutants to the Narrow River, including sediments, nitrogen,

phosphorus, pathogen indicators, hydrocarbons, heavy metals and road salts. It is therefore necessary that the Council consider the cumulative impacts of development when evaluating proposed projects and require appropriate measures to mitigate negative impacts, where possible.

**B. In this revision of the Narrow River SAMP the Council is primarily concerned about the following land use changes and development, and the resulting cumulative impacts.**

1. Individual Sewage Disposal Systems. ISDS can typically achieve an average of only 20 percent nitrogen removal during the infiltration and percolation of septic tank effluent (Siegrist and Jenssen 1990). In densely developed areas which use ISDS as the sole form of sewage removal, nitrogen loading to groundwater can contaminate drinking water supplies and risk exceeding the EPA standard of 10 ppm for safe drinking water. When these areas are adjacent to coastal embayments fed by groundwater springs and streams, the cumulative effect of many ISDS can also be a problem for coastal water quality, which in turn impacts aquatic vegetation, fish and shellfish habitat and the marine species food chain. Bacterial pollution from failing and substandard ISDS can result in shellfish closures and unsafe swimming conditions.

2. Impervious Areas. Increasing impervious surfaces reduces the recharge of groundwater and reduces the flow of freshwater from streams to coastal waters. Groundwater recharges streams and other surface waterbodies, thereby maintaining stream flow during periods of low flow or drought conditions (EPA 1995). Modifications to the quantity or quality of groundwater discharged into surface water ecosystems can have major economic repercussions as a result of adverse impacts on recreation, public health, fisheries, and tourism (EPA 1995).

3. Stormwater Runoff. Increasing impervious areas impact the potential quantity and quality of stormwater runoff. Stormwater runoff can carry sediments, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons and pathogenic bacteria and viruses. Stormwater discharges to coastal waters and tributary streams increases as impervious areas increase within the watershed. Pathogens carried in stormwater runoff from storm drains are flushed into the Narrow River during storm events and are responsible for high levels of bacteria contamination and shellfish harvesting closures.

4. Vegetation Removal and Soil Erosion. Buffer zones or vegetated areas adjacent to water resources are important landscape features which help to prevent erosion and control the transport of sediment into adjacent wetlands and water bodies. Buffer zones are valuable for removing pollutants and excess nutrients from surface water runoff and in some cases from the underlying groundwater. Residential and commercial development removes considerable areas of vegetation from the landscape and increases impervious areas. The cumulative effects of many individual unvegetated areas can result in increased sedimentation to the Narrow River and less removal of pollutants from surface water and groundwater.

5. Dredging. The dredging process disturbs and disperses large quantities of sediment, often reaching far beyond the project boundaries. The resuspension of sediment increases turbidity which degrades water quality and primary productivity (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).

6. Flood Zone Development. Development in flood zones increases the risk of life and property loss during storms and storm surges. The Narrow River is susceptible to storm-surge flooding with damage to public buildings, utilities, roads, and engineered structures for shoreline protection. Although the storm surge areas of the Narrow River are relatively small, they hold a disproportionate number of residents in their boundaries. It is important that setbacks, new construction standards, and mitigation measures such as relocation and acquisition of unbuildable property are applied during post-storm reconstruction.

7. Residential Activities. Fertilizers, pesticides and household chemicals all have the potential to enter groundwater or contribute to storm water runoff from many individual residential lots. These sources of nonpoint pollution are increasing in the Narrow River watershed with each new development. Controls on the use of lawn and garden fertilizers, pesticides and chemicals are necessary to limit the potential cumulative impacts of many residential activities. Domestic pets are also a concern because they provide sources of nitrogen and bacteria to groundwater and surface water runoff.

8. Marinas, Docks, and Recreational Boating. Marinas and boats can introduce heavy metals, petroleum hydrocarbons, solvents, antifreeze, antifouling agents, nutrients, bacteria, floatable/plastics, and creosote from pilings (Olsen and Lee 1985, Amaral et al. 1996). Vessel discharge of sewage has been correlated with unsafe increases in fecal coliform bacteria during high boat-use times (Gaines 1990, Amaral et al. 1996). Chromated copper arsenate (CCA), used as a wood preservative, can accumulate in biota and sediments, and is considered a priority pollutant by the EPA. Docks can also impact eelgrass beds and other submerged aquatic vegetation. The height of a dock above the bottom and the orientation of the dock are two major independent factors affecting the survival of eelgrass beds beneath and adjacent to docks (Burdick and Short 1995). Jet skis and boat propellers can damage eelgrass beds and contribute to erosion of the shoreline by increasing wave action in the Narrow River.

9. Public Water and Sewer Facilities. The experience of many communities nationwide is that sewer systems encourage high density development and increase runoff contamination of adjacent water bodies (Pye et al. 1983, RIDEM 1982). In the Narrow River there could be several cumulative and secondary impacts from the construction of water and sewer lines to accommodate existing and proposed development. Once an area is sewered, many of the constraints that limit development may disappear. Sites that have soils which do not meet percolation standards or minimum depth to groundwater requirements can support new development provided they have sewers available. Frequently these are also the few areas of the watershed that remain undeveloped and consequently provide buffer zones for critical habitats of fish and wildlife or water quality.

10. Wetland Alteration. Wetlands perform important hydrologic, water quality, and habitat functions, which can be stressed by small changes or impacts. Alteration of wetland hydrology or sediment budgets, increased surface runoff through ditching, and wetland conversion to agricultural fields or developable lots are just some of the examples where small alterations can result in a cumulative impact on the wetland or where ecological functions of the wetland are lost (EPA 1992). The continental United States has lost over 50% of the original wetlands since the founding of the nation, primarily through draining and filling. Residential development has the

potential to impact the ecological function of the remaining freshwater wetlands through draining and filling. Many of the wetland resources in the Narrow River watershed are hydrologically linked to the Narrow River via small streams which carry organisms, nutrients and organic detritus produced within the upland watersheds of the Narrow River. These wetlands also serve as habitat for wildlife, and retain flood waters and runoff pollutants during storms.

11. Noise and Lighting Impacts on Habitat. Elevated light and noise can be a problem for wildlife around the Narrow River. The cumulative effect of noise and lighting from many residential lots and increased recreational uses may discourage nesting by shore birds and breeding for many wildlife species.

### 810.6 Cumulative Effects on the Narrow River Ecosystem

#### A. Introduction

1. The Council is concerned about cumulative impacts because they affect the amount and strength of pollutants entering the Narrow River watershed; fish and wildlife habitat; and the aesthetic and recreational values of the region. The following pollutants and physical disturbances are the result of cumulative impacts.

2. Sediments. Suspended sediments constitute the largest mass of pollutant loadings to surface waters (EPA 1993). Immediate adverse impacts of high concentrations of sediment are increased turbidity, reduced light penetration and decreases in submerged aquatic vegetation (Chesapeake Bay Local Government Advisory Committee 1988), reduced prey capture for sight-feeding predators, impaired respiration of fish and aquatic invertebrates, reduced fecundity, and impairment of commercial and recreational fishing resources.

3. Nutrients. Excessive nutrient loading to marine ecosystems can result in eutrophication and depressed dissolved oxygen levels due to elevated phytoplankton populations. Eutrophication-induced hypoxia and anoxia have resulted in fish kills and widespread destruction of benthic habitats (EPA 1993). Surface algal scum, water discoloration, and the release of toxins from sediment may also occur. Species composition and size structure for primary producers may be altered by increased nutrient levels (EPA 1993, GESAMP 1990).

4. Pathogens. Fecal coliform bacteria provide evidence that an estuary is contaminated with fecal material that may contain pathogenic bacteria and viruses harmful to people. Often, the pathogenic viruses and bacteria do not adversely impact aquatic life, such as fish and shellfish. However, shellfish may accumulate bacteria and viruses that cause human diseases when ingested. Therefore, officials restrict shellfish harvesting in contaminated waters to protect public health. Pathogen indicators also impair swimming uses because some pathogenic bacteria and viruses can be transmitted by contact with contaminated water (EPA 1994). Nationwide, 37% of shellfish waters are limited or restricted by pathogens related to septic systems and 38% by urban runoff (EPA 1993).

5. Hydrocarbons and Heavy Metals. Petroleum hydrocarbons are derived from oil products, and often are introduced into the environment from auto and truck engines that drip oil. Many do-it-

yourself auto mechanics dump used oil directly into storm drains (Klein 1985). Concentrations of petroleum-based hydrocarbons are often high enough to cause mortalities in aquatic organisms (EPA 1993). Oil and grease contain a wide variety of hydrocarbon compounds. Some polynuclear aromatic hydrocarbons (PAHs) are known to be toxic to aquatic life at low concentrations. Hydrocarbons have a high affinity for sediment, and they collect in bottom sediments where they may persist for long periods of time and result in adverse impacts on benthic communities. Lakes and estuaries are especially prone to this phenomenon (EPA 1993).

6. Road Salts. In northern climates, road salts can be a major pollutant. Klein (1985) reported on several studies by various authors of road salt contamination in lakes the streams and cases where well contamination had been attributed to road salts in New England. Snow runoff produces high salt/chlorine concentrations at the bottom of ponds, lakes and bays. Not only does this condition prove toxic to benthic organisms, but it also prevents crucial vertical spring mixing (Bubeck et al. 1971, Hawkins and Judd 1972). There are no accurate estimates of road salt loading to groundwater or the Narrow River.

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# TITLE 650 – COASTAL RESOURCES MANAGEMENT COUNCIL

## CHAPTER 20 – COASTAL MANAGEMENT PROGRAM

## SUBCHAPTER 00 – N/A

PART 4 – Narrow River Special Area Management Plan

## 4.1 Authority

Pursuant to the federal Coastal Zone Management Act of 1972 (16 U.S.C. §§ 1451 through 1466) and R.I. Gen. Laws Chapter 46-23 the Coastal Resources Management Council is authorized to develop and implement special area management plans.

## 4.2 Purpose

A. The purpose of these rules is to establish the Narrow River Special Area Management Plan (SAMP) within the municipalities of Narragansett, North Kingstown, and South Kingstown to provide for the integration and coordination of the protection of natural resources, the promotion of reasonable coastal-dependent economic growth, and the improved protection of life and property.

B. The regulations herein constitute the RICR regulatory component of the Narrow River Special Area Management Plan (SAMP). For additional context and full understanding of this Part, please reference the additional chapters of the federally-approved Narrow River SAMP available on the CRMC web site (www.crmc.ri.gov) for further information, including all other federally-approved RICRMP plans. The additional chapters of the Narrow River SAMP provide the CRMC's findings and policies that form the basis and purpose of this Part. The other chapters of the Narrow River SAMP should be employed in interpreting R.I. Gen. Laws § 46-23-1, *et seq.*

## 4.3 Definitions

A. Definitions for this Part are as follows:

1. "Cumulative effects" means the physical, biological, or chemical outcome of a series of actions or activities on the environment.

2. "Cumulative impacts" means the total effect on the environment of development activities and/or natural events taking place within a geographic area over a particular period of time. They are not restricted to on-site impacts, but may include off-site impacts which exist or are going

to exist based on current land use planning. Cumulative impacts can result from traditionally unregulated changes in land and water uses. For example, actions such as incremental changes in the intensity of use of a site, post-development failure to maintain septic systems, or excessive use of fertilizers may have greater impact than the original regulated activity.

3. "Erosion and sediment control" means 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.

4. “Lands of critical concern” means lands that are presently undeveloped or developed at densities of one residential unit per 120,000 square feet. These lands may be adjacent to or include one or more of the following:

   a. sensitive areas of the salt ponds that are particularly susceptible to eutrophication and bacterial contamination;

   b. overlie wellhead protection zones or aquifer recharge areas for existing or potential water supply wells;

   c. areas designated as historic/archaeologic sites;

   d. open space;

   e. areas where there is high erosion and runoff potential;

   f. habitat for flora and fauna as identified through the RI Natural Heritage Program, large emergent wetland complexes, and U.S. Fish & Wildlife lands; and

   g. fisheries habitat.

5. “Lands developed beyond carrying capacity” means lands that are developed at densities of one residential or commercial unit on parcels of less than 80,000 square feet, and frequently at higher densities of 10,000 square feet or 20,000 square feet. Intense development associated with Lands Developed Beyond Carrying Capacity is the result of poor land use planning and predates the formation of the Council. High nutrient loadings and contaminated runoff waters from dense development have resulted in a high incidence of polluted wells and increased evidence of eutrophic conditions and bacterial contamination in the salt ponds. Most of the OWTS in these areas predate RIDEM regulations pertaining to design and siting standards, and have exceeded their expected life span.

6. “Land suitable for development” means 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

R.I. Gen. Laws Chapter 46-23 and in § 1.2.2 of this Subchapter; freshwater wetlands, as defined in § 1.1.2 of this Subchapter (see CRMC Rules and Regulations Governing the Protection and Management of Freshwater wetlands in the Vicinity of the Coast); and lands to be developed as streets and roads shall also be excluded from the calculated acreage of developable land.

7. “Nitrogen reducing technologies” means alternative wastewater treatment systems which reduce total nitrogen concentrations by at least 50%. Total nitrogen reduction is the annual mean difference by percentage between total nitrogen concentrations in the effluent of the septic or primary settling tank and the concentrations taken at the end of the treatment zone as defined by the specific technology.

8. “Narrow River watershed" means the environment within the surface watershed boundaries encompassing portions of the coastal communities of Narragansett, North Kingstown and South Kingstown, and as delineated on the land use classification maps in § 4.44 of this Part.

9. “Self-sustaining lands” means lands that are undeveloped or developed at a density of not more than one residential unit per 80,000 square feet. Within these areas, the nutrients discharged to groundwater by septic systems, fertilizers and other sources associated with residential activities may be sufficiently diluted to maintain on-site potable groundwater. However, the one residential unit per two acre standard is not considered sufficient to reduce groundwater nitrogen concentrations to levels which will prevent eutrophication, or mitigate for dense development in other portions of the watershed.

10. “Tributary” means any flowing body of water or watercourse which provides intermittent or perennial flow to tidal waters, coastal ponds, coastal wetlands or other down-gradient watercourses which eventually discharge to tidal waters, coastal ponds or coastal wetlands.

11. “Tributary wetlands” means freshwater wetlands within the watershed that are connected via a watercourse to a coastal wetland and/or tidal waters.

12. “Underground storage tank” or “UST” means any one or more underground tanks and their associated components, including piping, used to contain an accumulation of petroleum product or hazardous material.

## 4.4 Procedures

A. The Rhode Island Coastal Resources Management Program

1. The Rhode Island Coastal Resources Management Program Red Book; Part 1 of this Subchapter) should be referred to for specific regulatory requirements on buffers, setbacks, subdivisions, recreational docks, barrier beach development, beach replenishment and any other activities which occur within the Narrow River SAMP.

B. Application Process

1. The RICRMP has three categories of applications: Category A, B and A*:

    a. Category A activities are routine matters and activities of construction and maintenance work that do not require review of the full Council if four criteria are met: buffer zone compliance, abutter agreement, and proper state and local certifications.

    b. Category A* applications are put out to public notice for the benefit of the abutters to the affected property and local and state officials.

    c. Category B applications are reviewed by the full Council and the applicant must prepare in writing an environmental assessment of the proposal that addresses all of the items listed in § 1.3.1(A) of this Subchapter and any additional requirements for Category B applications listed for the activity in question.

2. A Category A review may be permitted for A* activities provided that the Executive Director of CRMC determines that all criteria within § 1.1.6(E) of this Subchapter and the relevant SAMP requirements and prerequisites are met. The proposed activity shall not significantly conflict with the existing uses and activities and must be considered to be a minor alteration with respect to potential impacts to the waterway, coastal feature, and areas within RICRMP jurisdiction.

3. The following activities which occur within the Narrow River SAMP require a CRMC assent (application approval).

    a. Activities within 200 feet of a coastal feature. (Category A, A*, B)

    b. Watershed Activities (specific activities taking place within the SAMP watershed).

        (1) New subdivisions of 6 units or more, or re-subdivision for a sum total of 6 units or more on the property proposed after March 11, 1990 irrespective of ownership of the property or the length of time between when units are proposed. (Category B)

        (2) Development requiring or creating more than 40,000 square feet of total impervious surface. (Category A*/B)

(3) Construction or extension of municipal, private residential hook-ups to existing lines, or industrial sewage facilities, conduits, or interceptors (excluding onsite wastewater treatment systems outside the 200' zone). Any activity or facility which generates or is designed, installed, or operated as a single unit to treat more than 2,000 gallons per day, or any combination of systems owned or controlled by a common owner and having a total design capacity of 2,000 gallons per day. (Category A*/B)

(4) Water distribution systems and supply line extensions (excluding private residential hook-ups to existing lines). (Category A*/B)

(5) All roadway construction and upgrading projects. (Category A*/B)

(6) Development affecting freshwater wetlands in the vicinity of the coast. (Category A/B)

4. For projects involving the following, refer to § 1.3.3 of this Subchapter for the appropriate category.

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

b. New mineral or aggregate (sand/gravel) mining.

c. Processing, transfer, or storage of chemical and hazardous materials.

d. Electrical generating facilities of more than 40 megawatts capacity.

e. All commercial in-ground petroleum storage tanks of more than 2,400 barrels capacity, all petroleum processing and transfer facilities [residential prohibited].

f. Proposed new or enlarged discharges (velocity and/or volume) to tributaries, tidal waters, or 200' shoreline feature contiguous area.

g. Solid waste disposal.

h. Desalination plants.

5. In addition to the activities listed above, if the Council determines that there is a reasonable probability that the project may impact coastal resources or a conflict with the SAMP or RICRMP, a Council Assent will be required in accordance with all applicable sections of this program.

6. All applicants shall follow applicable requirements as contained in the RICRMP, including any specific requirements listed under water types in § 1.2.1 of this Subchapter, additional Category B requirements in § 1.3.1 of this Subchapter, the requirements and prerequisites in § 1.3.3 of this Subchapter for Inland Activities, and any regulations in this SAMP chapter.

7. Applicants proposing the above listed activities are required to submit the following with their applications:

   a. A stormwater management plan prepared in accordance with § 1.3.1(F) of this Subchapter and as described in the most recent version of the Department of Environmental Management "Stormwater Design and Installation Manual";

   b. An erosion and sediment control plan (ESCP) prepared in accordance with the standards contained in § 1.3.1(B) of this Subchapter; and

   c. An existing conditions site map and a proposed final site map as required in § 1.3.3 of this Subchapter and as specified in the section for site plan requirements in the Department of Environmental Management "Stormwater Design and Installation Manual".

8. Preliminary determinations (PD) may be filed for any project by the municipality or the applicant. Preliminary determinations provide advice as to the required steps in the approval process, and the pertinent ordinances, regulations, rules, procedures and standards which may be applied to the proposed development project. Any findings and recommendations resulting from this preliminary review shall be utilized if the applicant returns to file a full assent request for the project, and will be forwarded to the Council as part of the staff reports for major development plans. Applicants for Category B activities within the SAMP watershed are required to utilize the Council's Preliminary Determination process in accordance with applicable requirements of the Land Development and Subdivision Review Enabling Act (R.I. Gen. Laws § 45-23-25 *et seq*.). Where the Council finds there is a potential to damage the coastal environment, the Council will require that suitable modification to the proposal be made.

C. Variances and special exceptions are granted by the Council under §§ 1.1.7 and 1.1.8 of this Subchapter, respectively.

1. Applicants desiring a variance from a standard must make the request in writing and address the six criteria as specified in § 1.1.7 of this Subchapter. The application is only granted an assent if the Council finds that the six criteria are met.

2. Special exceptions may be granted to prohibited activities to permit alterations and activities that do not conform to a Council goal for the areas affected or which would otherwise be prohibited by the requirements of the RICRMP only when the applicant has met the burdens of proof in § 1.1.8 of this Subchapter.

D. Coordinated Review with Municipalities

1. Under the Subdivision Review Act, one or more pre-application meetings shall be held for all major land developments or subdivision applications (Land Development and Subdivision Review Enabling Act, R.I. Gen. Laws § 45-23-25 et seq.). Pre-application meetings may be held when a preliminary determination is filed with the CRMC, or informally when the municipality requests information from CRMC. All major land development projects as defined under the act and residential subdivisions of 6 units or more shall be considered major land development plans and should file a preliminary determination request with CRMC. The purpose of these meetings is to:

a. Identify and discuss major conflicts and possible design alterations or modifications to obviate conflicts.

b. Discuss the likely onsite impacts of alternatives or modifications and on the ecosystem as a whole.

c. Ensure that there is consensus among the regulatory agencies on any changes, and that conflicts with permit requirements do not arise.

E. Federal Consistency

1. Activities involving a direct or indirect federal activity (includes activities that require a federal permit, such as an Army Corps of Engineers Permit) also require Council review in accordance with the federal consistency process contained in16 U.S.C. § 1456 (Coastal Zone Management Act). The Council has developed a handbook to assist those subject to federal consistency review. Persons proposing an activity involving a direct or indirect federal activity are referred to the most recent version of this handbook. See: http://www.crmc.ri.gov/regulations/Fed_Consistency.pdf.

F. Coastal Nonpoint Pollution Control Program

1. Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (16 U.S.C. § 1455(b)) requires each coastal state with a federally approved coastal management program to develop and submit a Coastal Nonpoint Pollution Control Program (CNPCP) to the EPA and the National Oceanic and Atmospheric Administration (NOAA) by July 1995. Rhode Island's CNPCP, developed by the RIDEM, the Department of

Administration and the CRMC, applies to four general land use activities: agriculture, urban (new development, septic systems, roads, bridges, highways, etc.), marinas, and hydro-modifications. There are also management measures to protect wetlands and riparian areas, and to promote the use of vegetative treatment systems.

### 4.4.1 Municipal Responsibility

A. The town officials and administration involved in construction, approval of construction and/or regulations regarding the zoning, density, and build-out of development are the municipal arm of this SAMP.

1. Local authorities are responsible for applying the regulations and land use policies to ensure proper application of this plan. Towns should exercise particular consideration of subdivisions because of the potential impacts from stormwater, sewage disposal, infrastructure demands, and decreased open space.

2. The CRMC evaluates projects that fall under this plan as referenced earlier, even if development is not completed all at once. A developer still falls under the CRMC major subdivision review conditions upon additional construction. Stormwater concerns, sewage disposal concerns, buffers, etc. may be difficult to accommodate with the addition of new lots. Therefore it is important for municipalities to apply SAMP regulations to initial development of a subdivision.

### 4.4.2 Water Quality Policies

A. The evidence presented in Chapter 3 Water Quality indicates that water quality continues to be degraded in the Narrow River due to existing residential sources of nitrogen and bacteria. Although research conducted at the University of Rhode Island suggests a correlation between housing density and the symptoms of eutrophication in the salt ponds (Part 3 of this Subchapter), there is no clear nitrogen loading threshold which CRMC can apply to each individual activity and development. Accordingly, CRMC addresses nitrogen loading through conservative land use regulations and nitrogen reducing technologies.

B. The installation and operation of nitrogen removal systems is permissible under Department of Environmental Management “Rules and Regulations Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems”. CRMC requires nitrogen removal systems as noted in Table 1 in §§ 4.4.2(E) and in 4.4.3 of this Part.

C. In addition to the impacts of nitrogen, other nonpoint sources of pollution like sediment from erosion and road runoff, petroleum hydrocarbons from vessel engines and road salts are also a concern. As impervious areas increase within the Narrow River these pollutants have a greater potential to reach coastal waters.

D. Table 1 in § 4.4.2(E) of this Part summarizes the land use classification system with the requirements for nitrogen reducing technologies, buffer zone and setbacks. The CRMC land use classification system which regulates land use densities and other activities in the SAMP region follow in § 4.4.4 of this Part.

E. Table 1: CRMC land-use classification requirements for density, setbacks, buffer zones and nitrogen reducing technologies for activities within 200 feet of a coastal feature and all watershed activities as defined in §§ 4.4(B)(3) and 4.4(B)(4) of this Part.

| Land-use classification | Description | Coastal buffer zone requirement[1] | Construction setback requirement[1] | OWTS setback requirement[1] | Nitrogen reducing technology requirement[1,2] |
|---|---|---|---|---|---|
| Developed beyond carrying capacity | Lands developed or undeveloped at < 80,000 square feet [SE or Var] | Coastal buffer based on § 1.1.11 of this Part [Var] | Coastal buffer plus 25 feet | Nitrogen reducing technology required [SE, Var] | New OWTS installations or alteration [4] [SE, Var] |
| Critical concern | Lands developed or undeveloped at 120,000 square feet and have sensitive salt pond or watershed resources [SE or Var] | 200 feet [SE or Var] | Coastal buffer plus 25 feet | 225 feet [SE, Var] | Lands subdivided after adoption of SAMP that do not meet the CRMC density requirement and substandard lots of record [SE, Var]. |
| Self-sustaining | Lands developed, undeveloped at 80,000 square feet [SE or Var] | 150feet [SE or Var] | Coastal buffer plus 25 feet | 200 feet [SE, Var] | Lands subdivided after adoption of SAMP that do not meet the CRMC density requirement and substandard lots of record [SE, Var]. |

| |
|---|
| [SE or Var] indicates if relief from the requirement or regulations requires a special exception, variance or both. |
| 1 - CRMC land use classification requirements for density, setbacks, buffer zones and nitrogen reducing technologies are for activities within CRMC jurisdiction (See §§ 4.4(B)(3) and 4.4(B)(4) of this Part) |
| 2 - A special exception is required for relief from the density requirement, coastal buffer, construction setback, OWTS setback or nitrogen reducing technology requirement unless the lot is pre-platted and cannot accommodate the requirement. |
| 3 - Nitrogen reducing technologies are defined in § 4.3 of this Part. |
| 4 - As defined by Department of Environmental Management "Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems" |

### 4.4.3 Land Use Classification for Watershed Protection (formerly § 920.1)

A. Self-Sustaining Lands

1. Policies and Regulations

a. Subdivisions as defined in § 1.1.2 of this Subchapter shall not exceed an average density of one residential unit per 80,000 square feet for Self-Sustaining Lands. The allowable number of units in conformance with this standard shall be calculated on the basis of available land suitable for development as defined in § 4.3 of this Part. The division of a tract, lot or parcel not subject to municipal regulation under the provisions of Chapter 45-23 *et seq*., for the reasons set forth therein, shall remain subject to the jurisdiction of the requirements of R.I. Gen. Laws § 46-23 *et seq*., and Parts 1 and 4 of this Chapter.

b. The number of allowable units in a cluster shall be calculated on the basis of lands suitable for development as defined in § 4.3 of this Part within the subdivision and in accordance with all local ordinances.

c. Any major land development project or any major subdivision of land as defined in R.I. Gen. Laws § 45-23 *et seq*. within Self-Sustaining Lands, occurring after December 8, 1986, must meet the minimum density requirement of one residential unit per 80,000 square feet. Relief from this regulation requires a special exception as defined in § 1.1.8 of this Subchapter. Lands which were subdivided prior to December 8, 1986, and do not meet the CRMC density requirement as defined in § 4.4.3(A)(1)(a) require a variance as defined in § 1.1.7 of this Subchapter.

d. Nitrogen reducing technologies as defined in § 4.3 of this Part are required for any lands subdivided after April 12, 1999 that do not meet the CRMC density requirement (80,000 square feet) for activities within 200 feet of a coastal feature and all watershed activities as defined in §§ 4.4(B)(3) and 4.4(B)(4) of this Part. Relief from this regulation requires a special exception as defined in § 1.1.8 of this Subchapter unless the lands were subdivided prior to April 12, 1999 and cannot accommodate the requirement. A nitrogen reducing technology cannot be used as mitigation to increase dwelling densities on parcels which can support the density requirement.

e. A minimum 200-foot setback from the Narrow River, its tributaries, and coastal wetlands, including tributary wetlands, is required for OWTS in Self Sustaining Lands for activities within 200 feet of a coastal feature and all watershed activities as defined in §§ 4.4(B)(3) and 4.4(B)(4) of this Part. Relief from this regulation requires a special exception as defined in § 1.1.8 of this Subchapter unless the lands were subdivided prior to April 12, 1999 and cannot accommodate the requirement.

f. A 150-foot buffer zone from the Narrow River, its tributaries, and coastal wetlands, including tributary wetlands, is required for activities within 200 feet of a coastal feature and all watershed activities as defined in §§ 4.4(B)(3) and (4) of this Part in Self Sustaining Lands. Relief from this regulation requires a special exception as defined in § 1.1.8 of this Subchapter unless the lands were subdivided prior to December 8, 1986 and cannot accommodate the requirement.

g. The installation of sewers is prohibited, unless all of the following conditions are met:

(1) the property meets the RIDEM regulatory requirements for the installation of a conventional OWTS,

(2) the proposal is agreeable to both the town and the CRMC,

(3) a deed restriction is attached to the property ensuring no further subdivision, and

(4) the properties to be sewered are within 500 feet of an existing sewer line or are within a subdivision which abuts the sewer easement.

h. The Council recognizes that in areas abutting the Narrow River, its tributaries and other critical resource areas, existing nitrogen reducing technologies may not be sufficient to reduce groundwater nitrogen concentrations to levels which will prevent further eutrophication in the Narrow River. If new technology improves the nitrogen removal capability of these systems and new research indicates the need for further nitrogen removal, CRMC will reevaluate the need for increased nitrogen removal.

2. Municipal policies

a. Some lands, as presently zoned by the towns, may not meet the density requirements for Self-Sustaining Lands (80,000 square feet) or Lands of Critical Concern (120,000 square feet). In such cases the CRMC will require the towns to be consistent with CRMC density requirements, where possible, during CRMC review of town zoning changes to the Comprehensive Plan.

b. The Council recommends the use of cluster development as a means to preserve open space, agricultural lands and aesthetic qualities, reduce impervious surfaces and the costs of development, and minimize the environmental impacts of development.

c. For activities outside CRMC jurisdiction but within the SAMP boundaries, CRMC strongly recommends that the towns adopt CRMC regulations for OWTS setbacks and nitrogen reducing technologies as identified in Table 1 of § 4.4.2(E) of this Part.

d. The Council recommends the use of wastewater management districts and the protocols established in the Rhode Island Septic System Inspection Handbook (see: http://www.dem.ri.gov/pubs/regs/regs/water/isdsbook.pdf) for septic system inspection and pump-out to limit the occurrence of failed on-site sewage disposal systems.

B. Lands of Critical Concern

1. Policies and Regulations

a. Subdivisions as defined in § 1.1.2 of this Subchapter shall not exceed an average density of one residential unit per 120,000 square feet for Lands of Critical Concern. The allowable number of units in conformance with this standard shall be calculated on the basis of available land suitable for development as defined in § 4.3 of this Part. The division of a tract, lot or parcel not subject to municipal regulation under the provisions of R.I. Gen. Laws Chapter 45-23 *et seq*., for the reasons set forth therein, shall remain subject to the jurisdiction of the requirements of R.I. Gen. Laws § 46-23 *et seq*. and Parts 1 and 4 of this Subchapter.

b. The number of allowable units in a cluster shall be calculated on the basis of lands suitable for development as defined in § 4.3 of this Part within the subdivision and in accordance with all local ordinances.

c. Any major land development project or any major subdivision of land as defined in R.I. Gen. Laws § 45-23-25 et seq. within Lands of Critical Concern, occurring after April 12, 1999, must meet the minimum density requirement of one residential unit per 120,000 square feet. Relief from this regulation requires a special exception as defined in § 1.1.8 of this Subchapter. Lands which were subdivided prior to April 12, 1999, and do not meet the CRMC density requirement as defined in § 4.4.3(B)(1)(a) require a variance as defined in § 1.1.7 of this Subchapter.

d. Nitrogen reducing technologies as defined in § 4.3 of this Part are required for any lands subdivided after April 12, 1999 that do not meet the CRMC density requirement for Lands of Critical Concern (120,000 square feet) for activities within 200 feet of a coastal feature and all watershed activities as defined in §§ 4.4(B)(3) and 4.4(B)(4) of this Part. Relief from this regulation requires a special exception as defined in § 1.1.6 of this Subchapter unless the lands were subdivided prior to April 12, 1999 and cannot accommodate the requirement. A nitrogen reducing technology cannot be used as mitigation to increase dwelling densities on parcels which can support the density requirement.

e. Lands of Critical Concern which are also zoned for 80,000 square feet by municipal zoning regulations may be developed at densities of one residential unit per 80,000 square feet only if a nitrogen reducing technology is used as the method of sewage removal. [In the event that a property has frontage on a sewer line then hooking up to the sewer will be mandatory].

f. A minimum 225-foot setback from the Narrow River, its tributaries, and coastal wetlands, including tributary wetlands, is required for OWTS in Lands of Critical Concern for activities within 200 feet of a coastal feature and all watershed activities as defined in §§ 4.4(B)(3) and (4) of this Part. Relief from this regulation requires a special exception as defined in § 1.1.6 of this Subchapter, unless the lands were subdivided prior to April 12, 1999 and cannot accommodate the requirement.

g. A 200-foot buffer zone from the Narrow River, its tributaries, and coastal wetlands, including tributary wetlands, is required for all development activities within 200 feet of a coastal feature and all watershed activities as defined in §§ 4.4(B)(3) and 4.4(B)(4) of this Part in Lands of Critical Concern. Relief from this regulation requires a special exception as defined in § 1.1.8 of this Subchapter, unless the lands were subdivided prior to April 12, 1999 and cannot accommodate the requirement.

h. New individual or community docks are prohibited.

i. The installation of sewers is prohibited, unless all of the following conditions are met:

    (1) the property meets the RIDEM regulatory requirements for the installation of a conventional OWTS,

    (2) the proposal is agreeable to both the town and the CRMC,

    (3) a deed restriction is attached to the property ensuring no further subdivision; and

    (4) the properties to be sewered are within 500 feet of an existing sewer line or are within a subdivision which abuts the sewer easement.

j. The Council recognizes that in areas abutting the Narrow River, its tributaries and other critical resource areas, existing nitrogen reducing technologies may not be sufficient to reduce groundwater nitrogen concentrations to levels which will prevent further eutrophication in the Narrow River. If new technology improves the nitrogen removal capability of these systems and new research indicates the need for further nitrogen removal, CRMC will reevaluate the need for increased nitrogen removal.

2. Municipal policies

a. Some lands, as presently zoned by the towns, may not meet the density requirements for Lands of Critical Concern (120,000 square feet). In such cases the CRMC strongly encourages the towns to amend zoning in these areas to meet the density requirements.

b. The Council recommends the use of cluster development as a means to preserve open space, agricultural lands and aesthetic qualities, reduce impervious surfaces and the costs of development, and minimize the environmental impacts of development.

c. Lands of Critical Concern should be priority areas for additional measures to minimize pollution loadings from development through municipal, state or federal acquisition for open space and conservation easements and/or tax relief and aquifer protection ordinances.

d. For activities outside CRMC jurisdiction but within the SAMP boundaries, CRMC strongly recommends that the towns adopt CRMC regulations for OWTS setbacks and nitrogen reducing technologies as identified in Table 1 of § 4.4.2(E) of this Part.

C. Lands Developed Beyond Carrying Capacity

1. Policies and Regulations

a. Nitrogen reducing technologies as defined in § 4.3 of this Part are required for all new installations or replacement of existing OWTS for activities within 200 feet of a coastal feature and all watershed activities as defined in §§ 4.4(B)(3) and (4) of this Part in Lands Developed Beyond Carrying Capacity. Relief from this regulation requires a special exception as defined in § 1.1.8 of this Subchapter, unless the lands were subdivided prior to April 12, 1999 and cannot accommodate the requirement.

b. Regular maintenance and, when necessary, the upgrading of OWTS are of the highest priority in unsewered densely developed areas.

c. For existing development, buffer zones along the perimeter of Narrow River, tributaries and tributary wetlands, and other shoreline features shall be required in accordance with § 1.1.11 of this Subchapter, as amended. For new development, buffers shall be an absolute minimum of 25 feet in width. Variances to the buffer standard shall be consistent with CRMC density requirements, where possible, during CRMC review of town zoning changes to the comprehensive plan.

d. The Council recognizes that in areas abutting the Narrow River, its tributaries and other critical resource areas, existing nitrogen reducing technologies may not be sufficient to reduce groundwater nitrogen concentrations to levels which will prevent further eutrophication in the Narrow River. If new technology improves the nitrogen removal capability of these systems and new research indicates the need for further nitrogen removal, CRMC will reevaluate the need for increased nitrogen removal.

2. Municipal policies

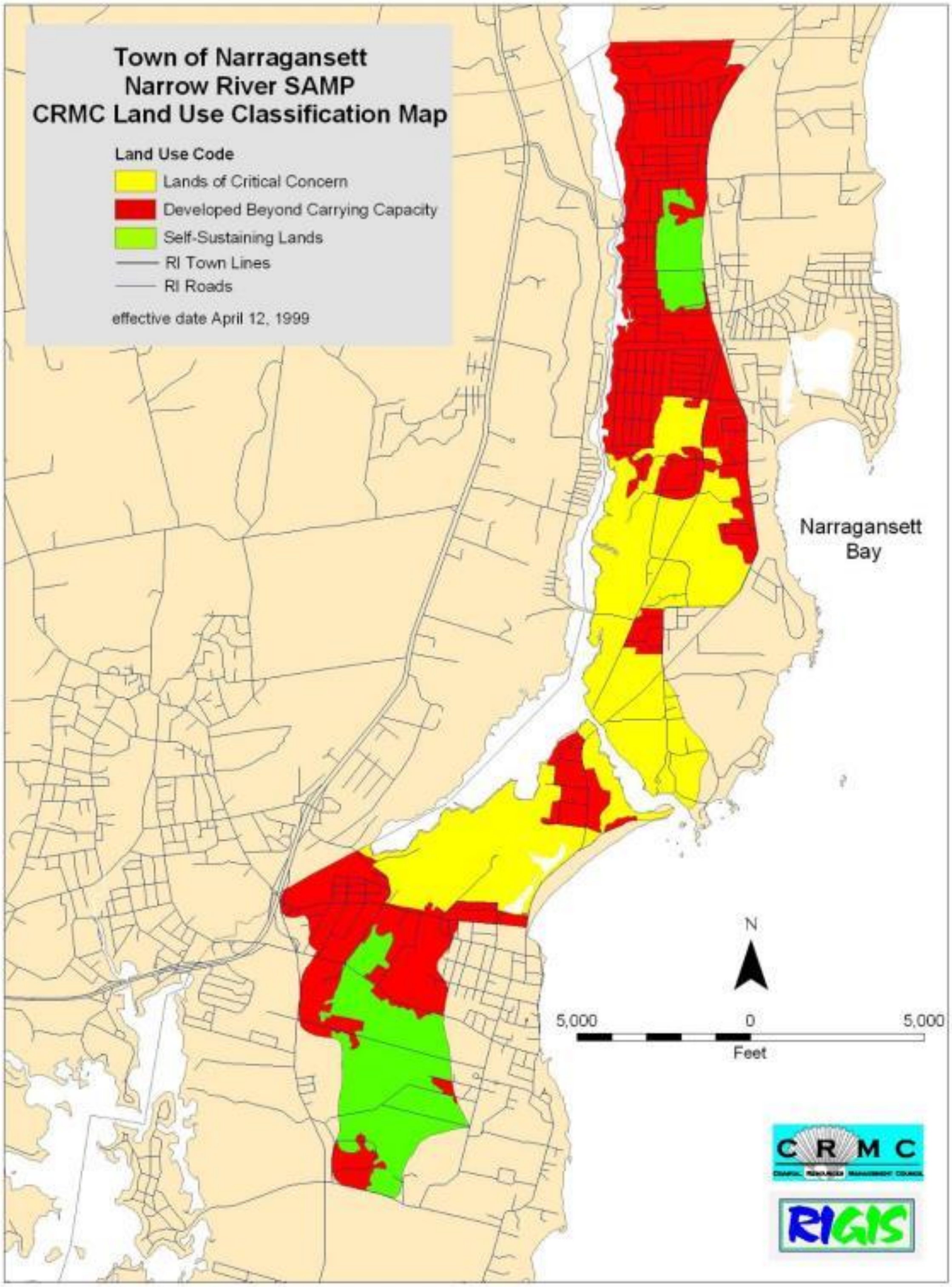
a. Undeveloped property within this land use designation should be developed at densities consistent with current town zoning requirements for the area in which the property is located.

b. For activities outside CRMC jurisdiction but within the SAMP boundaries, CRMC strongly recommends that the towns adopt CRMC regulations for nitrogen reducing technologies as identified in Table 1 in § 4.4.2(E) of this Part.

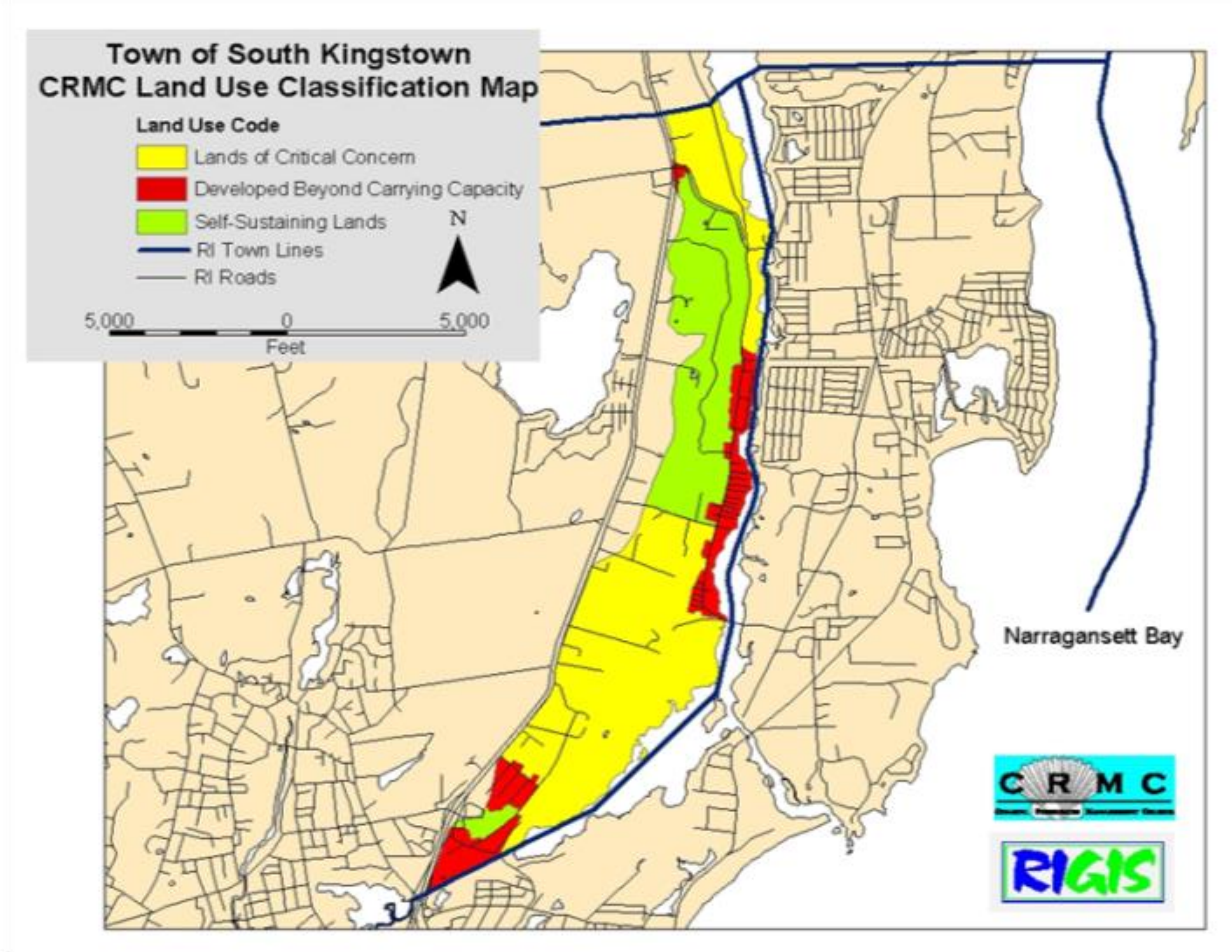
### 4.4.4 Land Use Classification System Maps

A. User-friendly, high resolution CRMC land use classification maps for the Narrow River SAMP communities of Narragansett, North Kingstown and South Kingstown (Figures 1 through 3 below) are available on the CRMC web site. See: http://www.crmc.ri.gov/samp_nr.html.

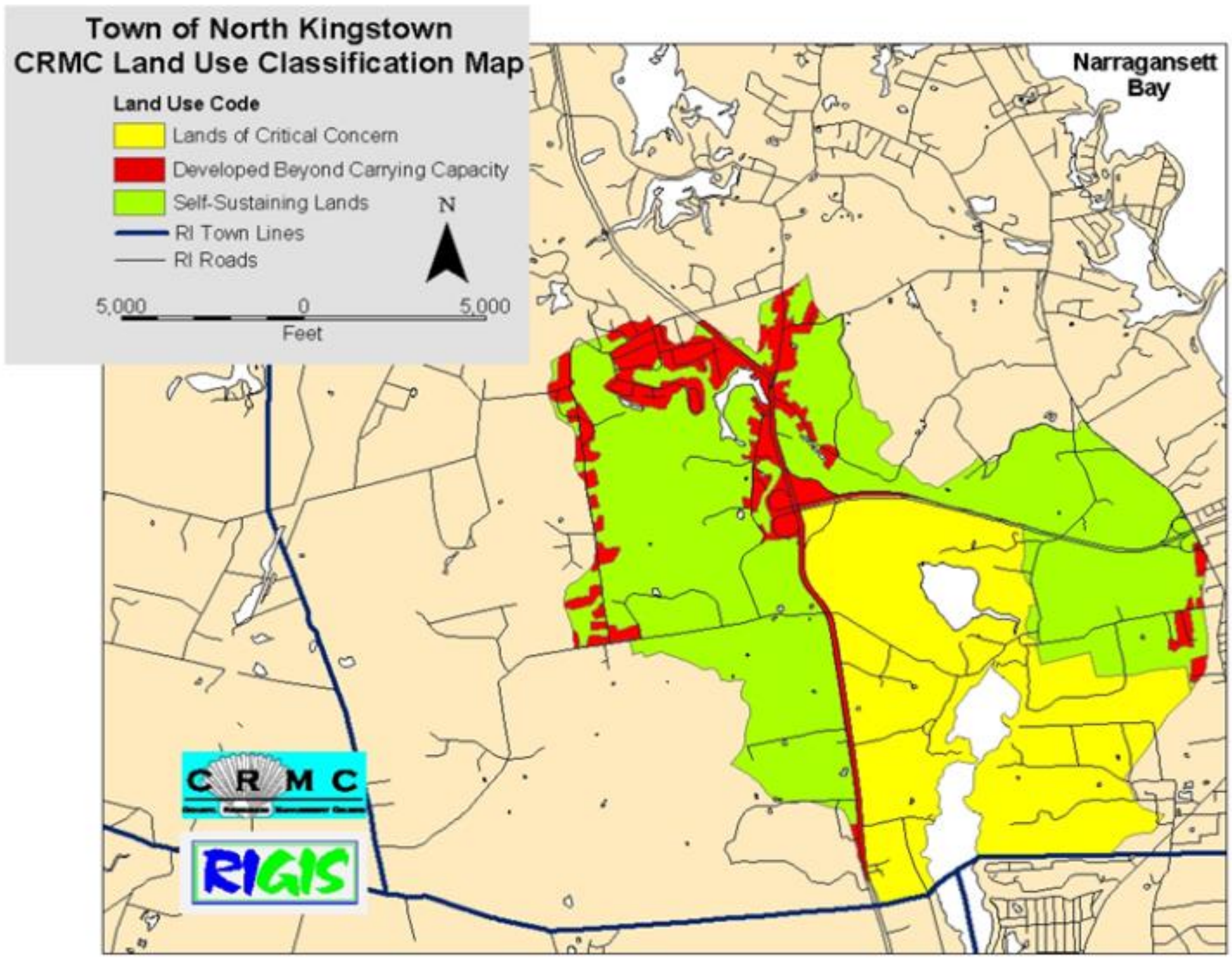
B. Figure 1: Land Use Classification System for the Town of Narragansett.



C. Figure 2: Land Use Classification System for the Town of South Kingstown.



D. Figure 3: Land Use Classification System for the Town of North Kingstown.



### 4.4.5 Watershed Controls for Septic System Management (formerly § 920.2)

A. The concurrent pressures from existing OWTS 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.

B. Policies

1. On an indefinite basis, 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 §§ 4.4.3(A)(1)(g) and 4.4.3(B)(1)(i) of this Part.

### 4.4.6 Watershed Controls for Erosion and Sedimentation (formerly § 920.3)

A. Management Policies and Regulations

1. 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. CRMC will require that applicants strictly adhere to the regulations under § 1.3.1(B) of this Subchapter for filling, removing, or grading of shoreline features, § 1.3.1(F) of this Subchapter for treatment of sewage and stormwater and the most recent version of the RI Soil Erosion and Sediment Control Handbook (See: http://www.dem.ri.gov/programs/water/permits/ripdes/stormwater/soil-erosion.php).

### 4.4.7 Control of Pollution from Storage Tanks (formerly § 920.4)

A. Policies and Regulations

1. Except for propane and compressed natural gas, burial of domestic USTs is prohibited in the Narrow River watershed.

2. Commercial USTs must meet all current state standards and applicants must apply for a CRMC permit. Applicants must demonstrate an adequate construction design and means for monitoring for leakage, and shall replace all leaking tanks according to RIDEM regulations.

### 4.4.8 Oil Spill Contingency (formerly § 920.5)

A. Policies

1. Oil spills shall be treated as outlined in the RIDEM Emergency Response Plan. See: http://www.dem.ri.gov/programs/emergencyresponse/erp.php#sec6_2. It is further recommended, in the event of a nearshore spill that poses a threat to the Narrow 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 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 Narrow River may facilitate cleanup activities.

### 4.4.9 Geologic Processes (formerly § 930)

A Dredging navigation channels and basins

1. Policies

a. All applications for dredging in the Narrow River watershed shall be consistent with the policies and standards contained in§ 1.3.1(I) of this Subchapter and all other applicable sections of the RICRMP.

b. Dredging to support existing recreational use is permitted under the CRMP but dredging for new recreational uses is prohibited.

c. The Council shall only support dredging projects that maintain the existing level of recreational use within the Narrow River.

d. Dredging by town or state agencies is permitted for the following:

(1) Dredging of the flood-tidal delta at the entrance to the Narrows; sand to be placed on Narragansett Town Beach;

(2) Dredging of the flood-tidal delta associated with Middle Bridge for navigational reasons to maintain current recreational watercraft uses, and for safety in those multiple uses; sand to be placed on Narragansett Town Beach.

(3) Dredging of a navigational channel from the inlet to Middle Bridge may be considered if it can be demonstrated that the habitat of the winter flounder south of Middle Bridge, and the waterfowl habitat of northern Pettaquamscutt Cove, is not degraded.

e. Dredging of the major flood-tidal delta system between Sprague and Middle Bridges may be considered if it can be demonstrated that flushing north of Middle Bridge is enhanced, and the habitat of northern Pettasquamscutt Cove is not degraded.

f. A dredging/maintenance plan is required for all proposed dredging operations (see § 4.4.9(A)(3) of this Part).

g. Due to the multiple and conflicting uses of the Narrow River and the current riverbank and salt marsh erosion from boat wakes, personal watercraft and waterskiing, and the likelihood that dredging may well increase these problems, a boating safety plan including speed limits and wake restrictions shall be presented in conjunction with any dredging project.

h. The CRMC favors the use of qualified dredge material for beach replenishment projects. Dredge applications for the Narrow River should consider the use of the material as beach replenishment for the Narragansett Town Beach.

i. The Council shall determine if a proposed dredging project constitutes maintenance of an existing level of use, or if it is improvement dredging.

2. Prohibitions

a. Dredging and disposal activities by private citizens or groups for docking areas, launching ramps, mooring areas, or similar uses and activities, are prohibited in the Narrow River and its watershed.

b. Dredging which will likely intensify recreational watercraft usage is prohibited.

c. Dredging is prohibited without an appropriate maintenance plan in place (see § 4.4.9(A)(3) of this Part for maintenance plan requirements).

d. Disposal 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 beach replenishment has been established. Subaqueous dumping of dredged material is also prohibited in the Narrow River.

3. Standards

a. All dredging activities shall be conducted in accordance with the standards contained in § 1.3.1(I) of this Subchapter and all other applicable sections of the RICRMP.

b. A dredge/maintenance plan put forth by a federal, state or municipal agency must clearly describe:

(1) location of project (limited to identified tidal deltas or a navigational channel);

(2) dredging specifics, such as amount of material, construction acres and methods, dewatering requirements, transportation requirements, disposal site;

(3) habitat and circulation impacts on the species that utilize the Narrow River, and on the Narrow River itself;

(4) maintenance of dredge area;

(5) measures to reduce impacts and, where appropriate restore or improve habitat and water quality; and

(6) any created, permanent well marked channel, wake restrictions and speed limits if a channel is to be identified (as close as possible to existing use area) and dredged (refer to the requirements of § 1.3.1(I) of this Subchapter).

c. Dredging will only be allowed to minimal dimensions necessary to support the demonstrated previous level of use.

### 4.4.10 Roads, Bridges and Highways (formerly § 930.2)

A. Policies

1. All road, highway and bridge construction, reconstruction and relocation projects within the Narrow River watershed require a permit from the CRMC.

2. The CRMC supports limited widening of the opening of Middle Bridge to ease boating safety concerns and to retard sedimentation north or the bridge, if it can be demonstrated that fish and wildlife habitat (especially winter flounder habitat south of the bridge on the western side) would not be adversely affected.

3. Best management practices in accordance with the most recent version of Department of Environmental Management "Stormwater Design and Installations Standards Manual" must be followed for drainage improvements so that direct runoff of pollutants and contaminants into the upper tributaries of the watershed and into Narrow River are mitigated (see § 1.3.1(F) of this Subchapter for information and requirements).

4. All structural and mechanical alterations proposed within the watershed shall include in their environmental considerations the aesthetic value of the region and the project's likely impact to it.

5. The regulatory process shall include the input of organizations other than state agencies for identify resource areas of significance.

6. All road, highway and bridge construction, reconstruction and relocation projects shall, to the maximum extent possible:

a. protect areas that provide important water quality benefits or are particularly susceptible to erosion or sediment loss;

b. limit land disturbance such as clearing and grading and cut and fill to reduce erosion and sediment loss; and

c. limit disturbance of natural drainage features and vegetation.

7. All applications for road, highway and bridge construction, reconstruction and relocation projects within the Narrow River watershed shall include an erosion and sediment control plan in accordance with the most recent version of the Rhode Island Soil Erosion and Sediment Control Manual (see: http://www.dem.ri.gov/programs/water/permits/ripdes/stormwater/soil-erosion.php).

8. In cases where chemicals are present on site for road, highway or bridge projects, applicants shall:

a. limit the application, generation, and migration of toxic substances;

b. ensure the proper storage and disposal of toxic materials; and

c. apply nutrients at rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface waters.

### 4.4.11 Living Resources and Critical Habitats (formerly § 940)

A. Regulations and policies

1. It is CRMC policy to consider the trends and status of fish and wildlife species including their habitat within the watershed when making decisions about development and recreational uses.

2. Winter flounder spawning grounds shall not be disturbed during the December-May spawning season.

3. All shellfish areas within the Narrow River are shellfish management areas and as such, are a high priority for protection.

4. The Rhode Island Natural Heritage Program must be consulted by the applicant if the project falls within a critical habitat. If a species is listed on the RIDEM rare and endangered list, the federal list, or both, RIHPC will be contacted to provide stipulations, recommendations and/or comments to the CRMC before the Council issues a decision.

5. Wetland restoration projects within the watershed are strongly recommended to maintain and improve the health and viability of the wildlife and finfish populations of the ponds.

6. It is the Council’s policy to manage and protect submerged aquatic vegetation (SAV) from loss and degradation in accordance with § 1.3.1(R) of this Subchapter.

7. The black duck is targeted through the North American waterfowl plan and RIDEM Fish and Wildlife species as a high priority species for conservation. This species and its vegetated habitat therefore have a high priority for protection by the Council.

8. The Council shall consider project impacts on waterfowl species including their habitat and nutritional resources such as vegetation, shellfish, and fish.

9. Limited *Phragmites australis* control programs may be approved by the Council in areas that have degraded due to invasion.

10. Buffer zones will be the maximum width under § 1.1.11 of this Subchapter in areas that abut Gilbert Stuart Stream to protect anadromous fish runs.

11. CRMC encourages conservation easements to be held by towns, and such organizations/agencies as land trusts, the Nature Conservancy, and the Audubon Society. Additionally, conservation easements may be granted to the CRMC directly.

12. The CRMC encourages the appropriation of such monies by the individual towns, local communities, private land trusts, conservation groups, and the Nature Conservancy for the preservation of lands in the Narrow River watershed. Priorities for acquisition 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 Narrow River's edge.

B. Prohibitions

1. Filling, removing, or grading (reference § 1.3.1(B) of this Subchapter) is prohibited on any wetland in the Narrow River watershed. For the purposes of this section, wetlands shall include coastal wetlands and all other wetlands subject to the jurisdiction of the CRMC that are located in the Narrow River watershed. However, the following exceptions may be permitted by the Council:

   a. The fifty (50) foot wetland perimeter and river bank wetland areas outside the wetland “edge” (R.I. Gen Laws § 2-1-20 (d) and (g)) shall not be considered part of the wetland under this section.

   b. Filling, removing, or grading of freshwater wetlands within the Narrow River watershed, excluding areas regulated as coastal wetlands (defined in § 1.1.2 of this Subchapter) may receive relief from this prohibition in instances where filling is required to gain access to otherwise buildable land and when no other reasonable alternatives to gain access exist and when the applicant has satisfied the variance burdens of proof set forth in § 1.1.7 of this Subchapter. Buildable land shall be defined as a land area which satisfies all federal, state, and municipal requirements for the intended development, including the pertinent requirements in the Narrow River SAMP, and meet all of the RIDEM regulations and requirements for OWTS in "Critical Resource Areas" unless a sewer line is available to provide service to the parcel. Unless otherwise located within Lands Developed Beyond Carrying Capacity any proposed sewer lines must comply with the requirements of §§ 4.4.3(A)(1)(g) or 4.4.3(B)(1)(i) of this Part as applicable herein. 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:

(1) The applicant shall be required to mitigate the area of wetland lost on a 1 to 1.5 area basis;

(2) the wetland that is replaced shall be consistent with that which is filled;

(3) the mitigation shall take place on-site and in an area which is hydrologically connected to the impacted wetland;

(4) setback and buffer requirements shall be required for the wetland replacement area;

(5) enhancement of existing wetland shall not be an acceptable form of mitigation under this section;

(6) all wetland replacement projects will require the approval of the RIDEM Freshwater Wetlands program or the CRMC pursuant to "Coastal Resources Management Program – Rules and Regulations Governing the Protection and Management of Freshwater Wetlands in the Vicinity of the Coast"; and (7) the applicant shall concurrently submit applications to the RIDEM and to the CRMC, when applicable, so that a concurrent review of the proposed activities can occur.

2. All alterations within the setback and buffer zone requirements established in accordance with §§ 4.4.3(A)(1)(e), 4.4.3(A)(1)(f), 4.4.3(B)(1)(f) and 4.4.3(B)(1)(g) of this Part are prohibited with the exception of:

a. Minor filling, removing and grading activities within setback areas (but not buffer zones) typically involving 10 cubic yards or less of material.

b. Minor alterations of buffer zones associated with CRMC approved buffer zone management activities.

c. The construction of driveways and/or roadways to provide access to buildable land as specified in § 4.4.11(B)(1)(b) of this Part where no other environmentally suitable alternative is available.

d. The Council shall encourage replacement of buffer zone areas lost to provide access as set forth in § 4.4.11(B)(2)(c) of this Part in other suitable areas of the project.

3. Dredging is prohibited in winter flounder areas during spawning season and if anadromous fish restoration projects are ongoing.

C. Standards

1. Excavation of any mudflats or other inter- or sub-tidal sediments requires consultation with RIDEM Division of Marine Fisheries Management.

2. Prior to any dredging project the applicant may be required to remove any shellfish present in the sediments and transplant them to a RIDEM/CRMC approved site. Appropriate sites include RIDEM spawner sanctuaries or sites deemed appropriate by Marine Fisheries Council or RIDEM Division of Marine Fisheries Management and CRMC.

3. Buffer zones shall be established according to the policies and standards of § 1.1.11 of this Subchapter. The SAMP buffer widths supersede those contained in Table 4 in § 1.1.11 of this Subchapter. Buffer zones shall be contiguous to the most inland edge of the coastal habitat of concern. The width of the buffer shall be not less than 200 feet in those lands classified as Lands of Critical Concern and not less than 150 feet for those lands which abut tributaries or tributary wetlands in Self Sustaining Lands. When the feature is a tributary wetland, the buffer width shall be measured from the inland edge of the tributary wetland.

**4.4.12 Storm Hazards (formerly § 950)**

A. Policies

1. Reconstruction after storms

a. When catastrophic storms, flooding, and/or erosion has occurred at a site under Council jurisdiction, and there is an immediate threat to public health and safety or immediate and significant adverse environmental impacts, the Executive Director may grant an Emergency Assent under § 1.1.14 of this Subchapter.

b. A CRMC Assent is required of all persons proposing to rebuild shoreline structures which have been damaged by storms, waves, or other natural coastal processes in the Narrow River watershed. When damage to an individual structure is greater than 50% of the total square footage of that structure, post-storm reconstruction shall follow all standards and policies for new development in the area in which it is located.

c. Setback requirements from § 1.1.9 of this Subchapter shall be applied.

d. All construction within Federal Emergency Management Agency (FEMA) flood zones must follow the required construction standards for the flood zone in which the structure is located. Municipal officials need to certify that these standards are correct and present on any application for activity submitted before the CRMC.

(1) Construction in coastal high hazard flood zones (V zones) as defined by federal flood insurance rate maps, shall follow the regulations as listed in § 1.3.1(C) of this Subchapter, as amended.

(2) Construction in areas of coastal stillwater flood hazards (A zones), as defined by flood insurance rate maps, shall follow the regulations listed in § 1.3.1 of this Subchapter, as amended.

e. A CRMC maintenance assent is required for all persons proposing to repair structures which have been destroyed less than 50% of the total square footage of the structure, by storms, waves, or natural processes.

f. The Council encourages post-storm reconstruction applicants to increase setbacks further from the coastal feature than the previous development without expanding the footprint.

2. Wetlands which are significant in shielding flood-prone areas from storm damage, particularly those salt marshes surrounding Pettaquamscutt Cove and the lower reaches, are priorities for preservation.

B. Prohibitions

1. Filling, removing or grading is prohibited on beaches, dunes, undeveloped barrier beaches, coastal wetlands, cliffs and banks, and rocky shores adjacent to Type 1 and Type 2 waters, and in the Narrow River watershed unless the primary purpose of the alteration is to preserve or enhance the area as a natural habitat for native plants and wildlife.

2. When damage to an individual structure is greater than 50% of the total square footage of that structure, post storm reconstruction is prohibited from occurring within setback zones.

3. Structural shoreline protection facilities are prohibited in the Narrow River.

C. Standards

1. Construction standards in flood zones

   a. A significant amount of construction within Rhode Island's coastal zone has the potential to fall within a Federal Emergency Management Agency (FEMA) designated flood zone. The approximate limits of the flood zones and the associated base flood elevations are shown on FEMA's Flood Insurance Rate Maps, which are commonly available at municipal building official's offices. It is extremely important (and required) to know if your project falls within a flood zone and the associated building standards that must be adhered to in that zone to minimize the inevitable damage that occurs when building in a flood hazard area. The CRMC requires all applicants proposing construction within flood hazard zones to demonstrate that applicable portions of the Rhode Island State Building Code (RISBC), specifically requirements for flood zone construction are addressed. The building official for your community can inform you of the requirements and restrictions that apply to your specific building site. A letter from the building official conferring that all the necessary building requirements for your flood zone have been met must accompany any application for construction work within the CRMP management area, and this SAMP.

### 4.4.13 Historical and Cultural Resources (formerly § 960)

A. The historical and cultural resources of the Narrow River watershed are a valuable asset to the communities in North Kingstown, South Kingstown and Narragansett. CRMC considers preservation of these resources as a high priority for the SAMP and utilizes the CRMC application process to ensure that the Rhode Island Historic Preservation and Heritage Commission (RIHPHC) has the opportunity to research various locations in the Narrow River watershed.

B. Policies

   1. Applications for major activities within the Narrow River watershed shall be forwarded to RIHPHC for review and comment as part of the standard CRMC regulatory process.

   2. Areas that are likely archeological sites are identified by RIHPHC. Though other areas may exist and RIHPHC reserves the right to require additional information and potential digs. Activity proposed within these areas will likely be required by RIHPHC to perform a phase I archeological investigation.

   3. The CRMC will await the response of RIHPHC prior to completion of its own staff review and subsequent Council decision. Unless a special exception occurs, the Council will incorporate the RIHPHC guidance into its regulatory decision-making and permit stipulations. If a proposed project is located within a demarcated RIHPHC area of interest, it may be helpful to contact RIHPHC prior to filing an application with CRMC, in order to be aware of their potential concerns.

4. Where possible, those sites identified by RIHPHC as having potential historical or archeological significance will be incorporated into the buffer zone by extending the boundary of the buffer where appropriate.

### 4.4.14 Cumulative Impacts (formerly § 970)

A. Managing for cumulative impacts is one of the major issues of concern for CRMC. CRMC will be focusing on the cumulative impacts of OWTS, impervious areas, stormwater runoff, vegetation removal and soil erosion, dredging the stabilized breachways and tidal deltas, barrier beach and flood zone development, residential activities, marinas, docks, and recreational boating, public water and sewer facilities, wetland alteration and noise and lighting impacts on habitat. All of these activities have the potential to cause effects in the ecosystem which increase the probability of shellfish closures, fish habitat degradation and loss, eutrophication, sedimentation of shellfish beds and much more.

B. Policies

1. It is the Council's policy to minimize cumulative impacts by anticipating and appropriately siting land and water uses and development activities to avoid cumulative effects to the Narrow River.

2. It is the Council's policy to consider the cumulative impacts of OWTS, impervious areas, stormwater runoff, vegetation removal and soil erosion, dredging the stabilized breachways and tidal deltas, barrier beach and flood zone development, residential activities, marinas, docks, and recreational boating, public water and sewer facilities, wetland alteration and noise and lighting impacts on habitat. These cumulative impacts are explained in Chapter 8 of the Narrow River SAMP.

C. Standards

1. In those areas which are designated as Lands Developed Beyond Carrying Capacity, innovative technologies and development techniques that will reduce pollutants are required for new development and improvements to existing development. These include, according to the type of development, alternative on-site sewage disposal systems (as required by §4.4.3(C)(1)(a) of this Part), narrower road widths; clustering of development to reduce road lengths with remaining open space maintained adjacent to surface waters; restrictions on layouts of subdivision cul-de-sacs and roadways to reduce impervious surface and encourage infiltration of stormwater; use of pervious materials for driveways; restrictions on the number of parking spaces per square foot of commercial development to match average daily use - not potential maximum; requirements that all overflow parking be constructed using pervious materials; and more accessible alternative transportation such as pedestrian, bicycle and mass transit.

2. In those areas which are designated as Self-Sustaining Lands or Lands of Critical Concern, residential and commercial development on substandard lots, and on all lots abutting the Narrow River requires innovative

technologies and development techniques that will reduce nitrogen. These include according to the type of development, alternative on-site sewage disposal; narrower road widths; clustering of development to reduce road lengths with remaining open space maintained adjacent to surface waters; restrictions on layouts of subdivision cul-de-sacs and roadways to reduce impervious surface and encourage infiltration of stormwater; use of pervious materials for driveways; restrictions on the number of parking spaces per square foot of commercial development to match average daily use - not potential maximum; requirements that all overflow parking be constructed using pervious materials; encourage more accessible alternative transportation such as pedestrian, bicycle and mass transit.

**Narrow River SAMP Chapter 9 – Non-RICR text**

## 920.1. Land Use Classification for Watershed Protection

D. Research Needs

1. There needs to be an evaluation of the impacts to the Narrow River from transporting water from aquifers outside the watershed, specifically how it affects flushing in the estuary.

2. There is considerable concern at the town and public levels to address the existing impacts of stormwater runoff to the Narrow River. One issue which needs to be investigated is the removal or best management of stormwater pipes entering the Narrow River.

3. The URI Watershed Watch program sampling data is a vital source of information for the CRMC and RIDEM. Since the state only samples for bacterial contamination, expanding URI Watershed Watch sampling for all the species of nitrogen (inorganic - nitrate, nitrite, ammonia, and organic), and phosphorus (inorganic and organic) is necessary to assess water quality trends. There is little documentation of the impacts of waterfowl on bacteria levels in the Narrow River. URI Watershed Watch volunteers should also record the number of waterfowl present at the time of sampling for bacteria.

4. The Town of South Kingstown recently had their parcel maps digitized and the data put into a geographic information system. CRMC will be using this data to overlay the Land Use Classification Maps and provide more accurate data to homeowners and developers about which category their property falls under (i.e., Lands of Critical Concern, Self-Sustaining Lands, or Lands Developed Beyond Carrying Capacity). The Towns of Narragansett and North Kingstown should also develop parcel map databases so that CRMC can utilize this information in the SAMP.

5. Some of the data from the RIGIS database is now ten years old (i.e., land use). As the RIGIS database is updated, the SAMPs should be amended to reflect the most recent information available about wetlands, land use, open space, etc.

6. A homeowner survey of fertilizer use and an educational program about appropriate fertilizer use in the Narrow River watershed would give managers a better understanding of the sources of nitrogen entering the Narrow River. Presently, estimates of nitrogen loading from home fertilizer use are based on research by Gold et al. (1990) (3.8 kg/acre) for the SAMP and Eichner and Cambareri (1991) (1.36 kg/1000ft2) for the Narrow River Stormwater Study (ASA 1995).

7. Recreational use of the Narrow River is increasing with more motorboats, kyakers, windsurfers etc. Although the towns have provisions for proper boat handling on the Narrow River, there needs to be an assessment of the impacts of boating on water quality, wildlife, erosion and submerged aquatic vegetation.

8. The data necessary to determine groundwater flow direction throughout the watershed of the Narrow River should be collected and a groundwatershed map of the Narrow River completed.

9. The watershed boundary around Silver Lake in South Kingstown needs to be identified as part of the Narrow River watershed or Point Judith Pond. Groundwater flow data will need to be collected around the pond to complete the analysis.

### 920.2 Watershed Controls for Septic System Management

C. Recommendations

1. A regional wastewater management plan should be undertaken on a cooperative basis by the municipalities, the RIDEM, 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 of areas that require sewer service and a schedule for their installation with priority consideration given to areas with concentrations of failed OWTS;

(c) A watershed wide OWTS 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 moneys towards these programs; and

(f) The development of programs to educate local residents about the use and maintenance of OWTS systems. Coordination with Save the Bay workshops as well as to take advantage of ongoing University of Rhode Island Cooperative Extension Service programs aimed at homeowners on this topic may be useful.

2. 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, the towns should undertake a program to support regular maintenance of OWTS within the watershed. The septic maintenance program should include, as a minimum, the following:

(a) OWTS 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 Sewage 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 per year;

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

3. Through the use of regular maintenance, or pumping, the life span of an OWTS, 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 drain fields for washing machine discharges;

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

(g) resting part of the leach field system periodically through design or installation of alternate beds.

4. The Council recommends the use of wastewater management districts and the protocols established in the Rhode Island Septic System Inspection Handbook for septic system inspection and pump-out to limit the occurrence of failed on-site sewage disposal systems.

**920.4 Control of Pollution from Storage Tanks**

3. Recommendations

(a) CRMC recommends that homeowners close their petroleum USTs by contacting RIDEM and following the proper procedures as indicated in the RIDEM UST regulations.

**920.6 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 cleanup activities. Such cleanup activities may entail individual mitigation efforts, i.e., minimizing chemical fertilizer applications, cisterns for catching 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 television advertisements, video tapes, and local newspaper columns.

B. Monitoring Activities

1. Watershed Watch, a citizen volunteer monitoring program coordinated by the University of Rhode Island Department of Natural Resource Sciences, was initiated in the Narrow River watershed during 1992 and has been in operation through 1997. The data collected by monitoring volunteers provides valuable data on the condition of the resource and the quality of the waters within the watershed. Watershed communities should continue to support these efforts with the intent of long term monitoring so that trends will become apparent as the data are continually collected. Determination of trends will assist in assessing the changes and impacts in the resources as the watershed is further developed and the policies and regulations developed in this plan are implemented. Monitoring data will assist in determining new areas of focus for future planning endeavors, as well as point to successful policies that have assisted in the maintenance, preservation, and protection of this unique Rhode Island resource.

**920.7 Future Research**

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

1. Detailed analysis of bottom sediment distribution, composition, and transport dynamics should 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.

2. Groundwater data are 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.

3. Little is known about the freshwater system in the northern region of the watershed. Water quality testing should be extended into the Mettatuxet River and in Silver Spring Lake. Hydrodynamic and sediment transport studies would be extremely beneficial.

**940 Living Resources and Critical Habitat**

## E. Recommendations

1. Fisheries Steward. One or more Narrow River fisheries stewards should be hired and charged with the following responsibilities:

(a) Monitor Narrow River fisheries resources and fishing effort, particularly in areas known to be productive. The assistance of volunteer monitoring groups like the URI Watershed Watch volunteers and university researchers should be encouraged.

(b) Select small areas known for shellfish (quahaugs and softshell clams) productivity and intensively manage growth and harvest to insure a continued recreational fishery through seeding, predator control, controlled fishing effort, and special regulations for softshell clams harvested from these areas. A major purpose of such initiatives is to demonstrate the potential of such areas to produce sustained annual harvests if the public cooperates.

(c) Assist in the development of public education programs on the Narrow River and their fisheries. This is an appropriate project for academics, nonprofits, and volunteer groups. Much of this effort is ongoing, however, funding limits the effectiveness of these programs.

(d) Identify major issues for future research and monitoring by the RIDEM and/or university researchers.

(e) Prepare annual reports on the conditions of the Narrow River and fisheries, activities undertaken and accomplished, and priorities for the following year. This report would be presented to the Rhode Island Marine Fisheries Council, funding agencies and the public.

2. Educational programs to inform 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.

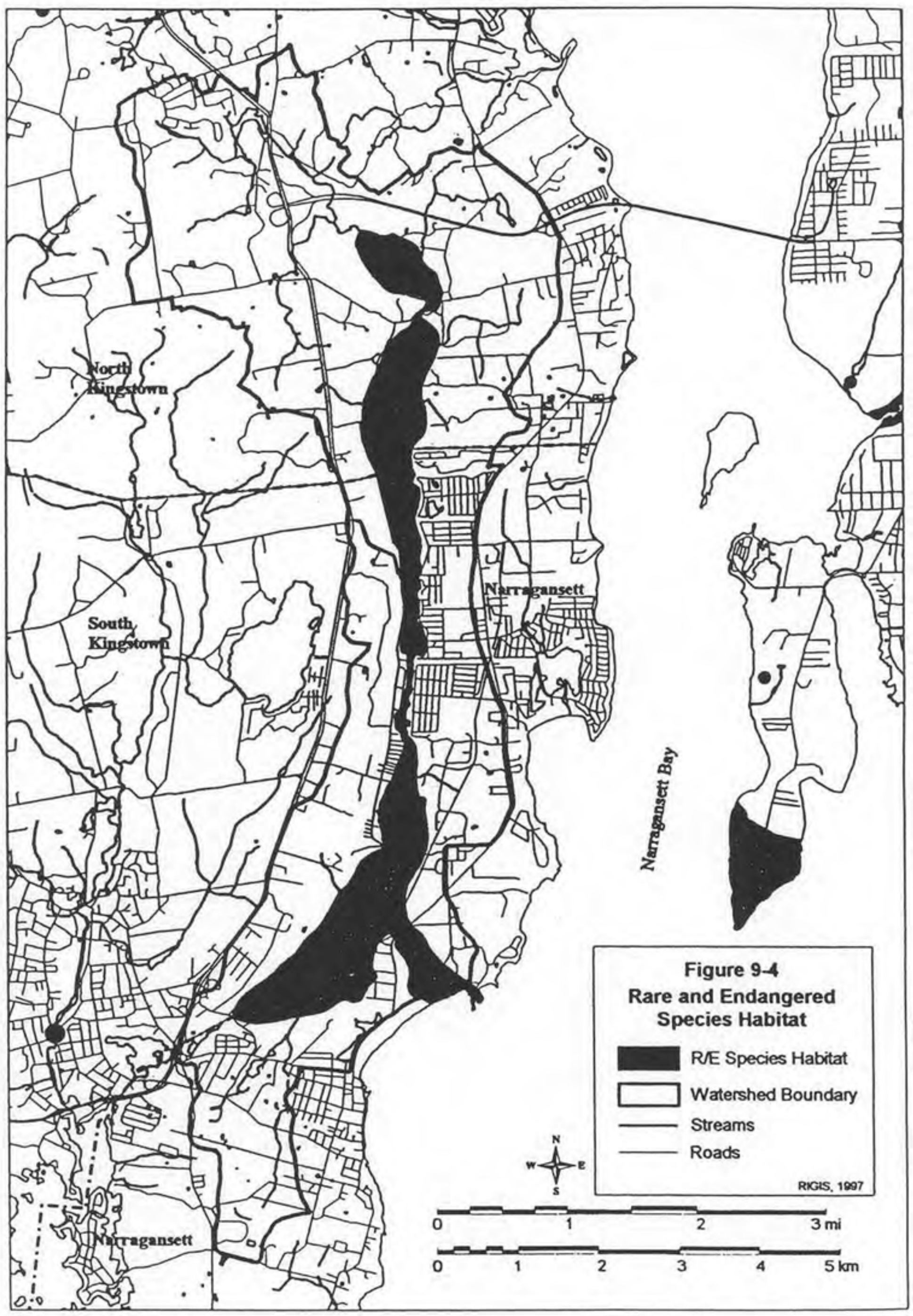
3. Researching the connection between fish and their habitat is essential to the management of the Narrow River species. The RIDEM Division of Fish and Wildlife should make this a priority in future research initiatives.

## F. Research Needs

1. Identify degraded and previously altered wetlands for restoration activities similar to the Galilee Bird Sanctuary project.

2. Study impacts of recreational boating on habitat quality and quantity.

Figure 9-4. Rare and Endangered Species Habitat.



## 950 Storm Hazards

A. Introduction

1. Much of the development around the Narrow River is vulnerable to coastal flooding and storm surge destruction. Between 1980 and 1988, coastal property values in Rhode Island increased 60 percent, from $32 million to $53 million (Flesner 1989). In order to protect private and public property and prevent the hazards associated with hurricanes and storm flooding CRMC developed policies and regulations to support existing hazard mitigation efforts by the Rhode Island Emergency Management Agency (RIEMA).

E. Recommendations

1. General

(a) Homeowners should be aware of the flood zone designation of their property, the associated storm/flooding risk, and the accompanying building standards with which they must comply. The municipal building official retains local information regarding flood zone designation and standards.

(b) Seasonal visitors, renters, town residents and town officials should be aware of evacuation routes and locations of shelters.

(c) Acquisition priorities should be set by municipalities and the state for areas vulnerable to storm/flood hazards.

(d) Town/State public works and emergency management officials should post roadside evacuation route signs in all pre-identified coastal flood/storm evacuation areas.

(e) Incentive should be provided to homeowners to relocate structures destroyed less than 50 % through State or Federal assistance (Upton-Jones Amendment) or tax breaks.

(f) Subsidies, through federal flood insurance or other sources, should be made available to owners of structures in critical erosion areas.

(g) Municipalities, non-governmental organizations, and the State should examine areas with storm/flood hazards for open space acquisition.

2. Research Needs

(a) There is a need for better understanding the correlation between oceanographic forces and shoreline response. With knowledge of the wave, climate, surge elevations and currents during storms and the subsequent sediment transport, the effects of hurricanes and severe winter storms could be better predicted.

(b) Shoreline change data including regular updates of shoreline change rates and continuation of the beach profile network should be collected and monitored on an ongoing basis.

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

3. Public Education

(a) More information on coastal erosion for the general public, especially coastal landowners and real estate agents dealing in coastal properties, should be provided. Short publications or pamphlets distributed to shorefront property owners would aid compliance with CRMC regulations and make citizens better caretakers of the coastal zone.

(b) Plans for debris removal and disposal which designate disposal sites for debris should be established, recognizing the lack of local landfills and the prohibition of debris in wetlands. Temporary storage sites should be identified by municipalities 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. Sites along the Narrow River that might be considered include:

(i) RIDEM boat launch at Mitchell and River Court

(ii) RIDOT scenic overlook/parking areas at Sprague Bridge

(iii) RIDOT commuter lot at Tower Hill Road

(iv) Narragansett Pier Town Beach parking lot

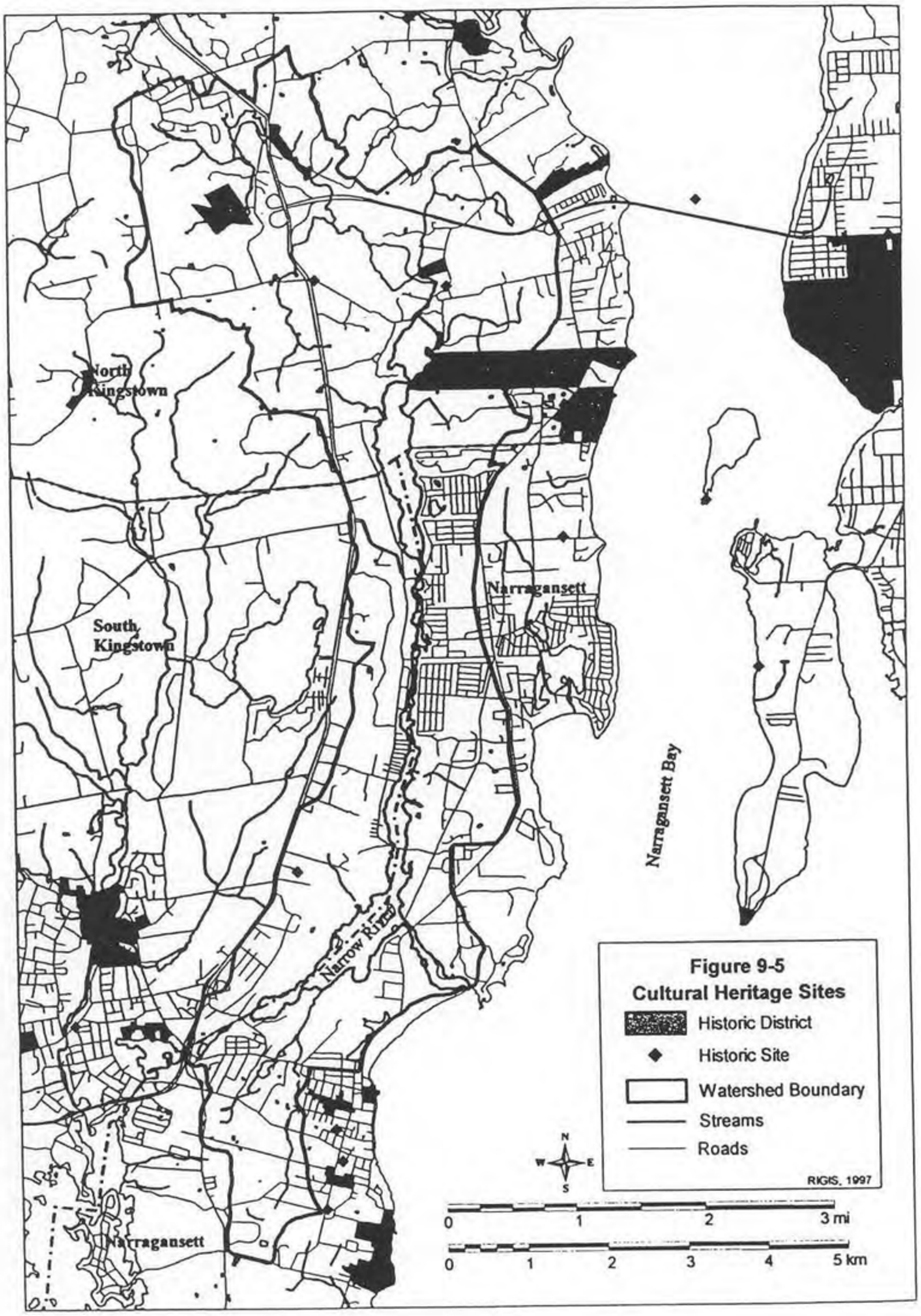
**960 Historical and Cultural Resources**

C. Recommendations

1. Sites which are identified by the RIHPC as having historical or archeological significance should be priorities for acquisition and preservation programs, using open space easements, land dedications, transferring of development rights, etc. See RIHPC for further guidance on targeted areas.

2. It should be a high priority for RIHPC to conduct a detailed survey and pre-identify areas likely to contain archeological or historical resources.

Figure 9-5. Cultural heritage sites.



## 970 Cumulative Impacts

E. Recommendations

1. The Council encourages the Narrow River watershed towns to adopt ordinances to minimize impervious surfaces in order to reduce cumulative impacts and transport of pollutants to the Narrow River. Possible management options include the following:

(a) Narrower road widths;

(b) Clustering of development to reduce road lengths with remaining open space maintained adjacent to surface waters;

(c) Restrictions on layouts of subdivision cul-de-sacs and roadways to reduce impervious surface and encourage infiltration of stormwater;

(d) Use of pervious materials for driveways;

(e) Restrictions on the number of parking spaces per square foot of commercial development to match average daily use - not potential maximum - and requirements that all overflow parking be constructed using pervious materials;

(f) More accessible alternative transportation such as pedestrian, bicycle and mass transit.

**Literature Cited**

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Rhode Island Department of Environmental Management Office of Environmental Coordination, R.I. Coastal Resources Management Council and R.I. Department of Administration. 1995. Rhode Island’s Coastal Nonpoint Pollution control Program. Providence, R.I.

Short, F.T., D.M. Burdick, S. Granger and S.W. Nixon. 1996. Long-term decline in eelgrass, Zostera marina L., linked to increased housing development. Seagrass Biology: Proceedings of an International Workshop, Rottnest Island, Western Australia, pp 291-298.

U.S. Environmental Protection Agency. 1993. Guidance Specifying Management Measures For Sources Of Nonpoint Pollution In Coastal Waters. Office of Water, Washington, D.C.

# Chapter 10
# Land Preservation and Acquisition

## 1000. Acquisition of Environmentally Sensitive Lands

### A. Current Initiatives for Preservation of Open Space

1. The most effective method to reduce potential water quality pollutants from land-based sources is through property acquisition. Property acquisitions are not only beneficial for resource protection, they have been proven to be an economic benefit to Rhode Island communities. The Aquidneck Island Partnership recently completed an economic perspective on open space (Johnston 1997) where the economic benefits of open space and Greenways were compared to net losses often imposed by residential and other development (Johnston 1997). One important conclusion of the report is that higher property values are associated with properties located closer to open space parcels, and lower property values are associated with properties farther from open space (Johnston 1997). Because open space requires few town services, and hardly any infrastructure, open space land provides more in revenues than it costs to maintain (Johnston 1997).

### B. Acquisition of Lands Within the Narrow River

1. Acquisition of lands within the Narrow River watershed has grown as a concept for preservation of existing scenic and natural resources. There are many governmental and private programs whose purpose is to preserve lands and structures with exceptional qualities. Following is an overview of existing local, state, federal and non-profit programs.

1. Local

   (a) The towns of South Kingstown, North Kingstown and Narragansett own property in the Narrow River watershed. The Narragansett Land Trust has preserved over 165 acres since 1986 in areas around Point Judith Pond and the Narrow River.

2. State - The Rhode Island Department of Environmental Management

   (a) In the late 1980s, voters in Rhode Island approved four major open space bond issues and numerous local referenda resulting in an investment of more than $100 million for recreation and open space land acquisition (DEM Land Preservation Programs 1997). Municipalities and nonprofits can apply for funds through the Open Space and Recreation Bond Fund Land Acquisition Program to purchase fee title or conservation easements to purchase recreational lands or important open space or to develop recreational facilities.

(b) The Rhode Island Land Protection Plan, adopted in 1996, identifies five major categories of land preservation: agriculture, forests, drinking water protection, recreation and natural heritage/biodiversity. Properties are reviewed for possible acquisition by RIDEM's Division of Planning and Development.

(c) Agricultural Land Preservation Program - The Farmland Preservation Act of 1981 is a state program where farmland is preserved through the acquisition of development rights, at a price defined as the difference between the fair market value of the land and the agricultural value. To date, this program has succeeded in protecting 32 active farms, totaling 2,609 acres.

(d) Natural Heritage Preservation Revolving Loan Fund - The RIDEM administers a fund that will allow preservation societies, land trusts, non-profit organizations, and local communities to preserve, in perpetuity, open space/agricultural lands deemed of scenic or ecological value. The monies are available on a revolving loan basis ($250,000 maximum loan) and are for lands not less than 5 acres.

(e) The Forest Legacy Program - Congress passed the Farms for Future Act in 1991 which created the Forest Legacy Program, and allows the state to acquire land or interest in land. The seller is allowed to retain title to the land or timber rights to the property.

(f) The CRMC is working with the South Shore Management Area Work Group organized by the Department of Environmental Management's Land Conservation and Acquisition Program to identify priority acquisitions along the south shore and the Narrow River. This group includes the towns of Westerly, Charlestown, South Kingstown, Narragansett and North Kingstown, the Audubon Society, The Nature Conservancy, local land trusts, the University of Rhode Island, Senator Chafee's office, the Rhode Island Natural Heritage Program, the U.S. Fish and Wildlife Service and other local nonprofit organizations.

3. Federal Programs

(a) Wildlife Restoration Act (Pittman-Robinson) - In 1937, federal legislation was passed to provide for the enhancement and protection of wildlife resources for public use. Funds for this program are derived from excise taxes on the manufacture of arms and ammunition including handguns and archery.

(b) U.S. Fish and Wildlife Sport Fish Restoration Act (Dingell-Johnson) This program is funded by revenues collected from manufacture's and importers of fishing rods, reels, and other fishing equipment. Allocation of these funds is based upon land and water area and fishing licenses.

(c) North American Wetlands Conservation Act Program (NAWCA) - Rhode Island will receive $1 million in 1997 and has the potential to receive $1 million a year from NAWCA for the next ten years to protect waterfowl habitat along the south shore of the state. The project area includes all or part of North Kingstown, South Kingstown, Narragansett, Charlestown and Westerly. RIDEM is the coordinating agency which will identify potential sites for conservation with the assistance of CRMC, local conservation organizations and not for-profit groups like The Nature Conservancy and The Audubon Society. The funding is the result of a grant proposal written by the U.S. Fish and Wildlife Service and RIDEM.

(d) The US Fish and Wildlife Service Pettaquamscutt Cove National Wildlife Refuge (Refuge) was established in 1988 for the purposes of protecting black ducks and other migratory species and to provide for the conservation and management of native fish, wildlife, and plant species. The Refuge is currently 174 acres. Key habitats include coastal saltmarsh, mudflats, shrublands, and grasslands. Management issues include management of the black duck; maintenance of water quality; management of public use and access; management of grassland and shrubland edge habitat; and cooperative protection of off-refuge sensitive habitat types.

4. Non-government Organizations

(a) The Narrow River Land Trust is a non-profit organization dedicated to the preservation of open space and since 1982 has preserved over 207 acres of land in the Narrow River watershed.

(b) Many nonprofit organizations do not make land acquisitions but provide the necessary water quality data and resource information for others to use in making acquisition decisions. Groups like Watershed Watch which is funded through the URI Cooperative Extension are dependent on volunteer water quality monitors from the Narrow River communities. The Nature Conservancy gives tremendous assistance to other organizations, towns and individuals in land protection projects. The Narrow River Preservation Association (NRPA) was organized in 1971 to protect the Narrow River Watershed and has since reviewed every application filed at CRMC and RIDEM that falls within the watershed. The NRPA has commissioned studies regarding the replacement of Middlebridge Bridge and in 1982 helped to found the Narrow River Land Trust, a separate organization dedicated to the preservation of open space. Recently the NRPA published a guide to living in the watershed titled "The Narrow River Handbook," which provides homeowners with information about the Narrow River environment and how to protect it from everyday activities around the home. The Land Conservancy of North Kingstown owns one property in the Narrow River watershed (1/2-3/4 acres) and has been in existence since 1987.

5. Private Land-owners

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 existence of these fragile resources. A conservation easement is a contract between a landowner and the state, a town, 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 permanently prevents residential, commercial and industrial development of the property, improper or unnecessary removal of vegetation, and the dumping or excavation of any materials. Executing the contract commits the landowner to donating or selling development rights to the state, town, conservation group or land trust, but retains all other rights of ownership not restricted by the agreement.

**B. Recommendation**

1. Critical Resource or Conservancy Zoning

(a) The towns are encouraged to make provisions in their respective zoning ordinances for the re-zoning of critical areas for conservation purposes in an effort to preserve the unique amenities of the watershed. Possible techniques to accomplish these goals are transfer of development rights, cluster developments and overlay districts where specific ecological concerns are addresses in the town comprehensive plan.

2. Municipal Easements

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

**Literature Cited**

Johnston, Robert J., Ph.D. 1997. Aquidneck Island and Open Space: An Economic Perspective. The Aquidneck Island Partnership and Coastal Resources Center, University of Rhode Island. Rhode Island Sea Grant Publication P1470 and RIU-T97-003.

North American Wetlands Conservation Act. 16 U.S.C. 4401 et seq.

Rhode Island Department of Environmental Management, Division of Planning and Development. 1997. Land Preservation Programs. Providence, RI.

U.S. Fish and Wildlife Sport Fish Restoration Act. 1950. 16 U.S.C. 777 et seq.

Wildlife Restoration Act. 1937. 16 U.S.C. 669 et seq.

## METADATA

**Narrow River SAMP Map File Information**

Figure 1-1 Narrow River Watershed [nr11final.map]
Figure 1-2 Waterbodies of the Narrow River [1-2.map]
Figure 3-2 Waterbodies of the Narrow River [3-2.map]
Figure 3-6 Watershed Watch Monitoring Locations 1995 [stat.map]
Figure 3-12 Glacial Geology [nr41a.map]
Figure 3-15 Location of Major Roadways in the Watershed [roads.map]
Figure 5-2 Wetlands [nr52a.map]
Figure 6-1 High Flood danger Zones [nr61a.map]
Figure 9-1 Land Use Classification for Water Quality Protection in the Town of Narragansett [nknr.map]
Figure 9-2 Land Use Classification for Water Quality Protection in the Town of South Kingstown [sknr.map]
Figure 9-3 Land Use Classification for Water Quality Protection in the Town of North Kingstown [chls.map]
Figure 9-4 Rare and Endangered Species Habitat [nr91a.map]
Figure 9-5 Cultural Heritage Sites [nr92a.map]

All files listed are in UTM meters NAD 83

| | | | Figures | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CRMC File** | **DESCRIPTION** | **RIGIS File** | **1-1** | **3-2** | **3-6** | **3-12** | **3-15** | **5-2** | **6-1** | **9-1** | **9-2** | **9-3** | **9-4** | **9-5** |
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| narriv.dbd | narrow river polygon | s44bcs93.e00 | x | | | x | | x | x | | | | x | x |
| twnbd83.cdf | RI town boundary lines | s44btl88.e00 | x | | | x | | x | x | | | | x | x |
| wpsgf.dbd | west passage polygon | s44bcs93.e00 | x | | | x | | x | x | | | | x | x |
| Hydpol83.dbd | fresh water body polygons | s44hhp88.e00 | x | | | x | | x | x | | | | x | x |
| Streams83.dbd | stream polygons | s44hhl88.e00 | x | | | x | | x | x | | | | x | x |
| Narrow.dbd | narrow river watershed boundary | s44hsb90.e00 | x | x | x | x | x | x | x | | | | x | x |

Metadata Cont.

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| Wqp83.dbd | Wesquaug Pond polygon | s44hhp88.e00 | x | | | x | | x | x | | | | x | x |
| 5kw83.dbd | 5 km scale white polygons | n/a | x | x | x | x | x | x | x | | | | x | x |
| 5kb83.dbd | 5 km scale black polygons | n/a | x | x | x | x | x | x | x | | | | x | x |
| 3miW83.dbd | 3 mi scale white polygons | n/a | x | x | x | x | x | x | x | | | | x | x |
| 3miB83.dbd | 3 mi scale black polygons | n/a | x | x | x | x | x | x | x | | | | x | x |
| glac83.dbd | glacial geology polygons | s44ggl88.e00 | | | | x | | | | | | | | |
| wetq30u3.dbd | wetland polygons -Narragansett Pier | q30wwt93.e00 | | | | | | x | | | | | | |
| wetq24u3.dbd | wetland polygons -Wickford | q24wwt93.e00 | | | | | | x | | | | | | |
| sampfhz.dbd | FEMA V/A zone polygons | s44hfz90.e00 | | | | | | | x | | | | | |
| rspecu3.dbd | rare species habitat | s44nrs93.e00 | | | | | | | | | | | x | |
| histsite.dbd | historic districts | s44chd95.e00 | | | | | | | | | | | | x |
| histdist.dbd | historic sites | S44chs95.e00 | | | | | | | | | | | | x |
| cmrctown.dbd | CRMC town boundary lines | s44btl88.e00 | | | | | | | | x | x | x | | |
| nanrfnl.dbd | CRMC land use classification boundary, Narragansett | Created (URI-CRC) | | | | | | | | x | | | | |
| roads96.dbd | All roads in RI | s44trd96.e00 | | | | | | | | x | x | x | | |
| | | | | | | | | | | | | | | |

Metadata Cont.

| CRMC File | DESCRIPTION | RIGIS File | 1-1 | 3-2 | 3-6 | 3-12 | 3-15 | 5-2 | 6-1 | 9-1 | 9-2 | 9-3 | 9-4 | 9-5 |
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| streams.dbd | Centerlines of all freshwater rivers & streams | s44hhl88.e00 | x | x | x | | x | | | x | x | x | | |
| hydropol.dbd | All freshwater lakes, ponds & reservoirs | s44hhp88.e00 | x | x | x | | x | | | x | x | x | | |
| townline.dbd | City and town political boundaries | s44btl88.e00 | x | x | x | | x | | | x | x | x | | |
| sknrfnl.dbd | CRMC land use classification boundary, South Kingstown | Created (URI-CRC) | | | | | | | | | x | | | |
| riland.dbd | RI state line boundary including coastline | s44bri89.e00 | x | x | x | | x | | | | | | | |
| narrive27.dbd | Narrow River polygon | s44bcs93.e00 | x | x | x | | x | | | | | | | |
| allroads.dbd | All roads by USGS 7.5 minute quad | qnntrd94.e00 | x | x | x | | x | | | | | | | |
| nknrfnl.dbd | CRMC land use classification boundary, North Kingstown | Created (URI-CRC) | | | | | | | | | | x | | |

CRMC files are Maptitude™ geographic files converted from 1997 RIGIS ArcInfo™ *.e00 files. CRMC files are in some cases only relevant portions of the correspo
RIGIS *.e00 file. CRMC metadata available.