RHODE ISLAND DIVISION OF PLANNING

State Guide Plan Element
Report # 121

Water Quality 2035

Rhode Island Water Quality Management Plan

October 13, 2016

CRMC
Coastal Resources Management Council

Rhode Island Department of Administration
Division of Planning
One Capitol Hill
Providence, Rhode Island 02908

www.planning.ri.gov

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- prepare Guide Plan Elements for the State,
- coordinate activities of the public and private sectors within the framework of the State Guide Plan,
- assist municipal governments with planning, and
- advise the Governor and others on physical, social, and economic planning related topics.

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Abstract

TITLE: *Water Quality 2035*

SUBJECT: Protection and restoration of the quality of the water resources of the State

DATE: Adopted by the State Planning Council on October 13, 2016

AGENCY: Division of Planning
Rhode Island Department of Administration
One Capitol Hill
Providence, RI 02908 (401) 222-7901
www.planning.ri.gov

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ABSTRACT:

Water Quality 2035 updates and replaces four previous State Guide Plan Elements:

- #162 Rivers Policy and Classification Plan (2004)
- #711 Blackstone Region Water Resources Management Plan (1981)
- #715 Comprehensive Conservation and Management Plan for Narragansett Bay (1992)
- #731 Nonpoint Source Management Plan (1995) & incorporated therein by reference; RI Groundwater Protection Strategy, and Rhode Island Wellhead Protection Program.

It serves to support both the Statewide and coastal water nonpoint source management programs as required by the United States Environmental Protection Agency and the National Oceanic and Atmospheric Administration. This plan describes existing practices, programs, and activities in major water quality areas and develops recommendations specific to each. It is intended to advance the effectiveness of public and private stewardship of the State's high quality waters for the next 20 years. As an element of the State Guide Plan, this Plan sets forth goals and policies that must, under State Law, be embodied in future updates of comprehensive community plans.

State Planning Council

The Council oversees the Statewide Planning Program's work. The State Planning Council adopts goals and policies related to planning, most of which are contained within individual plans, which are elements of the State Guide Plan. The Council has been designated as a Metropolitan Planning Organization (MPO) for transportation planning purposes. The body also advises the Governor on strategic planning matters.

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- **Lisa Vura-Weis ,** Vice Chair, Governor's Office
- **Parag Agrawal**, Secretary, Division of Planning, Associate Director
- **Dr. Nicole Alexander-Scott,** Rhode Island Department of Health, Director
- **Peter Alviti,** Rhode Island Department of Transportation, Director
- **Daniel Beardsley,** Rhode Island League of Cities and Towns, Executive Director
- **Jeanne Boyle,** Rhode Island League of Cities and Towns, President's Designee
- **Janet Coit,** Rhode Island Department of Environmental Management, Director
- **Jeanne Cola,** Representative of Nonprofit Housing
- **Roy Coulombe**, Public member
- **Barbara Fields,** Executive Director, Rhode Island Housing
- **Grover Fugate**, Rhode Island Coastal Resources Management Council
- **Carol Grant,** Commissioner, Rhode Island Office of Energy Resources
- **Marcus Mitchell**, Small Business Representative
- **Thomas Mullaney,** Rhode Island Department of Administration, Budget Office
- **L. Vincent Murray,** Rhode Island League of Cities & Towns, Local Government Representative
- **Bonnie Nickerson,** City of Providence - Department of Planning and Development, Director
- **Sandy O'Connor,** Governor's Designee
- **Stefan Pryor**, Secretary of Commerce
- **M. James Riordan**, Public Member
- **Raymond Studley**, Director, RI Public Transit Authority
- **Girard R. Visconti, Esq.**, Employer with more than 50 Employees
- **Scott Wolf,** Environmental Advocate

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- **Michael DeLuca,** Vice Chair, Town of Narragansett - Community Development
- **Barbara Breslin,** Federal Highway Administration, Advisory Member
- **John Chambers,** Fuss and O'Neill
- **Steve Devine,** Rhode Island Department of Transportation
- **Ashley Sweet**, Exeter Town Planner
- **Nate Kelly**, American Planning Association RI Chapter
- **Thomas Kogut,** Rhode Island Public Utilities Commission
- **Nicole LaFontaine,** Town of North Kingstown - Planning Department
- **Eliza Lawson,** RI Department of Health
- **Lisa Primiano**, Department of Environmental Management
- **Jennifer Siciliano,** City of Woonsocket – Planning Department
- **Arnold Robinson,** Roger Williams University
- **Michael Walker,** Rhode Island Commerce Corporation
- **Jeffrey Willis,** Rhode Island Coastal Resources Management Council
- **Ronald Wolanski,** Town of Middletown

Water Quality Management Plan Advisory Committee

The development of this Element is the product of many hard-working and dedicated individuals who helped to define major issues, and set goals, policies and actions on a broad range of water quality topics. This was not an easy task. It required time, energy, patience, many long hours of deliberation, and a strong interest on a personal and a professional level to come to a consensus as a Committee. It could not have been accomplished without the following individuals who contributed numerous hours of their time and provided technical and editorial review of the Element as it developed through its various draft stages.

- **Jane Austin** Save the Bay (Formerly)
- **Eric Boettger** US Natural Resource Conservation Service
- **Thomas Borden** Narragansett Bay Estuary Program
- **Janine Burke** Warwick Sewer Authority/ Narragansett Water Pollution Control Authority
- **Ken Burke** Water Resources Board(Formerly)
- **Clay Commons** Department of Health
- **Rachel Calabro** Rivers Council/ Save the Bay
- **Jeff Ceasrine** Narragansett Town Engineer
- **Ames Colt** Bays, Rivers, Watersheds Coordination Team (Formerly)
- **David Everett** Providence Planning Department
- **Alison Hamel** Department of Transportation
- **Peter Healey** Department of Transportation
- **Meg Kerr** RI Audubon Society
- **Alicia Lehrer** Woonasquatucket Watershed Council
- **Eugenia Marks** RI Audubon Society (Retired)
- **Vincent Murray** South Kingstown Planning Department
- **Jennifer Paquet** West Greenwich Planning Department (Formerly)
- **Margherita Pryor** US Environmental Protection Agency
- **Nicole Rohr** University of Rhode Island – Coastal Institute
- **Marilyn Shellman** Westerly Town Planner
- **Judith Swift** University of Rhode Island – Coastal Institute

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Department of Administration - Division of Planning

Jared Rhodes, Chief Statewide Planning Program
Land Use & Natural Resources Unit
Nancy Hess, Supervising Planner
Paul Gonsalves, Senior Planner

Coastal Resources Management Council

Jeff Willis, Deputy Director

Department of Environmental Management – Office of Water Resources

Susan Kiernan, Deputy Chief, Office of Water Resources
Ernie Panciera, Supervising Environmental Scientist
Jon Zwarg, Senior Environmental Scientist

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Executive Summary

Rhode Island is fortunate to have abundant water resources that when properly managed can meet societal needs for drinking water, recreation and commerce while also supporting healthy aquatic ecosystems. *Water Quality 2035* describes the goals, policies and actions needed for effective management of Rhode Island's water resources. As a State Guide Plan Element, it provides direction for state program development and facilitates coordination among the many entities engaged in water quality protection and restoration actions, including municipal governments.

The Plan was developed collaboratively by the Department of Environmental Management (DEM), Coastal Resources Management Council and Department of Administration, Division of Planning. An advisory committee provided input throughout the process and this Plan benefitted from recently completed plans for management of Narragansett Bay, non-point source pollution and aquatic habitats. By drawing together and describing in one place the programs, state policies and various actions related to water quality and aquatic habitat protection and restoration, this Plan supports the objective of streamlining the number of State Guide Plan Elements.

The *Water Quality 2035* Vision is that:

> ***RI's water resources will support healthy aquatic ecosystems and meet the needs of current and future generations by protecting public health, supplying high quality drinking water, providing bountiful recreation opportunities and supporting a vibrant economy.***

> **The Plan establishes two broad goals to implement the Vision: to both protect and restore the quality of Rhode Island's waters and aquatic habitats.**

It is understood that achieving these goals will take sustained effort over the next several decades. Accordingly, the Plan identifies as priorities protection and restoration of:

- drinking water supplies
- shellfish growing area waters
- waters used for public recreation including beaches, and
- high quality aquatic habitats.

Abating degradation due to excess nutrients is an additional priority that affects many uses of our water resources. Collaboration among all levels of government and other stakeholders on water protection and restoration will be important to the future success of our collective efforts.

Part 2 describes water quality and aquatic habitat conditions in Rhode Island. It highlights the hydrologic connectivity among components of our water resources: surface waters, groundwaters and wetlands, which points to the need for watershed-based approaches to managing water quality. The Plan recognizes the significant progress that has been made through the statewide implementation of water pollution, water quality management and wetland protection programs over the last four decades. Rhode Island's waters are cleaner as a result of programs that successfully curbed the discharge of sanitary waste and industrial (toxic) pollutants from specific sources due to implementation of federal and state programs including those mandated by the federal Clean Water Act. However, managing the more diffuse sources of pollution associated with human land uses, including the generation of stormwater runoff, continues to present significant challenges. Available data indicate significant portions of Rhode Island's surface waters continue to exhibit degraded conditions. The percent of the surface waters that do not meet water quality standards designed to protect the beneficial uses of the resources include: 36 percent of coastal (estuarine) waters, 39 percent of river and stream miles and 43 percent of lake acreage in RI (mapped at 1:24,000 scale)[1].

The most prevalent pollutants adversely affecting surface water quality are pathogens and nutrients. Other pollution concerns include toxics, sedimentation and the emerging concerns about personal care and pharmaceutical products. In addition, cyanobacteria blooms in freshwaters are a growing public health and management concern. Groundwater resources are most commonly impacted by nitrate and toxic compounds, including various volatile organic compounds. In addition to the effects of pollution, aquatic habitats face significant threats from other stressors including hydro-modification including dams and water withdrawals, the spread of invasive species and fragmentation due to land development. More work is also needed to mitigate the historic alterations of many aquatic habitats. Parts 3-5 describe a five-step framework for managing water quality:

Our water resources are highly vulnerable to impacts from a changing climate, including sea level rise, warming water temperatures, changing precipitation patterns, more stormwater runoff, flooded wetlands, and increasing impacts to cold water habitats.

1. monitoring
2. assessment
3. planning
4. implementation, and
5. evaluation.

Rhode Island's current organization of programs is described in relation to this framework. Rhode Island state agencies were generally found to have sufficient legal authority to regulate sources of pollution to RI waters. Continued progress toward water quality goals requires that effective levels of compliance, including enforcement, be maintained. Rhode Island also benefits from well-established laws and programs for protecting wetland resources and coastal habitats from physical alteration. However, the stressors identified in Parts 2 and later in Part 6 continue to threaten or degrade these habitats. Actions to strengthen the framework are identified for each step in the Implementation Matrix in Part 7.

In Part 4, the Plan describes the integral roles of monitoring and assessment in effective water quality management. Collaboration around monitoring by governmental, non-governmental and academic entities exists and is reinforced by the RI Environmental Monitoring Collaborative. Guided by Clean Water Act requirements, well established programs exist to monitor and assess surface water quality, however key gaps exist with respect to certain geographic areas (e.g. Sakonnet River, certain lakes) and parameters (e.g. cyanobacteria, fish tissue contaminants). In contrast to surface waters, there has been less monitoring of groundwater quality and aquatic habitat conditions. The Plan envisions continued collaboration to reduce key data gaps as resources allow, recognizing additional investment will likely be needed.

[1] DEM, 2014

Water Quality 2035 recognizes aquatic habitat as a key component of overall water quality condition.

Rhode Island also needs to continue to develop improved tools for assessing water quality and aquatic habitat conditions. These include biological indicators which offer a more effective means of assessing water quality with respect to ecological health. In recent years, work has been undertaken to develop methods to characterize wetland condition in RI - both freshwater and saltmarshes. Key monitoring programs need to be sustained, as well as adapted in light of climate change, in order to supply resource managers with information to support decision-making. Improvements in data management systems and data synthesis capacity are needed in order to efficiently share monitoring data and optimize its use.

Part 5 provides an updated description of key planning activities that support effective water quality management. It outlines watershed planning that occurs at regional, watershed and sub-watershed levels. As described in the Plan, watershed planning will be strengthened by a renewed effort to develop watershed action plans for 27 areas of Rhode Island as mapped by the DEM. These plans are intended to integrate recommended protection and restoration actions for a given watershed area with an objective of aligning interests and resources to accelerate implementation of needed actions. The watershed plans are intended to provide value-added information for municipalities and watershed organizations, promote consistency among state, local and watershed planning efforts and build public support for priority actions. Improved sharing of information is also intended to improve and benefit infrastructure planning that occurs at the local or regional utility level for wastewater and stormwater systems. *Water 2035* further envisions the continued need for more specific plans such as the federally mandated water quality restoration plans, referred to as Total Maximum Daily Load (TMDLs) which provide the technical basis for most water quality restoration work.

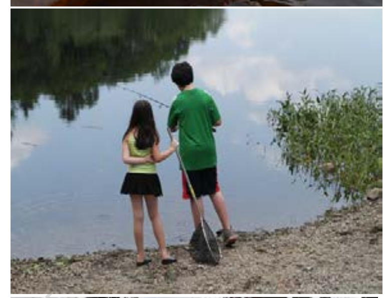
Major sources of pollution to Rhode Island waters include stormwater and wastewater discharges.

Part 6 of *Water Quality 2035* describes pollution sources and other stressors on aquatic habitats. Twenty-six pollution sources ranging in size and impact are discussed with recommended actions identified for each source in Part 7. . Discharges due to stormwater runoff are implicated in a majority of impaired surface waters and considered a widespread management challenge. Extensive retrofitting of existing urbanized areas is needed. Pollutants in stormwater runoff originate from a variety of land use activities including transportation, fertilization of lawns, agricultural practices and pet wastes among others. The planning, management and financing of stormwater infrastructure lags in comparison to wastewater infrastructure. Building capacity at both the State and local levels is needed in order to improve stormwater management and abate this pollution source. The State should use various tools to promote the broader adoption of sustainable approaches to managing stormwater, known as green infrastructure.

Abating water pollution associated with wastewater discharges will continue to be a major focus of water quality management in RI. While significant investment to upgrade public wastewater treatment facilities has successfully reduced nutrient pollutant loadings into Narragansett Bay and its tributary rivers, full restoration of water quality has not yet been achieved. Major work is continuing to address combined sewer overflows in the Providence region and Newport. Public wastewater systems have identified long-term capital needs ($1.8 billion) that far exceed the current financing capacity in programs relied upon to support such work. A major challenge going forward is to continue to ensure public wastewater systems can be properly maintained, repaired and upgraded in order to perform effectively. In addition, there are also needs in the portions of the State that rely on private on-site wastewater treatment systems including the phase out cesspools and broader use of advanced treatment where needed to achieve water quality goals.

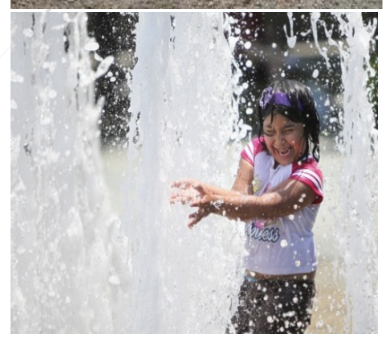
Part 7 concludes the Plan and contains the Implementation Matrix of recommended actions. Among state level water quality and habitat protection programs, there were programs identified as severely constrained or threatened by a lack of capacity such as:

- monitoring
- lake management including aquatic invasive species
- aquatic habitat restoration, and
- climate change.



While DEM and CRMC carry-out some of these activities, these topics represent areas where program development is a primary need.

This Plan also notes other important opportunities for the State to work closely with municipal governments to strengthen implementation of Rhode Island's management of water quality and aquatic habitats. These include improving coordination and integration of infrastructure planning for water supply, public and on-site wastewater disposal, and stormwater and floodplain management. In addition, fostering close alignment of comprehensive community plans with infrastructure planning will serve to facilitate sustainable economic growth. Full adoption of low impact development (LID) approaches to the design of new and re-development is needed to achieve protection and restoration of water quality and improvement in aquatic habitats. The State should expand technical assistance and training to meet the needs of municipalities charged with local implementation of many of the actions included. New strategies or approaches are needed to overcome the staffing limitations that exist in municipalities which constitute a significant barrier to the implementation of local actions.

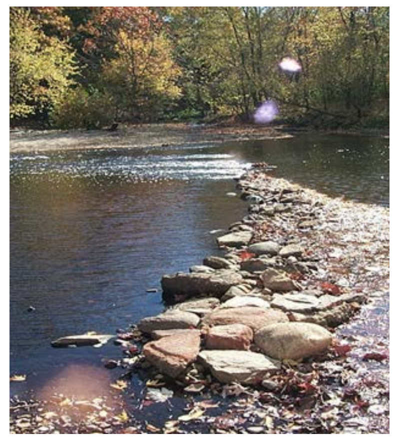


Part 1 Introduction & Vision

Key Points:

- Water is the most important natural resource to the future of RI.
- Water Quality is the sum of the physical, chemical and biological characteristics of a water resource, including its suitability as aquatic habitat.
- Achieving clean water goals requires continued efforts to prevent pollution or other degradation and to restore waters already degraded.
- *Water Quality 2035* has important linkages to other State Guide Plan Elements.
- Water quality management needs to take into account the effects of climate change, including increasing temperatures, more extreme weather events and sea level rise, on our water resources.

Introduction



In Rhode Island we are fortunate to have abundant water resources that when properly managed can meet societal needs for drinking water, recreation and commerce, and at the same time provide the foundation for healthy aquatic ecosystems. Historically, these resources were degraded by human activities such as the discharge of raw sewage and untreated industrial wastes and filling of coastal and inland wetlands. In recent decades, the quality of our water resources has been significantly improved but this progress should not be taken for granted.

This Water Quality Management Plan looks forward with a focus on the continuing need for careful management of our water resources. It sets long-range policy for the protection and restoration of water quality and aquatic habitats. The plan highlights current and emerging challenges to achieving our clean water goals. It recognizes that maintaining acceptable quality and quantities of water while balancing the needs of natural systems with human activity and development can be complex. The plan highlights opportunities to improve and adapt management in response to this challenge.

Why is Clean Water Important?

Water is essential for life. In Rhode Island the importance of clean water cannot be overemphasized – just ask those in RI and elsewhere that have had to go without water due to contaminated supplies. As stated in State Guide Plan 721, *Water 2030:*

"Water is the most important natural resource to the future of our State."

Water quality affects every RI citizen, and it is an important measure of the quality of life in RI. The mandates in place to protect water quality and habitat recognize the intrinsic ecological value provided by aquatic ecosystems that we share with other plant and animal life. We also depend on a healthy sustainable ecosystem to provide us with the clean water we need for drinking water, plentiful recreational opportunities and a range of economic activities. The many life sustaining benefits we receive from the natural functioning of aquatic ecosystems can be described as "ecosystem services." These ecosystem services are important to environmental and human health and well-being, yet they are often taken for granted[1]. With respect to clean waters, they include provision of food and drinking water, flood mitigation and control, natural filtering of pollutants, and provide recreational, aesthetic and cultural experiences among others. Improving our ability to quantify the value of ecosystem services is an active topic of research. The Environmental Protection Agency notes that considering the true value of ecosystem services within policy and decision-making could help us better manage resources in a way that benefits us economically, environmentally and socially[2]. A review of the economic values of Narragansett (RI portion only) estimated ecosystem values of $2.1 billion annually.[3] While not all ecosystem services are easily measured, consider the following information that is available regarding RI water resources:

Drinking Water -- Clean water safe for human consumption:

Both surface waters and groundwater are relied on as sources of Rhode Island's potable water supplies. Preventing degradation of drinking water supply sources helps sustain the reliable delivery of water safe to drink. Much of the water we consume requires some type of treatment before use. Whether applying to public or private supplies, the extent of treatment depends on the condition of the source water. Degraded source water costs more to treat to meet public health standards. Keeping source waters clean helps avoid added treatment costs and ensures public health. The Department of Health ensures that drinking water quality remains safe for consumption and published *Safe Water RI, Ensuring Safe Water for Rhode Island's Future*[4]. This report summarizes the impacts of climate change on drinking water utilities in the State. Other the management of drinking water utilities in the State is found in State Guide Plan RI *Water 2030*[5].

Recreation – Clean water for swimming, boating and fishing

Swimming -- Approximately one million people visit the seven state-run beaches in South County and close to 100,000 people visit state-run campgrounds annually. The total number of visitors is well over 3 million (RIDOH). Beach closures affect state revenue, related industries such as hospitality, restaurant, transportation, and lessen our quality of life.

Boating -- There were 34,772 boats registered in RI in 2014. According to the 2012 Northeast Recreational Boater Survey, Rhode Island saw a $227.2 million increase in the State's total economic output due to direct and indirect spending by boaters (equipment, repair, docking, loans, insurance, etc.). Spending by Rhode Island Boaters accounted for about 80% of that number. The total estimated year-round number of jobs related to the marine recreational industry in Rhode Island is 2,008 as of 2012, according to the Survey.

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[1] epa.gov/eco-research/ecosystem-services
[2] epa.gov/enviroatlas/ecosystem-services-enviroatlas
[3] *The Economic Value of Narragansett Bay, A Review of Economic Studies*, Pacheo, Andra and Tyrell, Timothy, URI, Department of Natural Resources Economics, 2003.
[4] http://www.health.ri.gov/publications/reports/2013EnsuringSafeWaterForRhodeIslandsFuture.pdf
[5] http://www.planning.ri.gov/

Recreational Fishing -- A total of 38,224 Rhode Island Saltwater Recreational Fishing Licenses were issued in 2011, resulting in $249,746 in total license fee revenues. Over 40,000 freshwater licenses are issued on an annual basis in RI. Residents pay $18 for a license, while out-of-state people pay $35. According to an American Sportfishing report, residents and tourists in RI spend about $38 million in total on freshwater fishing, while generating about $5.6 million in federal, state and local tax revenues.

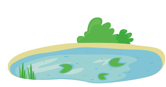
Vibrant economy – Clean water is needed for tourism, industry, commercial fishing, agriculture, and aquaculture.

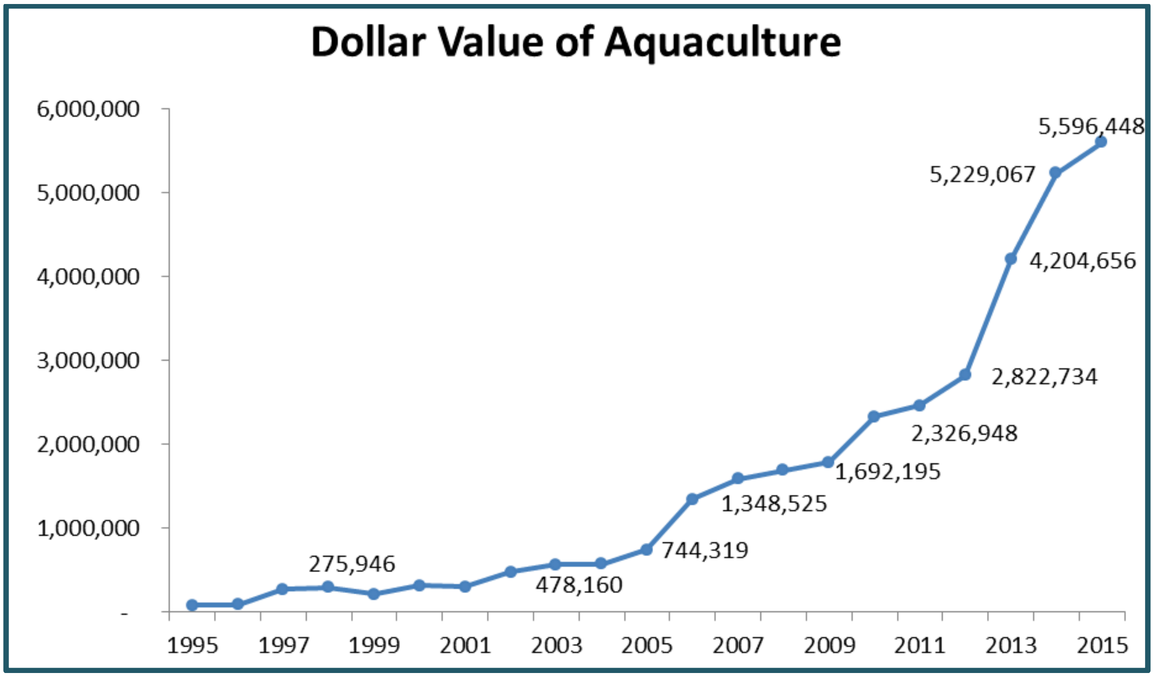
Tourism -- tourism is Rhode Island's second largest economic sector. Approximately $7 Billion is generated annually from tourism in the State. There are approximately 80,000 jobs in Rhode Island's tourism industry. Clean water draws tourists to our state to enjoy its scenic beauty and participate in water related recreational activities.

Industry – according to the 2009-2013 Bays Rivers Watershed Systems Level Plan[6], approximately 14,500 jobs and $636 million in direct wages come from industries that rely on an adequate supply of fresh water. The manufacturing firms that require intensive water use make up about 28% of the State's manufacturing wage base. It is critical that the State maintain a high quality of available water in order to effectively suit the growing sectors of biotechnology and other sciences.

Commercial Fishing and Aquaculture – The National Marine Fisheries Service (NMFS) econometric model estimates the contributions of Rhode Island landings to the State's economy for all sectors in 2010 equated to total sales of $150.4 million; total income of $106.4 million; and total employment of 4,968. Although much of this catch was in off-shore waters beyond the scope of this plan, many species depend on the inshore habitats addressed by this plan for part of their life cycle and/or feed on prey that depends on inland waters. There are 61 active aquaculture farms growing shellfish over 241 acres as of 2015 (CRMC 2015). The 2015 farm gate value of Rhode Island grown shellfish was $5,596,448 which is an increase of seven percent from the 2014 farm gate value of $5,229,067 continuing a growth trend depicted below.

[6] http://www.coordinationteam.ri.gov/documents/slpfinal.pdf





Source: Aquaculture in Rhode Island, 2015 Annual Status Report, CRMC

Agriculture - Agriculture provides numerous benefits to Rhode Island's economy, quality of life, and open space, and this industry depends on good water quality. According to DEM's Division of Agriculture, Rhode Island has 1,243 farms. Farmland includes cropland, pastures, woodland, and other land that can include streams, ponds and wetlands. The State has a growing number of farmers markets (50) and other retail venues. Findings of a University of Rhode Island agricultural economic impact study from 2012 show the 2,500 green industry businesses in Rhode Island sustain 12,300 jobs and contribute $1.7 billion annually to our State's economy.

What is "Water Quality"?

There is no "pure" water in the natural environment. All water includes natural and man-made substances that constitute its "water quality." Water quality conditions reflect what is in the water along with how much water is present. Over the years, scientific methods have been developed that allow a variety of measurements of water quality to be made through water sampling, laboratory analysis and other techniques. To interpret the resulting data, standards and criteria have been developed for many, but not all, of the parameters measured in surface waters and groundwater. For surface waters, the standards relate water quality conditions to the suitability of a water resource for particular uses such as recreation, and propagation of fish and wildlife, among others. Groundwater quality standards relate to its suitability for drinking water.

> **Water quality** is often thought of as the sum of all of the physical, chemical and biological characteristics of a given water resource.

Within this plan, the concept of water quality also encompasses the condition of aquatic habitats, including wetlands. Healthy aquatic ecosystems will have clean water and generally be free of other stressors, including hydromodification. Various methods and tools, including indices of biological integrity, can be used to assess the condition of aquatic habitats and the status of biological communities the live within them. The Monitoring and Assessment Section describes this topic in more detail.

Vision and Goals

This is the State's Plan to protect and restore the quality of Rhode Island's water resources. It encompasses freshwater and saltwater surface waters, groundwaters, and wetlands -- from inland lakes and streams to Narragansett Bay and coastal saltmarshes. The Plan sets forth a management framework with goals, policies and actions aimed at ensuring that Rhode Island's water resources supports healthy aquatic ecosystems and meet the needs of future generations. The Plan is long-range, intended to guide policy and action for the next twenty years while recognizing the need for adaptive management, especially in light of a changing climate.

Water quality is defined broadly to include the physical, chemical and biological characteristics of a water resource as well as the condition of its aquatic habitat. This is consistent with goals articulated in the 1972 Clean Water Act which articulated its principle objective as to "restore and maintain the chemical, physical and biological integrity of the Nation's waters". It further established a goal of attaining water quality sufficient to support the "protection and propagation of fish, shellfish and wildlife" as well as contact recreation – often referred to as the 'fishable-swimmable' goal[7]. Central to this Plan is a greater focus on watersheds as the appropriate basis for management of water resources. It is intended that State agencies will integrate work at the watershed scale and identify ways that such work can align with and support the related activities of municipal, regional and federal agencies, watershed organizations and other entities.

The Water Quality 2035 Vision is that:

> ***RI's water resources will support healthy aquatic ecosystems and meet the needs of current and future generations by protecting public health, supplying high quality drinking water, providing bountiful recreation opportunities and supporting a vibrant economy.***

Two goals have been established to meet the Vision:

WQ #1. Protect the existing quality of RI's waters and aquatic habitats and prevent further degradation.

WQ #2. Restore degraded waters and aquatic habitats to a condition that meets their water quality and habitat goals

Management Principles

The foundation for the Plan is a set of water quality management principles upon which the plan has been developed. These are:

- Protection and restoration are equally important to achieving RI's goals for water quality.
- Water pollution prevention whenever possible is a more cost-effective strategy than source control and restoration.
- Compliance with applicable federal, state and local regulatory programs is necessary for water quality protection and restoration.
- Watersheds are the appropriate unit for managing water quality and water resources.

[7] Adler, R. "*Returning to the Goals of the Clean Water Act*", Natural Resources Defense Council

- Water quality management is based on sound science and regularly integrates new information, including improved scientific knowledge, technological innovations and understanding of climate change principles.
- Monitoring is an essential component of water quality management effective management.
- Indicators of environmental conditions and performance, as well as analytical tools, are used to evaluate and report on progress toward water quality goals and objectives.
- Integrated, well supported data management systems are essential for water resource protection and restoration program management.
- Limited resources at all levels of government require and justify the prioritization of protection and restoration efforts.
- New technologies are adopted for use in water pollution management where beneficial.
- Stakeholders are involved in the planning and implementation of programs for water resource protection and restoration through meaningful public engagement.
- Rhode Island citizens are informed and aware of water quality management priorities and efforts to prevent and abate water pollution problems.
- All levels of government (federal, state, local), non-governmental organizations (NGOs) including watershed organizations, private entities and individuals, share in the responsibility and duty to protect and restore RI's water resources.
- State and quasi-state facilities demonstrate leadership in implementing effective water quality management practices.
- A collaborative effort is necessary across all governmental jurisdictions, agencies and programs to ensure success and efficiency in protecting and restoring RI's water resources.

Implementing the Vision will require that RI residents recognize the vulnerable nature of our water resources and aquatic habitats, and the importance of these resources to our health, the environment and the economic well-being of the State. All levels of government (local, state and federal) as well as all of RI's residents have a role to play.

Clean water is everyone's responsibility.

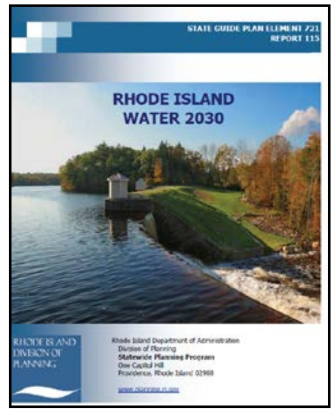
The State Guide Plan and Other Plans

This Plan is part of a tiered system of planning that supports water resource management. As an Element of the State Guide Plan (SGP), it is the intent of this Water Quality Management Plan (WQMP) to consolidate - at the statewide scale - all relevant policies and actions targeting the protection and restoration of water quality and aquatic habitat into one document. The plan provides a basis for evaluating proposals of state importance and will also help guide and inform municipal comprehensive planning – which is important given the strong link between water quality and land use. This includes drawing from the content of four existing State Guide Plan elements that had protection and restoration of water quality as a primary purpose:

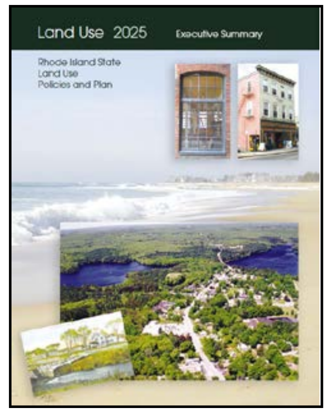
#162 Rivers Policy and Classification Plan (2004)
#711 Blackstone Region Water Resources Management Plan (1981)
#715 Comprehensive Conservation and Management Plan for Narragansett Bay (1992)
#731 Nonpoint Source Management Plan (1995) &incorporated therein by reference;
RI Groundwater Protection Strategy, and Rhode Island Wellhead Protection Program.

By creating a unified document, this Plan clarifies water quality management policy and supports the overarching goal of consolidating and simplifying the SGP as a whole. The intention is to make it easier for users, on all levels, to understand water quality topics and properly address them as appropriate within their respective authorities.

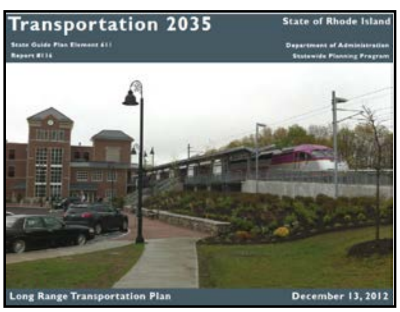
Given the issues involved in water resource management, including the relationship between land use and water quality, it is not unexpected that water topics are also addressed in several other existing SGP elements. The goals, policies, and actions in these other elements of the SGP have been reviewed to ensure consistency with the content of this Plan. While striving to minimize duplication through cross-referencing, in select cases, important water quality actions in these other plans are repeated in this Water Quality Plan and so noted.



Rhode Island Water 2030[8], SGP 721 (2012) is a Plan to ensure that the State has enough drinking water to meet its future needs. The relationship between *Water 2030* and this Plan is clear – adequate drinking water supplies depend on high quality water. Whereas this Plan will address the protection and restoration of all waters, including drinking water resources, the plan will not address issues of drinking water use, supply, availability, and infrastructure management that are covered in *Water 2030*.



Land Use 2025[9]: State Land Use Policies and Plan, SGP 121 (2006) is Rhode Island's plan for growth management and conservation in the 21st century. It is the overarching Element of the SGP combining the goals and policies of all other Elements with those for conservation and development. The impact of what happens or does not happen on the landscape is felt in the downstream waters. The development goals, policies and strategies of *Land Use 2025* impact local land use decisions, which in turn will potentially impact the water resources of the State. *Land Use 2025* recognizes the importance of water resources to the health and welfare of the State. It makes recommendations to protect water quality, to maintain the water and wastewater infrastructure and to implement a holistic planning approach at the watershed level.



Transportation 2035[10], SGP Element 611 (2012) provides goals, policies, and recommendations for the movement of both goods and people. It encompasses the highway system, public transit, transportation system management, bicycle travel, pedestrian, intermodal, and regional transportation needs. The Plan acknowledges our transportation network impacts water resources via stormwater and includes goals for managing stormwater to minimize these impacts.

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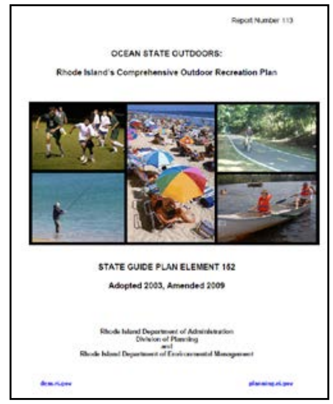
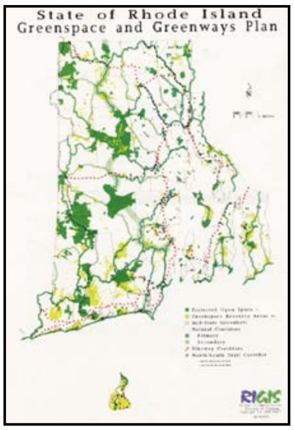
8 http://www.planning.ri.gov/documents/guide_plan/RI%20Water%202030_06.14.12_Final.pdf
9 http://www.planning.ri.gov/documents/121/landuse2025.pdf
10 http://www.planning.ri.gov/documents/trans/LRTP%202035%20-%20Final.pdf



Ocean State Outdoors[11]*:* Rhode Island's Comprehensive Outdoor Recreation Plan, SGP Element 152 (2009) sets policies and actions for providing priority recreation needs while protecting the State's open space and recreational resources. Specific policies are identified to protect water resources based upon recreation needs.



A Greener Path[12]*: Greenspace and Greenways for Rhode Island's Future,* SGP 155 (1994) sets policies and program initiatives to create a system of state and local greenspaces and greenways, including natural corridors, trails, and bikeways. It identifies that these areas have multiple values as open space, including protection of water resources.

Relationship to Other Plans

Additionally this Plan draws on other statewide agency plans or other strategies of relevance to water quality and aquatic habitat management that exist for other purposes. These include the *RI State Wildlife Action Plan* (2015) and *RI Nonpoint Source Management Program Plan* (2014) prepared by DEM and the Coastal Resources Management Program document as prepared by CRMC. The State Wildlife Action Plan includes detailed discussion and assessment of both terrestrial and aquatic habitats and wildlife species. Information and recommendations concerning aquatic habitats has been incorporated into this element. The RI Nonpoint Source Management Program Plan is a 5-year plan required by EPA. It guides program implementation and identifies specific actions that will be undertaken and identifies targeted watersheds. Other plans reviewed included: the *Systems Level Plan* of the Bays Rivers and Watersheds Coordination Team (2009)[13], the *RI Aquatic Invasive Species Management Plan* (2007) and *RI Wetland Program Core Elements Plan* (2015).

Comprehensive Conservation and Management Plan (CCMP) for Narragansett Bay - Narragansett Bay Estuary Program (NBEP)

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[11] http://www.planning.ri.gov/documents/guide_plan/scorp09.pdf
[12] http://www.planning.ri.gov/documents/guide_plan/greenways_rpt84.pdf
[13]The Systems Level Plan was developed by Rhode Island Bays, Rivers and Watersheds Coordination Team as authorized by RIGL 46-31 and adopted in 2004. In 2015, State Law was modified to repeal the mandate for the plan and eliminate the team as a state coordinating body.

More information on the NBEP and the CCP can be found at:

http://www.nbep.org/index.html

Rhode Island benefits from the designation of Narragansett Bay as one of 28 national estuary programs. The Narragansett Bay Estuary Program was established in 1987 by Section 320 of the Clean Water Act. The Program targets the bi-state watershed of Narragansett Bay and constitutes a *regional program* with involvement from both Rhode Island and Massachusetts. It is guided by a management committee with representation of both governmental and non-governmental entities engaged in the protection and restoration of Narragansett Bay. The NBEP generated the first federally required Comprehensive Conservation and Management Plan (CCMP) for Narragansett Bay in 1992. This CCMP was adopted into the SGP as a separate Element (715) in 1992 but the 1992 CCMP is now repealed by this WQMP.

In 2013, a new CCMP was issued by the NBEP. The new CCMP is not a SGP Element. It has been reviewed to foster consistency in this Plan with respect to recommendations that are applicable to RI statewide water quality policy. Relevant recommendations from the CCMP have been included in this Plan to fulfill integration between these related planning efforts and support the CCMP implementation. This will also allow the CCMP to serve its intended federal function as a regional management plan but the CCMP is no longer a SGP Element.

Water Quality 2035 contains six main parts, with supporting appendices and technical reports. Each part address a key question central to water quality management in Rhode Island. Policies to implement the Vision and Goals of the Element will appear in the text related to the topics discussed starting in Part 4. The Implementation Matrix in Part 7 contains all polices and the related actions.

Part 1 Introduction & Vision - This section provides an overview of the contents and introduces the Vision and goals of the Plan.

Part 2 Rhode Island's Water Resources & Trends - This section explains the Water Cycle, defines watersheds, and contains facts about Rhode Island's coastal and freshwater resources. It provides trends on water quality and aquatic habitat conditions and finally details the current status of Rhode Island waters by describing water quality impairments and threats.

Part 3 Water Quality Management Framework – This section describes the management approach of the Plan, details the various roles and responsibilities for water quality management and discusses setting watershed priorities. It begins to present policies to implement the goals identified in Part 1.

Part 4 Water Quality Monitoring and Assessment - This section describes what necessary environmental monitoring is needed in Rhode Island and presents and assessment of water quality and aquatic habitats along with certain polices.

Part 5 Planning This section outlines using watersheds as a basis for planning and management and the integration of planning activities to support watershed management. It presents polices for water quality management planning.

Part 6 Pollution Sources and Other Stressors on Aquatic Habitat - This section discusses overarching management issues for water quality management, various pollution sources and other stressors to aquatic habitat and presents management policies for each.

Part 7 Implementation – This Section summarizes the main issues and findings of the Plan. It presents the recommended actions for the policies discussed within the Plan in an implementation matrix.

Part 2 Rhode Island's Water Resources & Trends

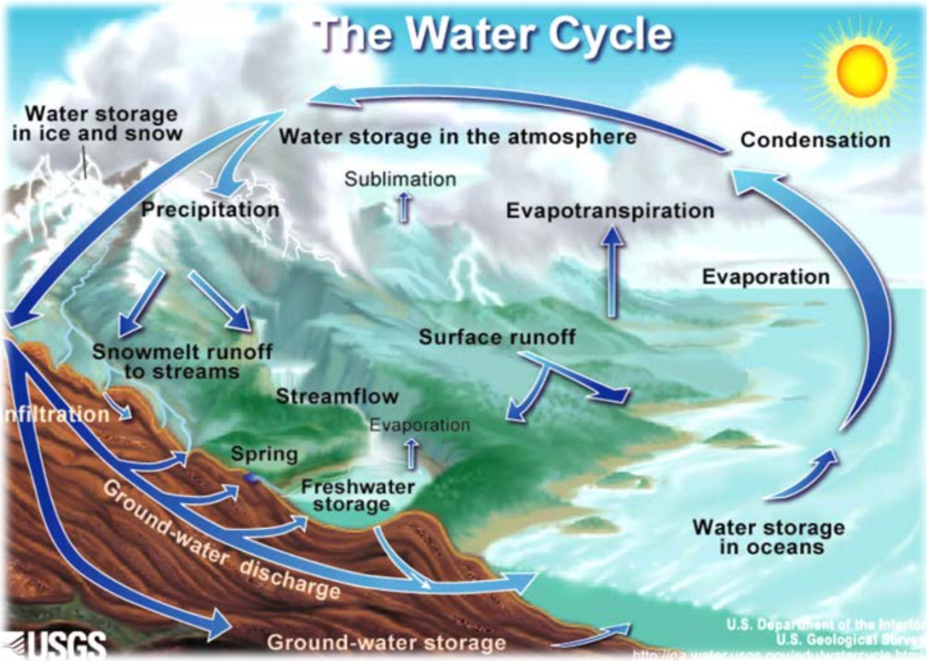
Key Points

- Every river, stream, lake or pond has a definable area within which water flows to it – the "watershed."
- Despite decades of notable progress in improving water quality conditions, a significant portion of our surface water resources still do not meet water quality standards due to pollution and other stressors.
- Greater progress has been achieved in controlling and abating the impacts of "point sources" – of pollution in comparison to dispersed "non-point" sources of pollution.
- Activities carried out on land strongly influence water quality and aquatic habitat condition.
- The two most widespread causes of documented water pollution in RI are pathogens and nutrients.
- Invasive species represent a significant threat to lakes, wetlands and coastal habitats.
- DEM's 2015 inventory of dams lists 667 dams, many of which no longer serve their original purposes such as harnessing power or supporting industrial activity. Unless removed or modified by fish passage structures, dams will continue to interfere with the free passage of various wildlife both upstream and downstream within a river system.
- Climate change is recognized as a threat to all aquatic habitats with salt and brackish marshes, coldwater streams, freshwater marshes, vernal pools among the most vulnerable.

The Water Cycle

The water resources of Rhode Island consist of rivers and streams, lakes and ponds, groundwaters, wetlands and estuarine and marine waters. Their form today was shaped by the region's geologic history including the advance and retreat of glaciers which carved bedrock and deposited layers of sediments in the creation of the landscape thousands of years ago. Our water resource features are interconnected by the continuous movement of water through our environment in a process known as the water cycle. The basic underlying principle is simple: all water is recycled. There is no new water. Small streams, fed primarily by groundwater, drain into larger streams, which in turn flow into river systems. All rivers in RI eventually empty into coastal waters. Most RI lakes are manmade – formed by impounding rivers. Freshwater wetlands exist in areas where the groundwater table is close to the surface and often in proximity with other surface waters. Coastal wetlands interact with estuarine and marine waters in the intertidal zone. Precipitation replenishes groundwater aquifers and surface water reservoirs. A recent extensive review of scientific literature reinforced the understanding that the temporary and small streams, inland wetlands and open waters within a watershed affect larger downstream waterbodies including rivers, lakes and estuaries[1].This *hydrological connectivity* reinforces the need for integrated, holistic management approaches developed on a watershed scale which will support the State's economy, protect public health, and maintain healthy natural systems.

[1] Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence (Final Report), US Environmental Protection Agency, Washington DC, EPA/600/R-14/475f, 2015



What is a Watershed?

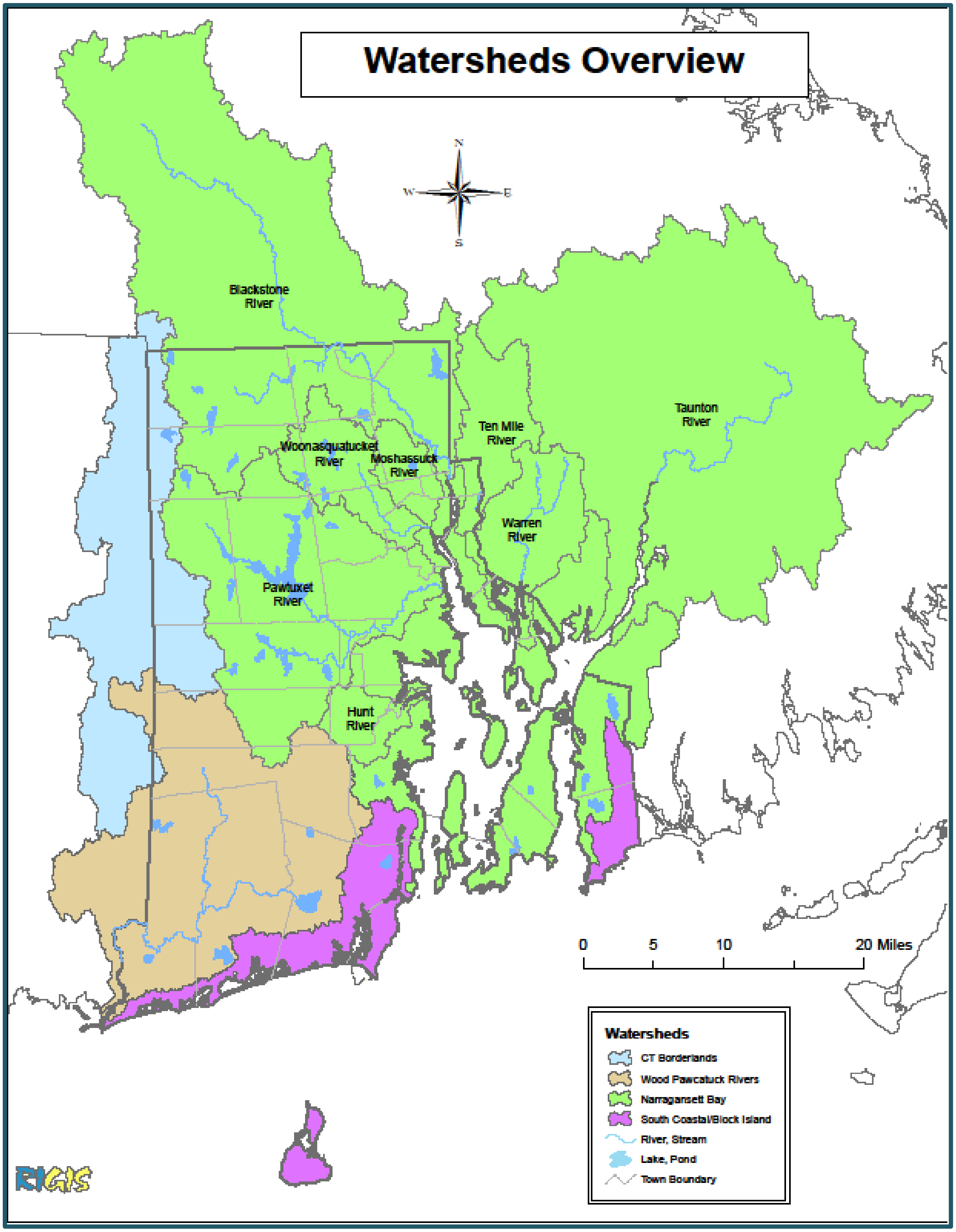
A watershed is the land surface that drains, or "sheds" water (and the pollutants in that water) to a single waterbody, such as a river, lake, coastal bay or ocean. Every body of water, no matter how large or small, has a watershed. Watershed boundaries are defined by topography and are often determined based on the management scale needed. Rarely do they correspond with state or municipal boundaries. Figure 1 shows the major watersheds in RI.

Land use and activities in the watershed landscape affect surface water and groundwater quality and quantity. Within a watershed, pollutants enter the waters in a variety of ways including through direct discharges, stormwater runoff, spills and other man-made releases, and atmospheric deposition. These pollutants move through a watershed and when present, in sufficient quantities, have the potential to adversely impact the quality of downstream water resources.

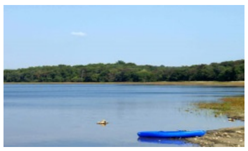
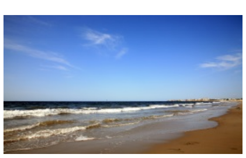
We all live in a watershed.

Figure 1, Rhode Island Watersheds, also illustrates watersheds that cross state boundaries and are shared with neighboring Massachusetts and Connecticut. These highlight the need for regional collaboration on water quality management in these areas. The sections which follow provide additional descriptions of the various components of RI's water resources.

Figure 1: Rhode Island Watersheds



Snapshot of Rhode Island Water Resources[2]

	***Freshwater Rivers and Streams:*** • About 1,400 miles of rivers and streams • 86% are small headwater streams
	***Freshwater Lakes and Ponds:*** • 20,749 acres of lakes, ponds and reservoirs and many other very small ponds • DEM estimates 75% of lakes 20 acres and larger are manmade impoundments
	***Groundwater Aquifers:*** • 22 major stratified drift aquifers covering 190 square miles • 4 federally designated sole source aquifers
	***Freshwater Wetlands:*** • An estimated 88,052 acres or approximately 12.8% of Rhode Island's land area is composed of freshwater wetlands including but not limited to swamps, marshes, bogs and fens • Forested swamps are the most abundant wetland type in RI
	***Estuarine Waters***: • 159 square miles of estuarine waters including Narragansett Bay and its sub–embayments, and Little Narragansett Bay • Coastal lagoons (salt ponds)are located along the southern RI shore and on Block Island
	***Salt Marshes:*** • About 3,800 acres of salt marsh located along RI's coastal shorelines
	***Marine Waters***: • Rhode Island Sound • Block Island Sound

[2]1:24,000, RIGIS, USFW, 2014, and RI Ecological Classification -2011, RIGIS

Coastal Water Resources

Rhode Island's *coastal waters* consist of both estuarine and marine waters. Estuaries are the transition zones from freshwater to salt water and are considered among the most productive ecosystems, creating more organic matter each year than comparably sized areas of forest, grassland or agricultural land.[3]RI *estuarine waters* provide nursery habitat for important commercial and recreational fisheries. More than 70% of Rhode Island's recreationally and commercially important finfish species depend on estuaries for a portion of their life cycle.[4]

Narragansett Bay

"Narragansett Bay is central to our identity and culture—from Battleship Cove to Beavertail, from Waterplace Park to the Newport Bridge. Our rich history of native communities and colonial settlement; our historic mill towns; our soaring bridges and waterfront parks; our fishing and sailing traditions; our boatbuilding expertise; our Naval heritage—even our recipes for quahog chowder—have all been shaped by the Bay, just as we, in turn, shape the Bay, and have done so for hundreds of years."[5]

At a glance:

- *196 square miles including Mt. Hope Bay and Sakonnet River*
- *Three main tributaries: Blackstone River, Pawtuxet River and Taunton River (MA)*
- *Average Depth: 26 feet[4]; Maximum Depth: 184 feet*
- *Supports a variety of estuarine habitat types important to biodiversity*

Narragansett Bay is Rhode Island's central geographic feature. It is a temperate, well mixed estuary. As defined in State Law, Narragansett Bay covers 196 square miles (including Mt. Hope Bay and the Sakonnet River). An estimated 147 sq. mi, delineated as the inland waters by the US Coast Guard, are characterized as estuarine and occupy 12% of the total area of the State. The remaining bay waters south of Aquidneck Island are considered marine[5]. The Bay and its watershed are shared with Massachusetts. While a large majority–(94%) of Narragansett Bay waters lie within RI, a larger portion of its watershed (approximately 60%) lies in Massachusetts. The average depth of the Bay is 26 feet while its deepest point in about 184 feet in the East Passage. The Bay receives most of its freshwater inputs from its three major tributary rivers; the Blackstone, Pawtuxet, and the Taunton Rivers in Massachusetts.

In Rhode Island, the head of Narragansett Bay forms where the Blackstone River empties into the estuarine Providence and Seekonk Rivers. Narragansett Bay connects to the ocean through three passages known as the East Passage, West Passage and Sakonnet River. The Narragansett Bay system includes many named coves and sub-embayments; the largest being Mount Hope, Greenwich Bays and the Pettasquamscutt (Narrow River) as well as several coastal ponds: Wesguge (Narragansett), Nag (Prudence Island), Prince's (Barrington) and Nannaquatucket (Tiverton). Water quality in the Bay is influenced by its circulation patterns, which are dominated by tidal mixing. Additional factors affecting circulation include winds and non-tidal currents produced by salinity and temperature gradients.

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[3]United States Environmental Protection Agency(EPA) – epa.gov/rep/basic-information-about-estuaries#whatis
[4]Meng L. & Powell, J.C., 1999
[5] Narragansett Bay Estuary Program
5 Chinman, R. and S. Nixon. 1985. Depth-Area Volume Relationships in Narragansett Bay. University of Rhode Island Technical Report 87.

Narragansett Bay is a phytoplankton-based ecosystem that is dominated by open water, or pelagic, habitat that supports a number of commercial and recreational fisheries including mackerel, herring and butterfish. The health of the pelagic habitat is tied to the bottom habitats which are essential to fish and invertebrate spawning, foraging, resting and hiding from predators. Consisting of primarily soft sediments, this benthic habitat type provides nursery habitat for commercially important finfish (winter flounder), crustaceans (lobster) and mollusks (clams). A variety of other habitats occur in and along the Bay: saltmarshes, tidal creeks and brackish marshes, rocky shores and reefs, eelgrass beds, mud and sand flats, and rocky intertidal zones. Together these support the biodiversity in the Bay.

While Narragansett Bay is RI's prominent estuary, the State's south coast is outside of the Narragansett Bay watershed and has several large estuaries. The Little Narragansett Bay portion of the Pawcatuck River, the Pettaqumascutt (Narrow) River, and the southern coastal salt ponds are separate but important estuary areas to the State.

Little Narragansett Bay and Pawcatuck River Estuary

At a glance:

- *2.1 square miles (Rhode Island portion only)*
- *Average depth: 6-7 feet*
- *Tributary: Pawcatuck River*

Little Narragansett Bay is a small estuary formed where the Pawcatuck River empties into coastal waters. The tidal portion of the Pawcatuck River separating RI and CT is estuarine. The Pawcatuck River estuary is highly stratified while Little Narragansett Bay is considered well mixed. These bodies of waters, which in combination cover about 4 square miles, are shared with Connecticut. Although much smaller than Narragansett Bay, this estuary also provides important habitat for a diversity of marine life[6].

Figure 2, Little Narragansett Bay- Pawcatuck River Estuary

[6] Dillingham, Timothy et al, "The Pawcatuck River Estuary and Little Narragansett Bay: An Interstate Management Plan", July 1992

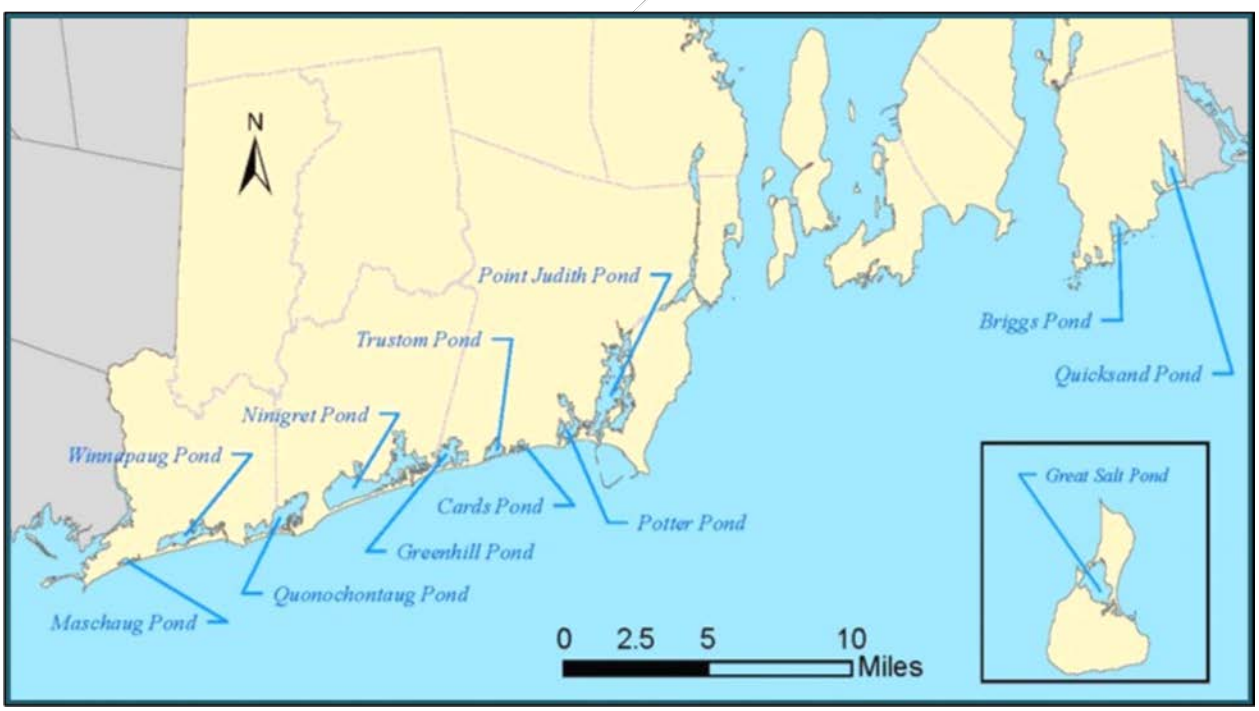
Coastal Ponds

At a glance:

- *Total of 6,583 acres*
- *Range from 43 to 1,711 acres in size*
- *Located behind coastal barriers*

Rhode Island's coastal ponds, often referred to as salt ponds, are coastal lagoons: shallow, productive marine embayments separated from the ocean by barrier spits.[7] The Coastal Resources Management Program (CRMP) has a special area management plan for the southern coastal ponds in Westerly, Charlestown, South Kingstown and Narragansett. Eleven salt ponds are located along RI's southern shore; in addition to the Great Salt Pond, found on Block Island, there are also several coastal ponds located within Narragansett Bay. Salt ponds are dynamic, forming and reforming due to coastal processes involving erosion, sediment transport and gradually rising sea levels. The ponds typically have an inlet through which water and sediment is exchanged. The expansion of commerce in the 20th century led to the construction during the 1950s of permanent breachways (inlets) to several of the ponds, which altered the salinity levels and aquatic life in the ponds. During storm events, the barrier spit separating the pond from the ocean can be overwashed. Rhode Island's coastal ponds vary in salinity from brackish to more highly saline. RI salt ponds are highly productive ecosystems that contain both intertidal and subtidal habitats including tidal marshes, eelgrass beds, oyster reefs, and soft bottom sediments. These support important fishery spawning and nursery grounds and serve as prime feeding areas of migrating waterfowl.

Figure 3, Rhode Island Coastal Salt Ponds



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[7]CRMC

Submerged Aquatic Vegetation

Submerged aquatic vegetation, specifically seagrasses, are integral to the health of shallow coastal estuaries. These flowering underwater plants have narrow leaves of ¼ wide that can grow to three feet long. Seagrasses are a critical component of marine and coastal waters. Good water quality is required to for seagrasses to survive and as a result they are susceptible to nutrient pollution and sedimentation. Unfortunately, SAV habitats are also often adversely affected by a number of anthropogenic activities: boat propellers; dredging and filling; fishing techniques such as scallop and clam dredging or toothed rakes; excessive habitat shading from docks or piers; and elevated nutrient levels that create algal blooms and high turbidity. Located in shallow waters (generally less than 2 meters at low tide), eelgrass beds exist in both Narragansett Bay and RI's coastal ponds. A characteristic plant of higher salinity waters is eelgrass (Zostera marina), while lower salinity waters support widgeon grass (Ruppia maritima) and certain other plants species. Good water quality is required to for seagrasses to survive. Seagrass beds are highly valued habitat that:

- Support large numbers of plants and animals. Bay scallops, hard clams, tautog, starfish, snails, mussels, blue crabs, and lobster are just some of the species that depend on the SAV eelgrass beds at some time during their lifecycle.
- Produce significant quantities of organic material as the base of an active food cycle.
- Stabilize bottom sediments through root structures and the baffling of waves and currents by leaves.
- Provide nutrient uptake in the leaves and roots of SAVs and associated algae.
- Superior nursery habitat for finfish and shellfish.

Researchers mapped about 1,400 acres of seagrass beds in RI coastal waters (excluding Block Island) through 2012 aerial photography interpretation and targeted field verification. A significant portion, 38%, exist in the southern coastal ponds. Surveyed periodically through aerial photography interpretation and field verification, researchers have noted an increase in seagrass acreage in Narragansett Bay of 23.6% between 2006-2012.

Salt marshes are among the most ecologically valuable habitats associated with our coastal water resources and already are facing challenges from climate change.

Salt Marshes

At a glance:

- *Cover about 3,800 acres[8]*

Salt marshes are characterized by plants that can handle regular tidal flooding by salt water and typically contain several different types of plants located in zones called upper marsh, high marsh, and low marsh. In Rhode Island, salt marshes are found along the shores of salt ponds, in the Narragansett Bay and estuarine rivers (such as the Pettaqumascutt [Narrow River] Estuary). Statewide mapping[9] in 2011 determined RI had about 3,800 acres of saltmarshes, with the majority (2,500 acres) located within Narragansett Bay.

While covering a small surface area, salt marshes are the most ecologically valuable habitats associated with our coastal water resources. They are highly productive ecosystems that provide nursery grounds and foraging habitat for hundreds of species of fish, shellfish, birds, and mammals. They are an important habitat for economically important fish, crustacean, and bird species including migratory waterfowl. In addition to their habitat value, salt marshes serve as natural pollution treatment systems by filtering out pollutants before they reach our coastal waters. The location of salt marshes helps protect coastal areas by buffering against storm surges and floods.

Nine salt marsh locations were designated in 2005 as waterfowl focus areas through a partnership of governmental and conservation organizations known as the Atlantic Coast Joint Venture. The partnership, which includes the DEM Division of Fish and Wildlife, is focused on conservation of habitat for birds in the Atlantic Flyway. The areas cited as of particular importance for conservation of waterfowl are:

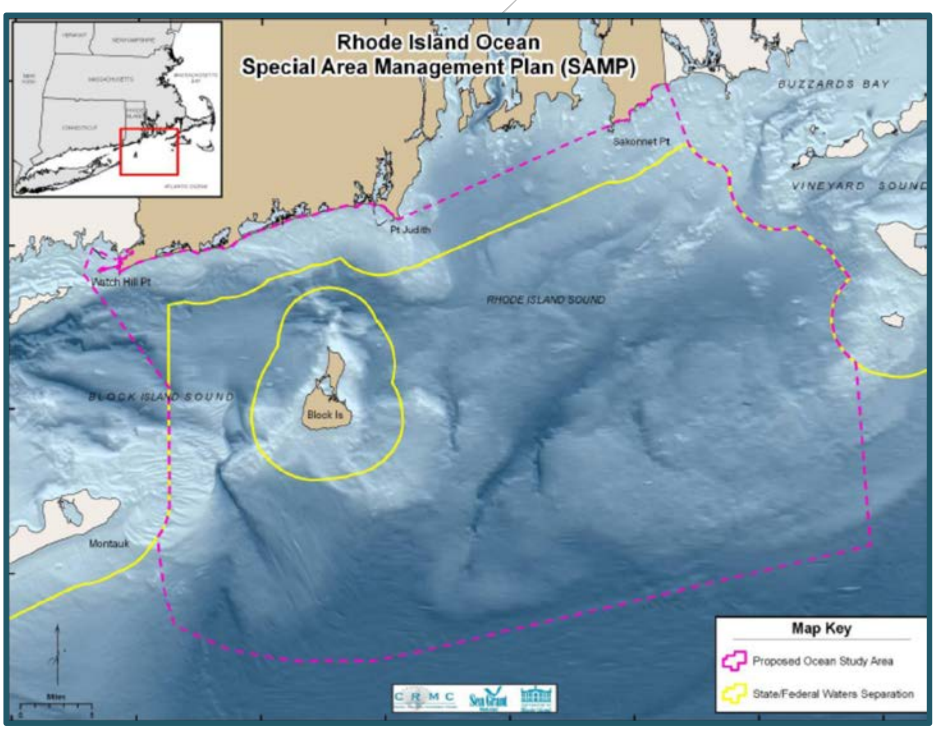
- Hundred Acre Cove (Barrington)
- Warren/Palmer River (Warren)
- Arnold Neck Salt Marsh (Warwick)
- Boyd Marsh (Portsmouth)
- Hamilton Cove (North Kingstown)
- Fogland Point Salt Marsh (Little Compton/Tiverton)
- Briggs Marsh (Little Compton)
- Pettasquamscutt Cove (South Kingstown and Narragansett)
- Dyer Island (Portsmouth) and
- the southern shore coastal ponds:
    - Winnapaug, Quonochontaug, Ninigret/Trustom, Potter, and Point Judith.

[8] RIGIS 1;24,000
[9] http://www.crmc.ri.gov/maps/maps_slamm.html

Marine Waters

Rhode Island marine waters include nearshore waters along the southern coast as well as open ocean waters of Rhode Island and Block Island Sound. DEM tracks information on about 79 miles of shoreline *marine* waters along the State's southern shore extending from Westerly to Little Compton. This area hosts major state and municipal saltwater beach facilities on the seaward side of the barrier spits that form the salt ponds discussed above. The State's jurisdiction in marine waters extends out to the three nautical mile territorial limit, where waters are then considered federal. Rhode Island's marine waters include Block Island and Rhode Island Sounds. In addition, in 2011, as part of the federal NOAA approval of the Ocean Special Area Management Plan, CRMC's jurisdiction was expanded to apply state jurisdiction to federal waters. For this purpose, an off-shore boundary, called a Geographic Location Boundary, was designated. It extends well beyond the three-mile limit and allows the CRMC to review any federal activity or project out to 30 miles off the coast of Rhode Island, including activities like the development of renewable energy through offshore wind energy development, underwater transmission cables, or LNG pipelines or terminals. More information on renewable energy is in the State Guide Plan Element, Energy 2035[10]. Habitats in marine waters have been categorized into nearshore and offshore – both of which are important to valuable commercial and recreational fisheries

Figure 4, Ocean SAMP Boundaries



10 http://www.planning.ri.gov/documents/LU/energy/energy15.pdf

Freshwater Resources

<u>Rivers and Streams</u>

Branch River (DEM Photo)

<u>At a glance:</u>

- *Total miles of rivers and streams: 1,400 (RIGIS 1;24,000)*
- *84% of total river miles are small, headwater streams*
- *Three major river basins: Blackstone, Pawtuxet, Pawcatuck*
- *Most rivers have been altered by the construction of dams*

A river or stream is a body of water that flows through a defined channel. Rhode Island has approximately 1,420 miles of freshwater rivers and streams that flow year round. Referred to as perennial rivers and streams, these consist of 452 named waterbodies along with dozens of unnamed small streams. (Figure 5, Rhode Island Freshwater Hydrology). The channel or streambed of these rivers and streams is typically below the water table allowing groundwater to be a continual source of streamflow. Two other types of streams also occur in Rhode Island: intermittent and ephemeral. Intermittent streams cease flow during certain periods; e.g. may be dry during the summer ephemeral streams are those which form temporarily in response to precipitation events. The small headwater streams in the upper parts of the watersheds constitute the origins of our larger rivers. These streams constitute 85% of RI's stream miles. The water quality and the aquatic habitat surrounding these streams strongly influences downstream water quality in the larger river sections.

The topography of RI results in most rivers and streams categorized as low gradient – meaning that they are not steeply sloped. Most are also shallow and wadeable. Rhode Island has few large rivers. Table 1, Large Rhode Island Rivers, lists the six largest rivers in RI based on their average flows. The three deepest and largest rivers – the Blackstone, Pawtuxet and Pawcatuck - drain 58% of Rhode Island's land area and have average flows well above all other RI rivers.

DEM estimates that headwater streams make up 85% of the Total River and stream miles in RI.

Figure 5, Rhode Island Freshwater Hydrology

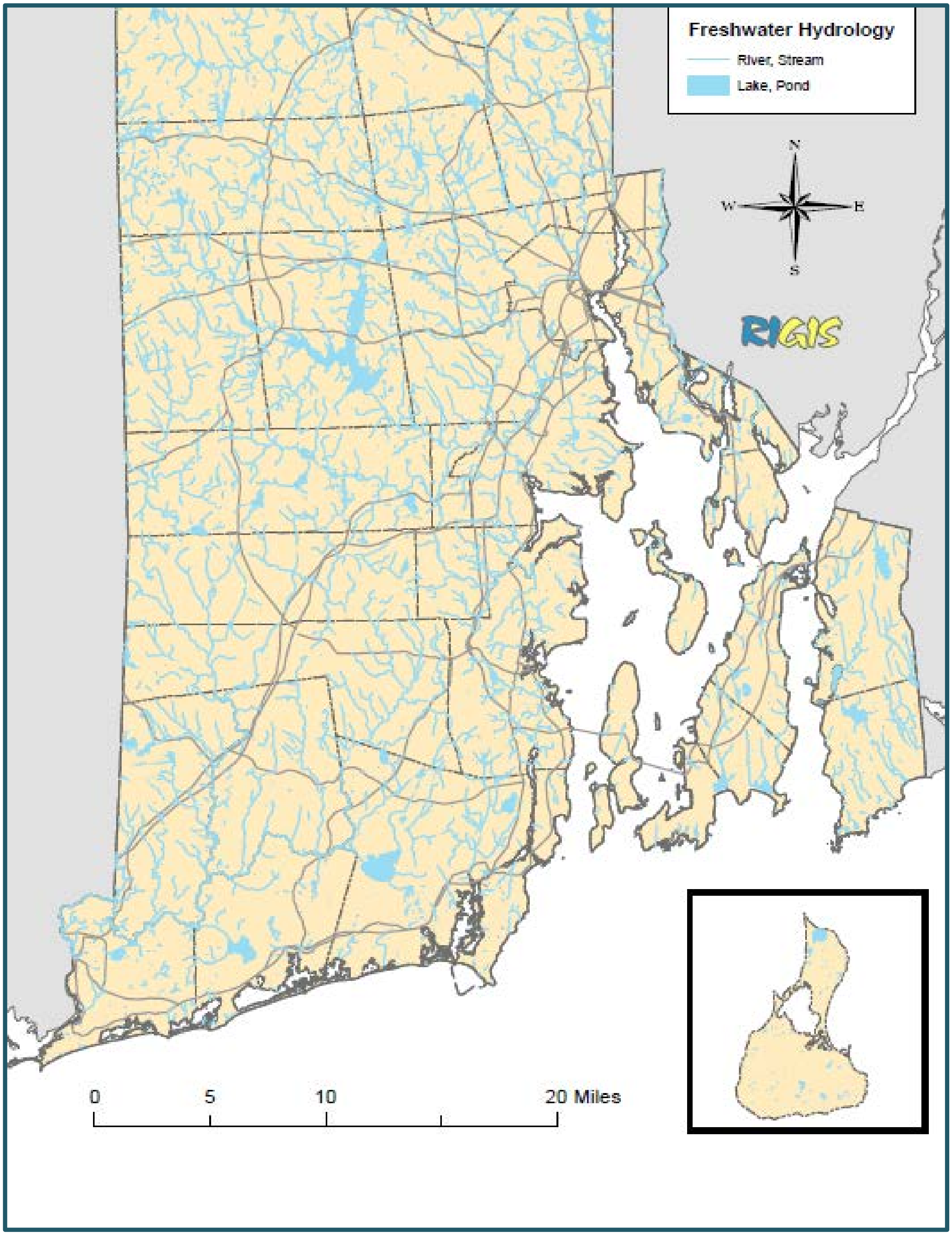
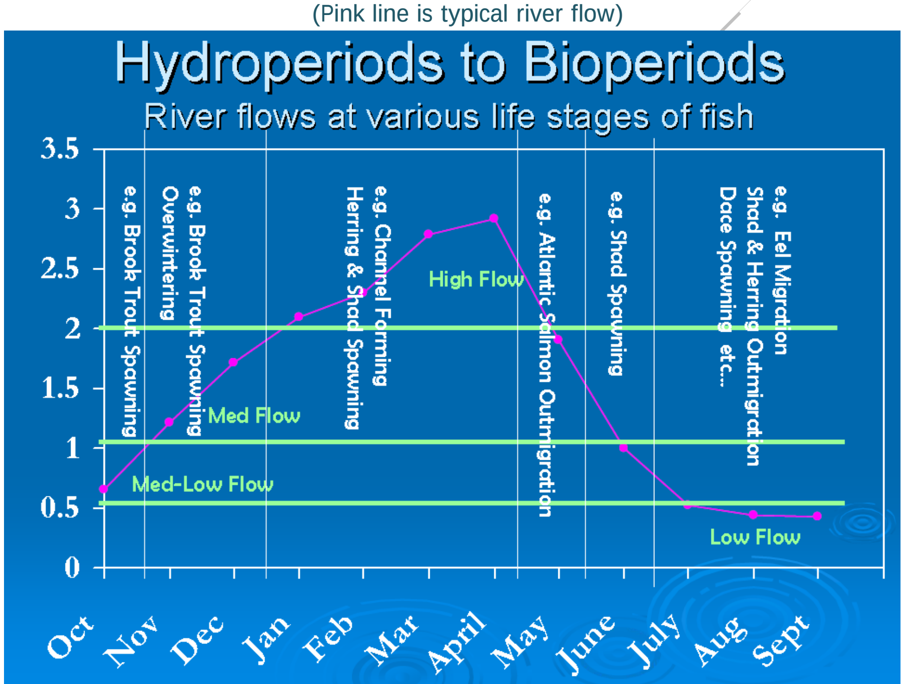


Table 1, Largest Rhode Island Freshwater Rivers[11]

River Name	Length (miles)	Average Flow (gpm)	Average Flow (MGD)
Blackstone River	48 total length (16.1 in RI)	450,176	648
Pawcatuck River	28.8	308,360	444
Pawtuxet River	28.3	155,150	223
Branch River	8.8	73,648	106
Wood River	13.8	67,410	97
Woonasquatucket River	12.5	32,448	47

Rivers function with a natural hydrologic regime that reflects flow variations throughout a year. In our State, rivers generally exhibit higher flows during spring, due to snowmelt and other precipitation, and exhibit lower flow periods during the drier summer months. Both plants and animals have adapted to this regime with certain species dependent on differing riverine flow conditions for specific parts of their life cycles. See Figure 6, Hydroperiods to Bioperiods below.

Figure 6, Hydroperiods to Bioperiods
(Pink line is typical river flow)



Rhode Island's rivers and streams provide important habitat for a large variety of animals and plants. Fish, amphibians, birds, insects, invertebrates and reptiles live in rivers or forage there for food. According to DEM, 5 freshwater and 8 anadromous fish species found in riverine habitats are identified as species of greatest conservation need in RI. The American Brook Lamprey, found only in northeast RI, is considered a state threatened species. About one-third of RI's stream miles have been formally designated as coldwater habitat suitable to support brook trout.

Rivers play a vital role in connecting natural habitats, which extends their benefit to both flora and fauna well beyond the surface area they cover. By connecting habitat both upstream and downstream, rivers can help to form corridors of natural habitat. This reinforces the need for management approaches that take into account the entire watershed area of a river and stream.

[11] Source: RIDEM, with flows derived from streamflow data, 2015

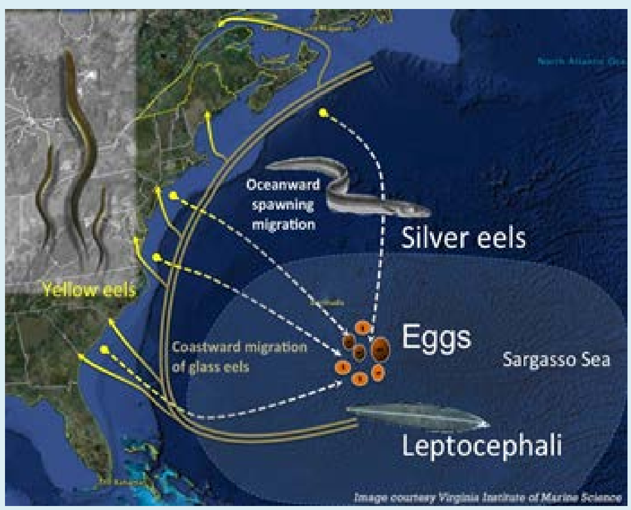
Rhode Island's rivers and streams are essential to the life cycles of certain migratory species of fish that spend portions of their lives in both fresh and salt waters. These include American eel, river herring, American shad and Atlantic salmon among others. DEM working with partners has identified watersheds considered suitable for anadromous fish restoration through improvements to fish passage. A number of projects to facilitate passage have been completed through the collaborative effort and involvement of federal agencies, watershed organization, fishing organizations and other partners. See further discussion in Part 6.

Horseshoe Falls, Pawcatuck River
Wood Pawcatuck Watershed Association Photo

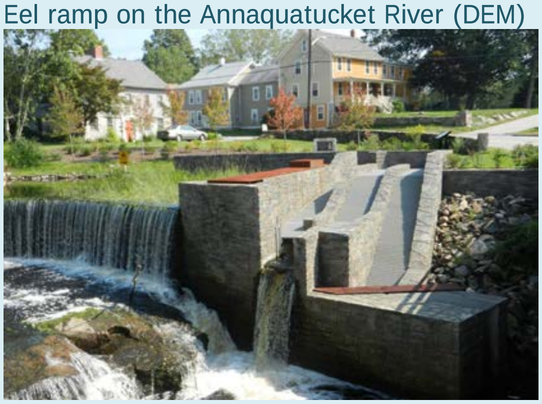
From River to the Sea and Back: American Eel Migration

(Adapted in part from "Spotlight on the American Eel" by Patrick McGee, RIDEM
And Atlantic States Marine Fisheries Commission, Special Report No. 90. Proceedings of the Workshop on American Eel Passage Technology. July 2013)

The American Eel is an often overlooked, yet interesting animal that has become the focus of widespread conservation efforts throughout the eastern Unites States, particularly here in RI. They are a valued bait fish and function as both a predator and food source within marine and freshwater habitats. While they live, forage and grow in freshwater habitats, the American Eel will migrate thousands of miles to sea to spawn. The exact locations remain a mystery to scientists, we know the life cycle begins in the Sargasso Sea in the middle of the Atlantic Ocean. Eggs spawned there develop into larva that drift on ocean currents until they are strong enough to actively swim. These tiny eels disperse into coastal rivers and estuaries where they continue to feed and grow. The eels may spend 5-30 years in freshwater riverine systems until they are ready to spawn which leads to a final migration back to the Sargasso Sea. American Eels are much less abundant than they were in the 1970's and 1980's. Stressors on eel populations include habitat fragmentation due to dams, overfishing, predation and water pollution. The DEM Division of Fish and Wildlife has installed eel ramps at a number of locations to aid juvenile eels in their upstream migration and is planning for additional ramps as part of new fish passage projects or as retrofits to existing fish ladders. Scientists have identified the need for additional research as part of a continuing process of improving the effectiveness of both upstream and downstream eel passage.

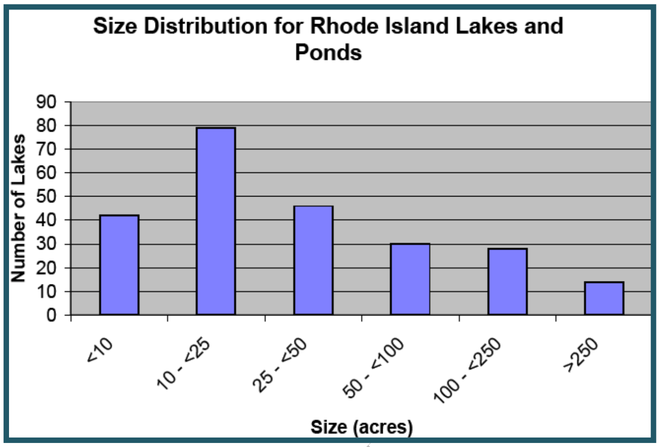


Eel ramp on the Annaquatucket River (DEM)



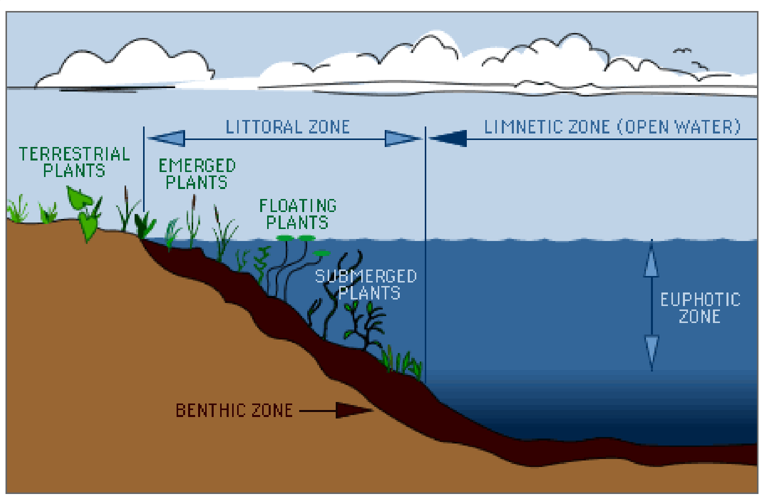
Juvenile eels (DEM)

Freshwater Lakes and Ponds



Rhode Island's landscape includes hundreds of freshwater lakes and ponds covering 20,749 acres (mapped at a 1:24000 scale excluding more than 3600 small ponds). DEM tracks 236 named lakes, ponds and reservoirs (hereafter referred to as lakes) which are widely distributed throughout the State. This number does not include small ponds which are generally less than 5 acres in size. See Figure 6, Rhode Island Freshwater Hydrology. Generally lakes are thought of as being larger than ponds, but this isn't necessarily the case in RI where historically both terms were used to name waterbodies without a clear relationship to size. From a national perspective, most of RI's lakes would be considered relatively small - 70% are 50 acres or less in size. Only 4 exceed 500 acres - Watchaug Pond, Flat River Reservoir, also known as Johnson's Pond, Worden Pond and the Scituate Reservoir. Worden's Pond is the State's largest natural pond covering 1,051 acres.

Most RI lakes and ponds are in fact man-made impoundments resulting from the construction of dams of varying sizes and types on rivers or streams. USFW reports 78.1% of Rhode Island ponds are impoundments, 11.6% are natural and 10.3% were formed by excavation. Among the 236 lakes tracked by DEM, only 25% are considered natural lakes or ponds and of these only 5 are larger than 100 acres. Rhode Island's lakes and ponds, including their shorelines, are rich habitats for fish and wildlife. They provide breeding locations, food resources, nesting sites, refuge from predators and migratory stop-over locations for numerous species. Thirty-seven freshwater fish species have been found in RI lakes[12].



The biological communities inhabiting lakes are commonly categorized into zones. As depicted to the right[13], the littoral zone is an area that supports growth of plants, including desirable macrophytes, due to penetration of sunlight to the bottom. The growth of native plants within this zone is integral to the lake ecosystem by providing food sources, a substrate for algae and invertebrates and habitat for fish and other organisms that is very different from the open water environment. Where the depth of lake is sufficient, the lake also has a limnetic zone which consists of the open water area where light does not generally penetrate all the way to the bottom but does support the growth of

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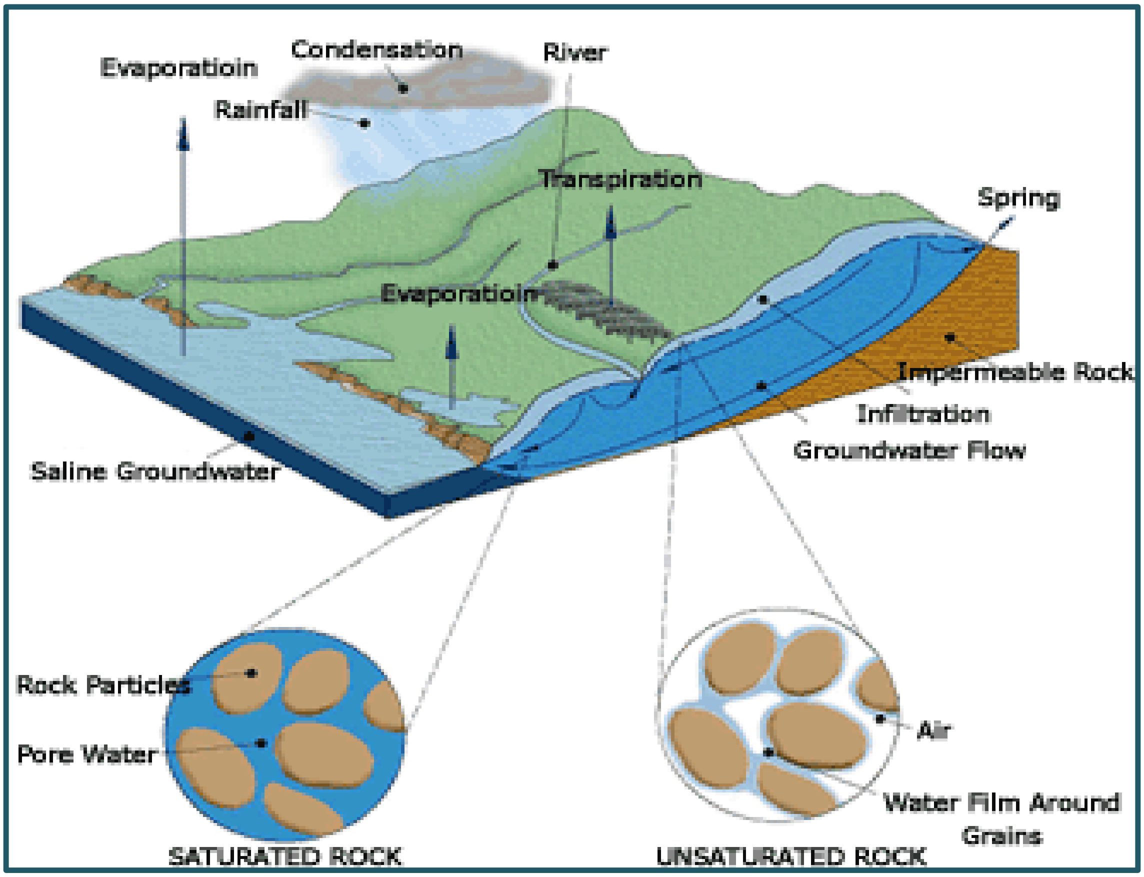
[12] Libby, Alan. Inland Fishes of Rhode Island. Rhode Island Division of Fish and Wildlife. West Kingston, RI. 2013
[13] Source: lakeaccess.org

phytoplankton. In Rhode Island, many shallow lakes support plant growth across the entirety of their bottom area which has implications for lake management including control of aquatic invasive plants.

Groundwaters

Groundwater is a locally abundant and widely used resource that supplies an estimated 26% of RI's population with drinking water through public and private wells[14]. An estimated 27 million gallons a day of groundwater are used for water supply, irrigation and other beneficial uses. Two-thirds of RI communities rely on groundwater to a significant degree for their water supply. Four aquifers have been designated as a "*sole source aquifer*" by the EPA. These are Block Island, Jamestown, the Pawcatuck River Watershed and the Hunt-Annaquatucket-Pettasquamscutt watershed. State Guide Plan 721, *Water 2030*[15] also details goals and polices for groundwater that is used for drinking water.



Subsurface geology influences the amount of groundwater that is available and the ease by which it can be extracted from the ground in a particular location. Glacial deposits of stratified drift and till overlie fractured bedrock across the State. In river valleys, glaciers deposited deep deposits of stratified drift (sands and gravels) that characteristically have large amounts of pore space that store groundwater. This type of aquifer, referred to as a stratified drift aquifer, covers about one-third of the State. The deposits range from a few feet to 100 feet or more in depth. Twenty-two major stratified drift aquifers have been mapped and are shown on Figure 7. These aquifers are the most productive groundwater resource and most support large capacity public water supply wells; e.g. wells that pump a million gallons or more per day.

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[14] (USGS)
[15] http://www.planning.ri.gov/documents/guide_plan/RI%20Water%202030_06.14.12_Final.pdf

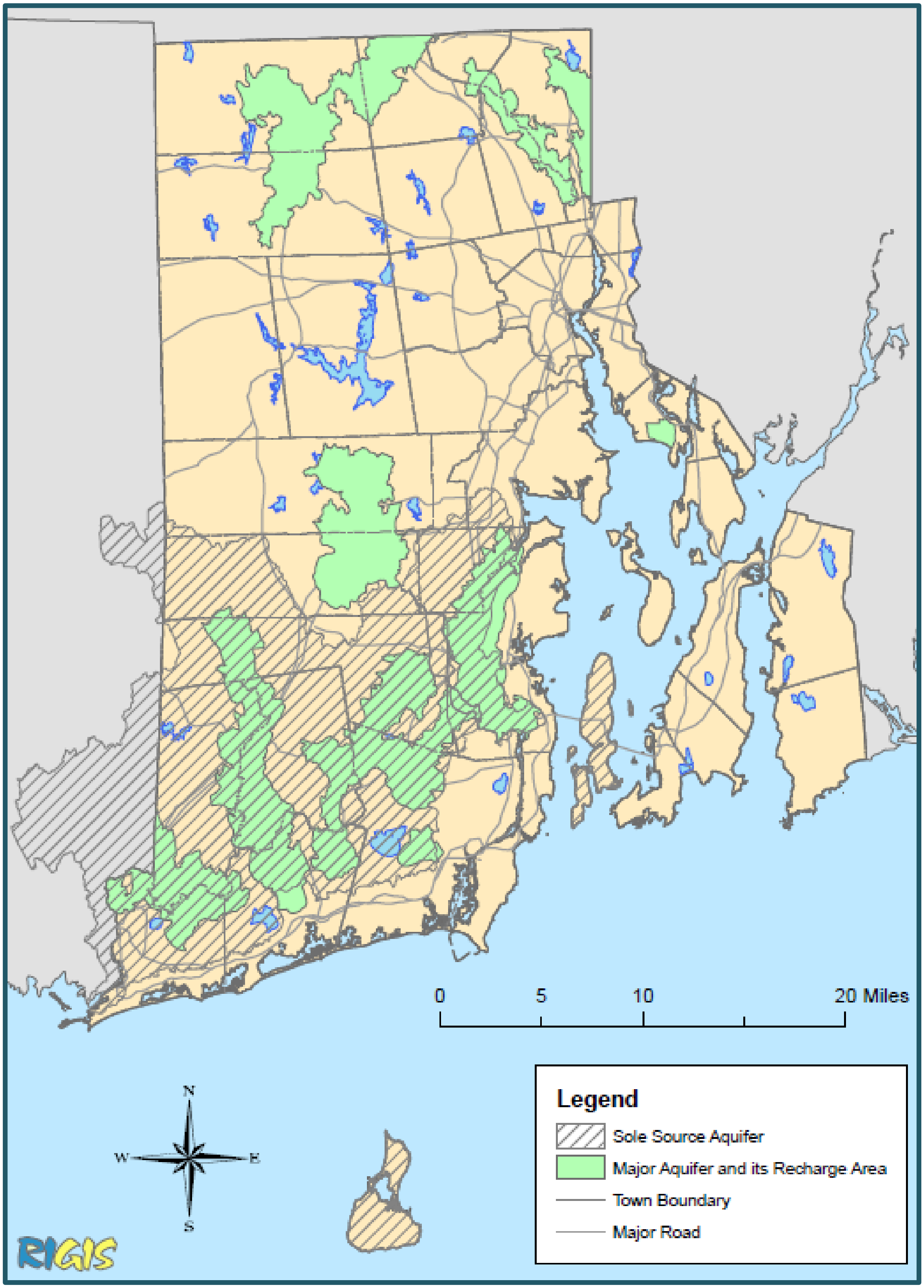
The land areas surrounding the stratified drift aquifers exhibit a different type of subsurface geology. Covering most of the State, these areas contain glacial till, which is mix of sediments and rock of varying sizes that limits the space available for storage of water. The depth of glacial till deposits to the bedrock formation varies considerably but averages twenty feet[16]. Till deposits are not a suitable water supply source and they function primarily to recharge the underlying bedrock. In a few locations along Route 1 in Southern RI and on Block Island, the till and stratified drift are mixed in a deposit formed by glacial end moraines. Bedrock underlies all of the stratified drift and till deposits. Water is stored and moves through narrow fractures in the rock. Bedrock is the most common source of water in rural areas, supplying private wells and small capacity public wells.

Groundwater in the glacial deposits generally follows topography and the pattern of surface water flows, although there can be exceptions. Groundwater movement in fractured bedrock is less well understood and less predictable. Wells that extract groundwater may also exert influence on the velocity and direction of groundwater movement. Compared with surface waters, groundwater naturally moves very slowly at rates that may be inches per day in till to feet per day in stratified drift. This has implications for managing water quality in that actions taken to reduce pollutant loadings transported by groundwater may take long periods, even decades, to achieve results.

Typical Private Well
Photo: Bing.com

[16](USGS)

Figure 7, Rhode Island Groundwater Resources



Freshwater Wetlands

The most abundant wetland type in RI is forested wetland, commonly known as Red Maple Swamp.

Freshwater wetlands are areas where water covers the soil, or is present at or near the surface of the soil for some or all of the year. Vegetated wetlands support both aquatic and terrestrial species many of which have specially adapted to the conditions present in wetlands. Wetlands often represent a transitional zone between land and water, exhibit hydric soils and a rich species diversity of plants and animals. In addition to their ecological functions, wetlands provide ecoservices with significant value to society including flood storage, protection from shoreline erosion, natural water quality improvement, natural resource products and opportunities for recreation and aesthetic appreciation[17].

The most comprehensive mapping of freshwater wetlands (RIGIS) reports 88,052 acres (excluding larger open waters habitats) which equates to 12.8% of the State's land surface area. They are widely dispersed across the landscape and vary in size and type. The most abundant freshwater wetland in RI is the forested swamp with most of that dominated by red maple. Scrub-shrub wetlands (shrub swamps) are next in abundance. Emergent wetlands (marshes), bogs and fens are much less common. Bogs were the most scarce wetland type at 96 acres statewide. The survey found 83% of freshwater wetlands are seasonally flooded, which reflects the important function they perform in temporary storage of runoff and floodwaters.

Tillinghast Pond West Greenwich
Photo: Providence Journal

[17]EPA 1995

Trends in Water Quality and Aquatic Habitat Conditions

Rhode Island's history is linked to its water resources. Rivers, once the life blood of Native Americans, became the power for grist mills of colonial settlers and later fostered the industrial revolution. With the establishment of the first mill to spin cotton using water power on the Blackstone River in the late 1700s, Rhode Island is widely acknowledged as the birthplace of the Industrial Revolution in the United States. The subsequent invention of the power loom and cotton cleaning machinery spurred a rapid expansion of the textile industry and its associated base metals and machinery industries during the 1800s that would turn portions of Rhode Island's estuaries into urban waters of national importance[18]. During this period, approximately 500 small and large mills built dams on nearly every tributary to every major river in the State[19]. The legacy of this history is that our waters have endured human impacts for over two centuries. Understanding these impacts can help shape effective management strategies for today and the future.

As our population grew, raw sewage was discharged directly into rivers or coastal waters for decades until improved treatment practices were adopted. The United States Geological Survey (USGS) noted "The damming of rivers and the historical disposal of untreated industrial, municipal and domestic wastes from industry, cities and homes made some of the rivers in New England Coastal Basins among the most contaminated in the Nation in the early 20th century." Stress on our water resources continued into the 20th century with the expansion of manufacturing in the jewelry and silver industries, continued population growth and the introduction of the automobile and the subsequent building of roads and interstate highways leading to increased urbanization.

Initial State Response to Water Pollution

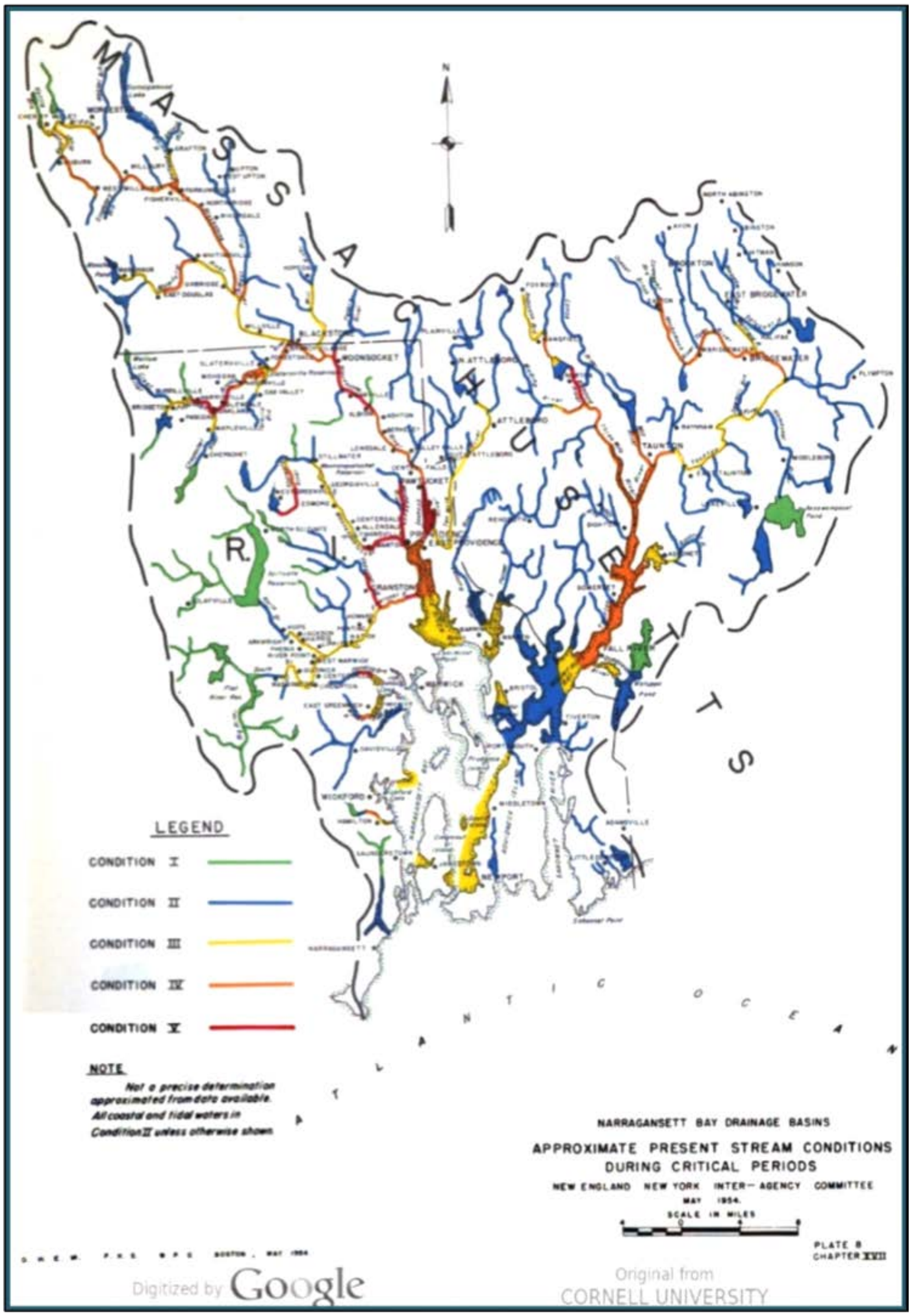
As impacts were recognized, government acted to address water pollution and improve sanitary conditions. RI has some of the oldest sewage collection systems in the Country, our first sewage treatment works were built in Woonsocket in 1897 and Providence in 1901. Rhode Island's first water pollution act was enacted in 1920. It created a Board of Purification of Waters and directed that pollution from oil, domestic sewage and manufacturing wastes be regulated. The Board became a division of the Department of Health in 1935 evolving into the Division of Water Pollution Control in 1963. A 1946 report on water pollution by the Department of Health concluded:

> "*The latest studies of the waters of the State made by the Division of Sanitary Engineering, Department of Health, indicate that with population growth and increased industrial activity, pollution has reached farther down Narragansett Bay than ever, causing extensive damage to natural resources. The war years prevented the taking of remedial measures because of governmental restrictions on the use of scarce materials for such work. This has magnified the problem to a degree which makes immediate action to abate pollution an urgent necessity.*"

The formation of the Blackstone Valley District Commission followed in 1947 with construction of centralized wastewater services to Pawtucket, Central Falls and parts of Cumberland. By 1956, when the federal water pollution control act was amended to provide some financial assistance for treatment plant construction,

[18]Nixon
[19]NBNERR

twelve wastewater treatment plants were operating but water pollution was still prevalent. A map available from 1955 (shown below) depicts the significant pollution impacts in rivers in the Narragansett Bay Watershed at that time[20]. The waters are categorized as suitable for water supplies (I and II), suitable for industrial uses (III and IV) with varying need for treatment. Category V waters were considered unsuitable for any water supply use. Many of these waters remain a focus on management attention today.



[20] New England - New York Interagency Committee (NENYIAC). 1955. The Resources of the New England - New York Region. Part Two. Chapter XVII. Narragansett Bay Drainage

Federal Clean Water Act Accelerates Water Pollution Abatement

In the 1970s, in response to environmental degradation, major federal and state environmental laws were adopted ushering in the development and expansion of the state regulatory programs aimed at water, air and hazardous waste. The federal law known as the Clean Water Act (CWA) was enacted in 1972. It set a goal the attainment of "*fishable and swimmable waters*" – something managers today continue to strive for. Section 208 of the Act resulted in a statewide planning process overseen by the Statewide Planning Program to identify sources of water pollution, determine the seriousness of the water pollution problems and identify workable means to control each type of pollution. The CWA and the resulting 208 Water Quality Management Plan approved by the State Planning Council and EPA in October 1976, laid the groundwork for future legislative actions and spurred development of RI's state water pollution control programs, including mandatory permits for point source discharges. Implementation of the CWA also led to significant investment in the modernization of wastewater treatment which in turn significantly reduced pollutant loadings discharged into our rivers and coastal waters.

Rhode Island received $284.2 million via the EPA Federal Construction Grants Program that was matched by $64.6 million in state bonds resulting in a total investment of over $348 million in wastewater treatment facility and system improvements from the mid 1970's to 1998. Between 1977 and 1980, construction of five new wastewater plants was completed and plants providing the lowest level of treatment (primary) were all upgraded to secondary treatment by 1995. This progress was documented in the 2000 Status and Trends Report of the Narragansett Bay Estuary Program which noted significant reductions in the organic waste and biochemical oxygen demand (BOD) discharged by wastewater treatment plants as a result of the upgrades to secondary treatment and improved disinfection[21].

During the 1980-1990s, there was also success in reducing the release of toxics via wastewater discharges. The implementation of industrial pretreatment programs in the early 1980s, which regulated the pollutants being discharged into sewer systems, helped to drive dramatic reductions in the discharge of toxic metals such as cadmium, copper, and nickel, and toxic organic compounds such as cyanide. As an example, The Narragansett Bay Commission has reported a 97% reduction in total metal loadings at its Field's Point WWTF, from 950,000 lbs. in 1981 to 22,924 lbs. in 2013. The reductions in turn led to lower trace metal concentrations being found in the surface sediment samples taken from the most industrially impacted area of the Bay, including the Providence and Seekonk Rivers, in 1997-1998[22].

Primary, Secondary, and Advanced Treatment

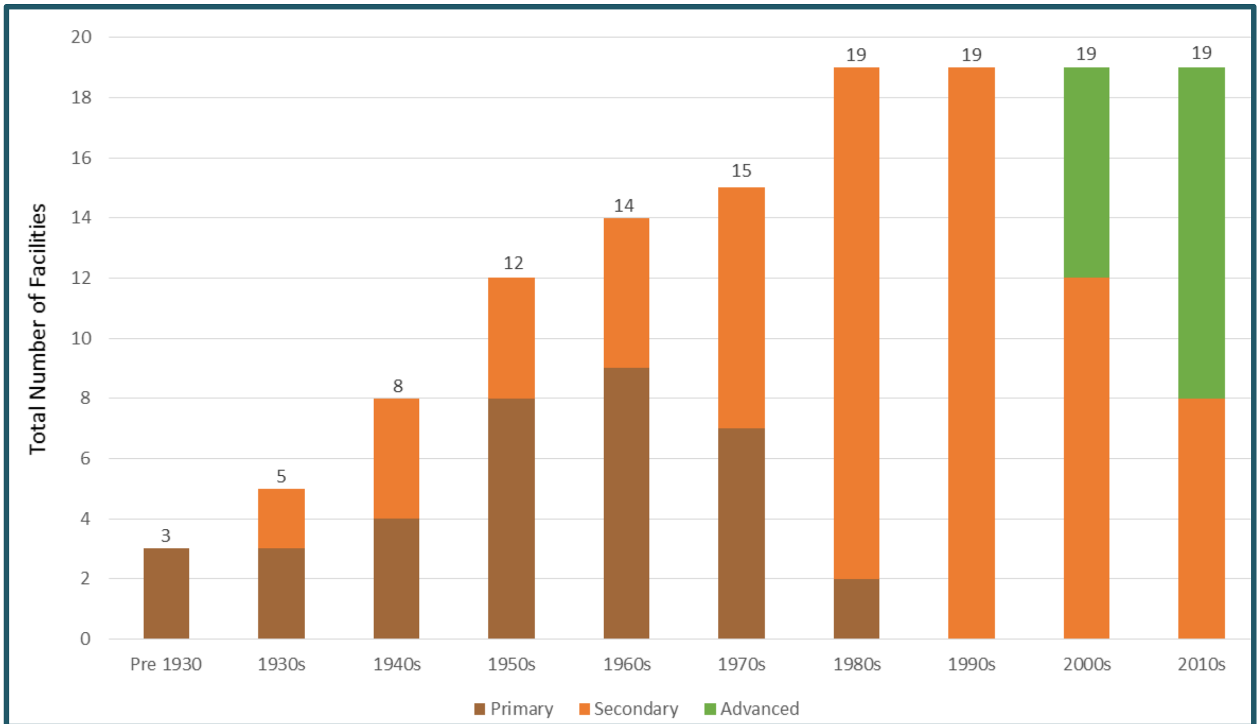
Primary Treatment is the initial stage of wastewater treatment that removes floating material and material that easily settles out.

Secondary Treatment is the second stage in most wastewater treatment systems in which bacteria consume the organic matter in wastewater. Federal regulations define secondary treatment as meeting minimum removal standards for BOD, TSS, and pH in the discharged effluents from municipal wastewater treatment facilities.

Advanced Treatment, often referred to as tertiary treatment, involves treatment levels beyond secondary treatment. This may involve various technologies to further reduce the pollutants of concern, such as nutrients.

[21] *Narragansett Water Quality: Status and Trends 2000*, DEM, Narragansett Bay Estuary Program and Narragansett Research Reserve, April 2000.
[22] Ibid

Figure 8, Trends in Level of Treatment at RI Wastewater Facilities
(Source: DEM)



Expansion of Pollution Control Regulatory Programs

In addition to Clean Water Act activities, the 1980s were a very active period of growth for other environmental protection programs that benefit water quality protection. During the 1980s, spurred by new federal and state laws, federal and state environmental regulatory programs were created or strengthened to better control sources of pollution associated with petroleum products, hazardous materials and solid and hazardous wastes. During this decade, EPA established programs established to regulate underground storage tanks, respond to UST leaks and cleanup uncontrolled hazardous waste sites, which would become commonly known as "Superfund" sites. The state RI Groundwater Protection Act was adopted in 1985 following notable instances of pollution in public and private drinking water wells. It provided needed state authority to develop a program to prevent and respond to various forms of groundwater pollution. Assisted by new EPA funding provided to the State, DEM first promulgated comprehensive rules for hazardous waste management and underground non-sanitary discharges in 1984, underground storage tanks in 1985 and above ground storage of oil in 1991. All these programs, which have evolved and been modified over time, have proven successful in abating both surface and groundwater pollution as evidenced by:

- Reduction in number of leaking underground storage tanks used to store oil and gasoline products;
- Elimination of abandoned USTs.
- Elimination of floor drains discharging into the ground at facilities with a high potential to pollute groundwater including automotive garages.
- Construction of more effective caps on closed landfills.
- Completed remediation actions at hazardous waste sites, including those designated as national priority sites under the EPA Superfund Program.
- Elimination of lead in gasoline reducing air deposition of this pollutant.

Growing awareness and experience with the costs of cleaning up contaminated land and water also led to creation of pollution prevention programs. DEM established its program in 1987 to assist business and industry in their efforts to eliminate or reduce their use of hazardous or toxic materials. The URI Center for Pollution Prevention was established in 1988 and continues to provide technical support to all phases of the DEM program and others engaged in "P2" efforts. At the federal level, in 1990 Congress adopted the Pollution Prevention Act. This law established as national policy that "pollution should be prevented or reduced at the source whenever feasible" and led to federal funding supporting further development of state P2 programs. DEM, in collaboration with URI, performed more than 250 on-site assessments of RI manufacturing facilities which led to process changes and other actions that eliminated more than 55 million gallons of industrial waste and wastewater from being generated. (See also Part 6, Wastewater Infrastructure Financing.)

Recognition of the Need for Watershed Based Approaches

In 1987, the CWA was amended to provide funding for states to develop non-point source pollution management programs. This important change reflected growing recognition that degraded water quality conditions in many waterbodies are cumulatively affected by numerous and diffuse sources of pollution that are distributed across the landscape such as on-site wastewater systems, soil erosion and stormwater runoff. Rhode Island developed its first Non-point Source Pollution Program Plan in 1995 (State Guide Plan Element 731) which laid out the need to involve partners and plan and carry out work on a watershed scale. The plan was approved by the State Planning Council and EPA. During the same period, CRMC developed the RI Coastal Nonpoint Pollution Control Program as a component of its overall coastal zone management program. This plan, required by Section 6217 of the 1990 Coastal Zone Management Act, was approved by NOAA in 2000.

Other key program developments reflecting watershed-based approaches to management included during this time included the establishment of the regional Narragansett Bay Estuary Program, the launch of the Greenwich Bay initiative and the development of Special Area Management Plans within the CRMC coastal management program. In addition, DEM water quality restoration planning evolved into the TMDL program and development of water quality restoration plans, known as TMDLs, the first of which was approved in 1999. Details on these programs are described in Part 3, Water Quality Management Framework.

Major Investment in Pollution Controls – Wastewater Treatment Plants

Throughout the last twenty years, state environmental programs have continued to evolve and adapt to new understanding of the nature of stressors to water quality. Wastewater permits have been refined to reflect water quality based effluent limitations derived from technical analysis and modeling rather than minimum technology requirements. This led to major investment in WWTF improvements which came to fruition between 2005 and 2014. Areas of focus have included further reductions in nutrient pollutant loadings from WWTFs and abatement of combined sewer overflows (CSOs).

The three major WWTFs discharging to the Pawtuxet River (Warwick, West Warwick and Cranston) were among the first in Rhode Island to move to advanced treatment to remove nutrients – both phosphorus to protect the river and nitrogen to protect downstream coastal waters. Revised permits issued in 1989 compelled WWTF upgrades to reduce discharges of ammonia and organic material. Construction was completed by 2006 and all three WWTFs have achieved compliance with their current effluent limits. Subsequent monitoring during the expected worst condition period found that dissolved oxygen in the Pawtuxet River had been restored to acceptable levels.

Aware of evidence of hypoxia in the Providence River due to various scientific studies and reflecting a national trend in estuarine management, in the mid-1990s DEM began focusing on reducing WWTF loadings of nitrogen in order to abate persistent hypoxic conditions in the upper Bay. As WWTFs designed upgrades for other purposes, nutrient reduction was incorporated. A major fish kill in Greenwich Bay in 2003[23] drew major public attention to the issue of bay eutrophication. In 2004, on the basis of recommendations from the Governor's Commission on Narragansett Bay and its watershed, the General Assembly established a goal of achieving a 50% reduction in seasonal summer nitrogen pollutant loadings from Rhode Island's WWTFs. Building on work already underway, in 2005 DEM released a nutrient reduction plan that targeted eleven RI WWTFs to achieve a 50% reduction in the summer seasonal nitrogen loadings into upper Narragansett Bay over levels from 1995-1996. The plan reflected an adaptive management approach to nutrient controls that phased in the necessary nutrient reductions and allows for continued monitoring and re-assessment of the need for further reductions. Revised permits with effluent limits ranging from 5-8 mg/l of total nitrogen were issued and WWTF upgrades proceeded. Work was largely completed by the end of 2014 with some continuing construction scheduled for completion in 2017. In addition to reductions in RI, several WWTFs in Massachusetts which discharge upstream of RI waters have been required by the EPA to reduce nutrient pollutant loadings. The largest of these, the Upper Blackstone Water Pollutant Abatement District WWTF serving the Worcester metropolitan region, achieved its limit of 5 mg/l in 2011. See Part 6, Wastewater Treatment Facilities for discussion of more current activities.


Newport Wastewater Treatment Facility

[23] *The Greenwich Bay Fish Kill August 2003: Causes, Impacts and Responses* http://www.dem.ri.gov/pubs/fishkill.pdf

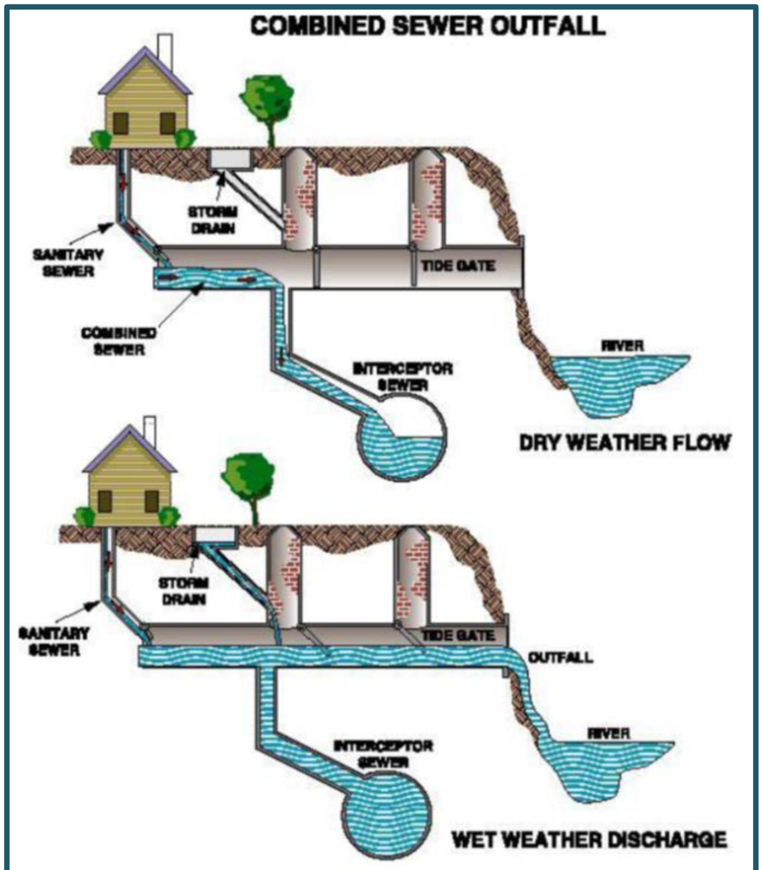
Greenwich Bay Fish Kill 2003

Source: "The Greenwich Bay Fish Kill – August 2003, Causes, Impacts and Responses", RIDEM, September 2003

On August 20, 2003, a fish kill had occurred in the vicinity of Greenwich Bay Marina. The kill consisted of mostly small juvenile menhaden, but many hundred(s) of small crabs, an occasional larger blue crab, grass shrimp, a few blackfish, some horseshoe crabs, and some American Eels were also observed along the shore or floating at the surface. The menhaden which washed up appeared intact. The eels appeared to be the largest animals affected. Along the western shore of the Bay, many noted a rotten egg smell associated with hydrogen sulfide being produced by sediment chemistry and bacterial processes.

The fish kill was caused by the absence of dissolved oxygen (anoxia) in the waters of Greenwich Bay, particularly in its deeper waters and near its western shore. The condition caused fish and other marine animals living in these areas of the bay to suffocate. Readings from a monitoring station set up in June 2003 at a Greenwich Bay Marina dock, at the mouth of Apponaug Cove, showed dissolved oxygen levels had dropped to zero in that area. This event was part of a much larger event involving blooms and low oxygen levels in a larger area of Narragansett Bay that extended from well before to well after August 20. Multiple factors influenced the formation of this low oxygen event including excessive nutrient loadings and climatic conditions (precipitation, temperature, winds). Significant rainstorms had occurred triggering a significant bloom in the shallow bay, itself followed by a gradual and then very rapid decline in dissolved oxygen. The nutrient loading was attributable to multiple sources including the wastewater treatment plant, on-site wastewater systems and stormwater runoff.

Combined Sewer Overflows (CSO):



During significant rain events excessive amounts of rain water can enter a sanitary sewer system. The capacity of the sanitary sewer is exceeded and the excess flow, which is a mixture of sewage and rain water, is discharged into receiving waters untreated. This overflow is referred to as a Combined Sewer Overflow or CSO. Addressing CSO is a complex issue. The problem is that there are connections from catch basins, roof drains, yard drains, sump pumps, etc. that collect rainwater or ground water that are connected to the sanitary sewer system rather than a storm drain system or discharged into the ground. The primary sources of bacteria in the Providence and Seekonk Rivers and Upper Narragansett Bay are from CSOs. There are 86 CSO outfalls known to discharge into the Providence River and its tributaries. CSOs also degrade water quality in Newport Harbor from the Newport system and Mt. Hope Bay (from Fall River, MA.).

Narragansett Bay Commission (NBC)

NBC has been implementing a three phase CSO control plan. NBC established a goal of reducing annual CSO volumes by 98% and achieving an 80% reduction in shellfish bed closures. Phase 1 and 2 of the CSO Abatement strategy have been completed. Phase 1, **which cost $375 million**, entailed construction of a bedrock storage tunnel with 66 million gallons of capacity under the City of Providence, two stub tunnels and a major facility upgrade of the Bucklin Point WWTF. The Phase I bedrock storage tunnel became operational in late fall 2008. On average, the tunnel captures over 900,000 gallons per year and directs that flow for treatment to the Fields Point WWTF. As a result, DEM has been able to raise the rainfall amount that triggers the closure of shellfishing in the upper bay region and thereby allow for more open days of shellfishing. Completed in December 2014, Phase II, **costing $213 million**, included construction of two near-surface interceptors, one to receive overflows along the Woonasquatucket River and one to receive overflows along the Seekonk River. Phase II also entailed construction of sewer separations for the CSO located on the Seekonk River and the CSO located on the Moshassuck River, and construction of a wetlands facility in Central Falls. Phase III is discussed in Part 6 under Wastewater Discharges to Surface Waters and Collections Systems (Sewers).

City of Newport

Newport has two outfalls where CSO's occur from facilities on Wellington Ave and Washington Street. The Wellington Avenue and Washington Street Facilities both currently provide treatment to any CSO that occurs. Treatment includes screening to collect solids and floatables from flow that enters the facilities. The facilities also provide storage which prevents some overflows from occurring. Any flow that is discharged into Newport Harbor is disinfected with chlorine. Upgrades to the process are being planned and are described in Section 6.

Urbanization, Impervious Cover, and Stormwater Runoff

Impervious cover refers to any man-made surface (e.g., asphalt, concrete, rooftops and compacted soil) that water cannot infiltrate and therefore generates stormwater runoff when it rains.

Another long-term water quality trend in New England noted by USGS and other researchers has been the degradation of rivers and streams due to urbanization[24]. One way this relationship between urban land uses and water quality is evaluated is by measuring the extent of impervious cover in a watershed. Impervious cover is used as an indicator of the intensity of land development and has been scientifically linked to adverse impacts on surface water quality. The negative impacts result from both the pollutant loadings transported by stormwater runoff and the physical changes that occur with increased volumes and velocities of runoff; e.g. eroded stream channels and reduced biodiversity of existing streams. Because water runs more rapidly off of an impervious area, flooding also becomes both more common and more intense downstream. Meanwhile, because less water is soaking into the ground, water tables may be altered with potential impacts to wetlands, streams and wells fed by groundwater.

The Center for Watershed Protection developed the "Impervious Cover Model" which has been supported by over 200 scientific and technical studies. This Model is based on the average percentages of impervious cover at which stream quality declines, and classifies those impacts into three categories:

- Sensitive streams-watersheds that are below a 10% impervious cover. Impacts are generally minor and the water quality and habitat is good to excellent.
- Impacted streams - watersheds between 10 and 25% impervious cover. Impacts to water quality and habitat.
- Non-supporting streams - watersheds with over 25% impervious cover. Impacts are severe water quality and habitat degradation. The impacts are so significant that they are not considered suitable for restoration.

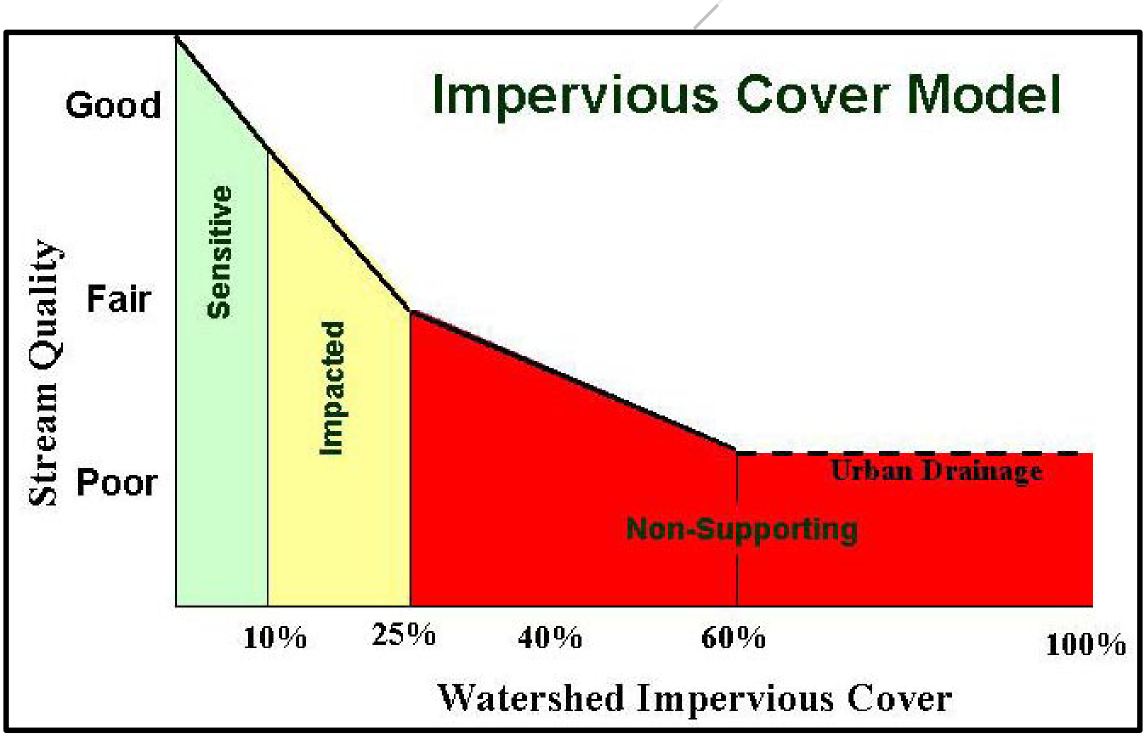
These ranges are part of a continuum, and there can be variation between individual streams. The model is most reliable when impervious cover exceeds 10%. In watersheds below 10%, water quality and habitat can be still be degraded, in fact recent studies by the Center, have shown water quality degradation at levels above 5% impervious cover.

Over the last fifty years, the extent of impervious cover in RI has increased as a result of development during this period. Based on data from 2011, RI has a statewide average impervious cover (IC) of 13%. As a general assessment in support of its Nonpoint Source Pollution Management Program, DEM estimated the percent of impervious cover for watershed lands in RI as grouped into watershed planning areas as described in Part 4. The results reveal that IC in just over half the State (51.1%) was below the 10% threshold reflecting both the need and the opportunity to manage future growth to prevent future degradation. The majority of these watersheds lie outside of the Urban Services Boundary (USB)

[24] Coles, James F. et al, "The Effects of Urbanization on the Biological, Physical and Chemical Characteristics of Coastal New England Streams". Professional Paper 1695. United States Geological Survey. 2004

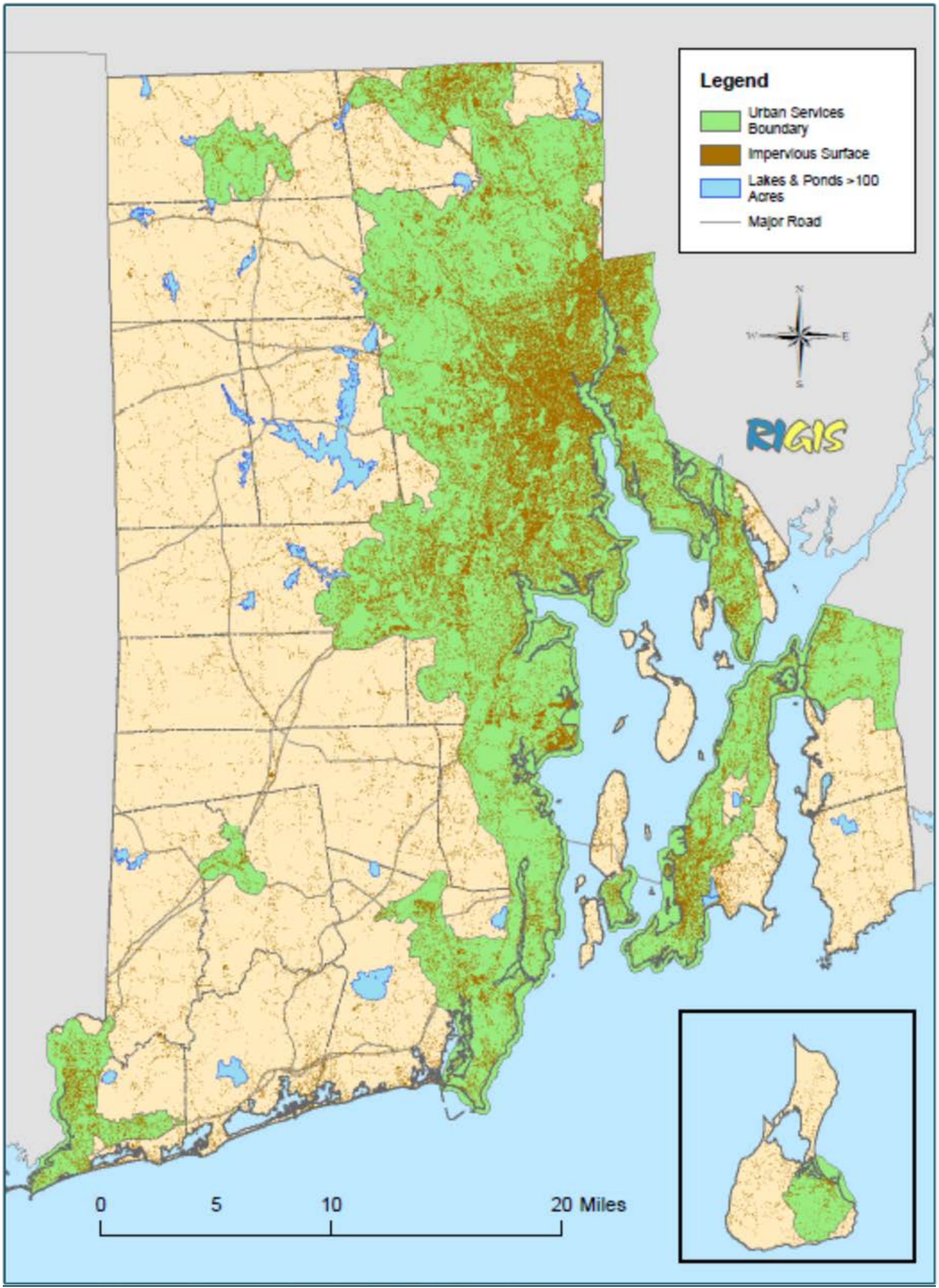
from the Future Land Use Map of SGP 121, *Land Use 2025*[25]. (See Figure 9, LU 2025 Urban Services Boundary and Impervious Surfaces.) In another 40.3% of the State land area, the IC % fell above 10% and below 25%. The most heavily developed watershed lands with IC levels greater than 25% constituted 8.6% of the state. These very urbanized watersheds had higher percentage of stream miles with documented water quality impairments indicating a need for sustained restoration efforts, although data gaps limit a full comparison among watersheds. These urbanized area largely fall within the designated urban services boundary or growth centers.

Rhode Island biological data collected from rivers and streams is generally consistent with the IC model revealing a higher percentage of rivers and streams within the urbanized watersheds having been found to have more water quality impairments than those in more rural watersheds. This has implications for the prevention and restoration goals that will be pursued on a watershed basis. Those areas already above 25% present challenges with respect to water quality restoration and will require a sustained effort to retrofit the existing landscape over time to abate the pollution stemming from urban runoff. In contrast, the graph below shows how the emphasis in watersheds with low percentages of impervious cover can prevent pollution problems from developing by using smart growth land use principles, planned growth and low impact development (LID) practices.



[25] http://www.planning.ri.gov/documents/LU/Finalsland_LU2025.jpg

Figure 9, LU 2025 Urban Services Boundary and Impervious Surfaces



Habitat Protection and Restoration

Rhode Island's historic population growth and resulting built environment has resulted in the physical destruction and degradation of aquatic habitats including significant loss of freshwater and coastal wetlands. Prior to regulation initiated in the 1970s, many wetlands were filled, ditched or drained. Researchers estimate that extensive areas of salt marsh along the coastal United States were either outright destroyed or otherwise degraded by humans dating back to colonial times. In RI, it is estimated that 53% of previously existing salt marsh acreage in RI has been lost[26]. Downtown Providence was once known as the Great Salt Cove, prior to filling and conversion to uplands. Salt marshes have also been altered, by partial filling, ditching and construction of road and rail crossings. Mosquito ditches are very straight, narrow channels that were dug to drain the upper reaches of salt marshes. Historically, it was believed that ditching marshes would control populations of mosquitoes that breed there. It is now known that ditching, in fact, drains standing water which support populations of mosquito-eating fish (*e.g.*, killifish), leading to increases in mosquitoes.

Similarly, it has been estimated that 37% or more of freshwater wetlands have been historically lost to physical alteration (Dahl, 1990). Significant physical alteration of the upland buffers to both coastal and freshwater wetlands has occurred as well. Some 30% of Narragansett Bay's marshes have inadequate or non-existent buffer zones. The various physical disturbances in salt marshes and freshwater wetlands can lead to changes which leave areas vulnerable to invasive species, in particular *Phragmites* which out-competes native salt marsh vegetation, and reduces local biodiversity. Some 1200 of the existing 3700 acres of salt marsh in Narragansett Bay are impacted by *Phragmites* and other invasive plant species[27]. While physical disturbances to wetlands are minimized through regulatory programs, sea level rise according to CRMC is now a significant threat to coastal wetlands.

Water pollution also contributes to the loss of habitat. In particular, the historic range of eelgrass beds has diminished – a situation attributed in part to degraded water clarity which inhibits passage of light needed for eelgrass to survive. Water pollution also affects wetlands through stormwater discharges which may deposit sediment, nutrients and other pollutants into the wetland. Approximately 58% of Narragansett Bay's marshes are impacted by polluted runoff. DEM monitoring of freshwater wetlands found 107 of 164 wetland areas assessed documented stormwater discharges delivering pollutants such as nutrients, sediment, and salt, among others into the wetland.

As with water quality, programs to protect, manage and restore aquatic habitats have evolved over time. From initial mandates related to management of game species, programs evolved to include attention on non-game species, rare species and biodiversity. This led to development of the Natural Heritage Program which aimed to inventory and protect rare and threatened plant and animal species. Rhode Island also adopted a strong Freshwater Wetlands Act (1972) which has served to limit the loss of wetlands by requiring state permits for wetland alterations.

Long-term protection of certain aquatic habitats has been achieved through open space conservation including sites of high biodiversity or rare species. Over time, Rhode Islanders have proven strong supporters of investment in open space in reaction to the state becoming more densely developed over time. Over the last thirty years, voters have authorized $127 million in state bond funds to support

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[26] Bromberg, KD and MD Beatness, 2015
[27] Save The Bay 2002

open space preservation through programs that leverage matching investment. Approximately 32% of RI's 88,052 acres of freshwater wetlands are considered permanently protected through acquisition by The Nature Conservancy and the Audubon Society of RI. Of this acreage, the State owns approximately 10,900 acres of protected wetlands Other lands acquired border lakes, ponds, rivers and streams, providing valuable habitat and water quality protection. A steady growth in the number of local land trusts occurred from 1980 to 2010 providing additional partnership opportunities for federal, state and local government programs for aquatic habitat protection. Now numbering over 45 organizations, local land trusts operate in 36 of 39 municipalities with Central Falls, West Warwick and Woonsocket being the exceptions.

Rhode Island's historical development resulted in another form of physical disruption to riverine habitats - the construction of dams. RI has over 667 inventoried dams, many of which no longer serve their original purposes such as harnessing power or supporting industrial activity. Unless modified by fish passage structures, dams interfere with the free passage of various wildlife both upstream and downstream within a river system. They also disrupt the normal transport of fine sediments. For over 40 years, the DEM Division of Fish and Wildlife has implemented a program to improve river connectivity often through the construction of fish passages. Scientific understanding of the efficacy of various approaches to fish passage has improved resulting in refined approaches and greater emphasis on dam removal and the use of naturalized passages. Interest in restoring connectivity has grown over the last decade with projects pursued by partnerships among governmental and non-governmental organizations.

In 2002, pursuant to RIGL 46-23.1, RI established the Coastal and Estuarine Habitat Restoration Program and Trust Fund which is administered by CRMC. The program allocates about $225,000 per year, to support a range of projects to plan, design, implement and monitor habitat restoration actions for saltmarshes, submerged aquatic vegetation, fish passage and shellfish beds. Projects are selected through a competitive process with input from a Technical Advisory Committee. The program's investment of about $2 million has help leveraged over $20 million in investment in restoration from federal, other state and partner sources. The State strategy for coastal and estuarine habitat restoration, adopted in 2008, is currently being updated. The State Estuary and Coastal Habitat Restoration Strategy, is a program describing the State's coastal and estuarine habitats, restoration goals, inventory of restoration projects, projected comprehensive budget and timeline to complete the goals, funding sources, an outreach element, and provisions for updating the plan and project inventory.

Water Quality Impairments and Threats

Overview of Threats

The condition of Rhode Island's water resources is adversely impacted by stressors which cause water pollution and degradation of aquatic habitat. Stressors are associated with human activities, climate change and spread of invasive species. The stressors affecting water quality result largely from human activities relate to how we use our land and waters and include activities which negatively impact our waters by causing changes to their chemical, physical or biological characteristics. In addition to direct discharges of pollutants, stormwater plays a major role in washing pathogens, nutrients and sediment from the landscape into surface waters

As further discussed below, the most widespread water pollution concerns in Rhode Island are currently nutrients and pathogens. This mirrors findings by the EPA that names these groups of pollutants as two of the top three causing water quality problems in surface waters across the nation. EPA reports sediment as the third. The two most widespread causes of water pollution documented in Rhode Island are:

Pathogens- Waterborne pathogens include bacteria, viruses and other organisms that may cause disease or health problems in humans. In some areas, sources of pathogens include various discharges of sanitary wastewater including combined sewer overflows, sewer system overflows and Waste Water Treatment Facilities (WWTF). However, throughout much of Rhode Island, other sources of pathogens are dominant and may include on-site waste water treatment systems (OWTS), , pet wastes, agricultural animal wastes, as well as waterfowl and wildlife. When pathogens are present in water at elevated concentrations, the beneficial uses of waters are adversely affected prompting restrictions (closures) at public beaches and on the harvest of shellfish.

Nutrients- Nutrients are chemical elements that all living organisms need for growth. Problems arise when too much of a nutrient is introduced into the environment through human activities. In surface waters, excess nutrients fuel algal blooms that upset the ecological balance and can lead to water quality degradation in a process known as eutrophication. Severe algal blooms can result in the depletion of oxygen in the water that aquatic life needs for survival. Algal blooms also reduce water clarity preventing desirable plant growth, such as seagrasses, reduce the ability of aquatic life to find food and clog fish gills. Certain types of algal blooms, cyanobacteria, may result in the release of natural toxins that can be harmful to humans, pets, marine mammals, fish and shellfish. In groundwater, excess nitrogen can cause nitrate concentrations to rise to levels unsafe for drinking water. Freshwaters are primarily affected by excess phosphorus, while in coastal waters nitrogen is the nutrient of highest concern. In some cases, both nutrients may interact and contribute to the water pollution problem. Major human sources of nutrients in RI include WWTF discharges, fertilizer use, on-site wastewater discharges, animal manure, pet wastes, and air pollution sources.

Surface Water Conditions

The federal Clean Water Act (CWA) requires all states to assess and report on the overall quality of their waters. DEM implements a water quality assessment program to fulfill this mandate for RI. For surface waters, the process to measure progress toward state and federal CWA goals involves determining how well waters support their designated uses. Seven designated uses are evaluated:

- fish and wildlife habitat (aquatic life use)
- drinking water supply
- shellfish consumption
- shellfish controlled relay and depuration
- fish consumption
- primary contact recreation, and
- secondary contact recreation.

In the assessments, use support status is determined by comparing available water quality information to the applicable water quality standards. The results of this comparison are then used to assess each waterbody's specific designated uses as "Fully Supporting" or "Not Supporting". If data is not available to evaluate a designated use, it is considered "Not Assessed". Waterbodies that are not meeting their criteria or designated uses are placed on the State's List of Impaired Waters, which is also known as the 303(d) list. Results are summarized in biennial reports referred to as Integrated Reports. See Part 4, water Quality Monitoring and Assessment for further description of water quality standards and the assessment process.

The following section draws from the 2014 Integrated Report assessment cycle[28] and other information to provide a summary description of water quality conditions in Rhode Island. For purposes of assessment, DEM has assigned waterbody identification numbers to most of Rhode Island's surface waters. (880 waterbody units statewide[29]). Data was available to assess many but not all waters for at least one designated use. The percent of waters assessed were as follows: 64.6 % of river miles, 77% of lake acreage and 99.9 % of estuarine waters. Overall, the assessment results indicate that despite decades of notable progress in improving water quality conditions, a significant portion of our surface water resources do not yet meet water quality criteria due to pollution and other stressors. In addition, while the data provides a solid foundation for characterizing water quality concerns, data gaps prevent a comprehensive assessment of water quality with respect to all beneficial uses. Part 4, Monitoring and Assessment, discussed these gaps in more detail.

[28] http://www.dem.ri.gov/pubs/303d/303d12.pdf
[29] The 880 waterbody units include 551 rivers or river segments, 236 lakes or ponds, 132 estuarine water areas and 1 unit for the coastal shoreline.

Coastal Waters

Data exists to characterize water quality in all of Rhode Island's estuarine waters -Narragansett Bay, Little Narragansett Bay and coastal ponds. While a majority of waters are of good quality, there are certain areas which continue to persistently reflect water quality degradation due to human activities (see Figure 10, Impaired Water Bodies in Rhode Island.) The most heavily impacted areas continue to be the upper reaches of Narragansett Bay and urbanized tidal rivers and embayments such as Greenwich Bay. In these areas, the major sources of water pollution are combined sewer overflows, wastewater treatment plant discharges and urban runoff. Power plant cooling water discharges are a management concern in the Providence River and the Mt. Hope Bay region. RI's southern coastal ponds, while located in less developed watersheds, also remain vulnerable to pollution. Major sources of pollution to the coastal ponds include on-site wastewater treatment systems, fertilizer use and pet and animal wastes. Stormwater runoff plays a significant role in carrying pollutants into the ponds. The coastal shoreline waters along Rhode Island's southern shores were found acceptable for both swimming and shellfishing.

Overall: According to DEM in 2014, over a third of estuarine waters (36% or 57.4 square miles) are impaired for one or more designated use.

- Shellfish Consumption Elevated pathogens result in 23%, or 31.7 square miles, of Rhode Island's shellfishing waters being closed to and unavailable for harvest (excludes off-shore waters).

- Recreational Uses (swimming) - Over 87% of estuarine waters are categorized as acceptable for swimming and other recreation; about 10% are not safe for recreation.

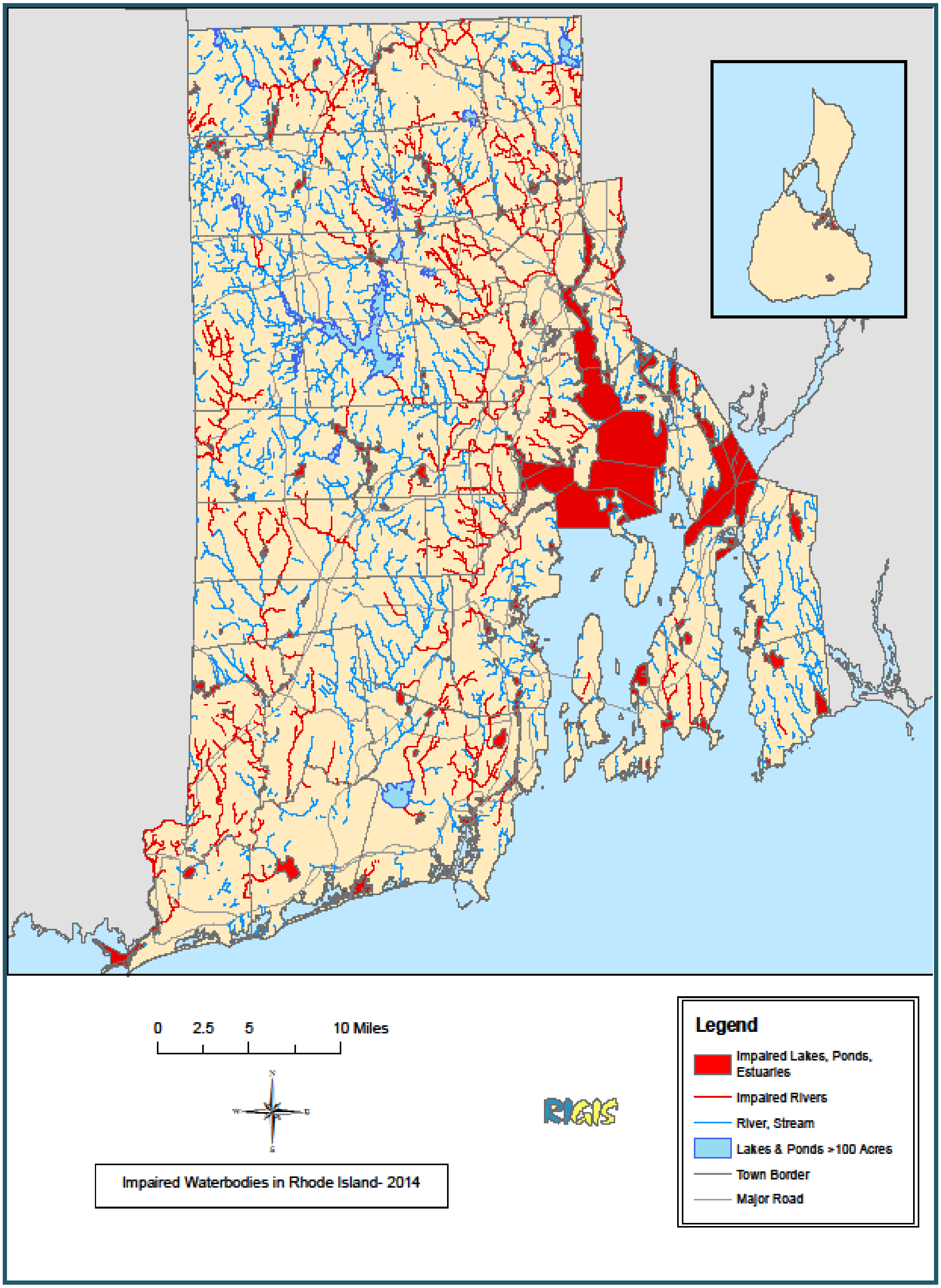
- Fish and Wildlife Habitat - About one-third (32.5%) of Narragansett Bay exhibits degraded condition due to low dissolved oxygen levels associated with excess amounts of the nutrient nitrogen. All RI coastal ponds are considered vulnerable to nutrient enrichment.

- Fish Consumption - Coastal waters have been categorized as supporting the fish consumption designated use. However, additional data generated on mercury in the tissue of marine finfish in Narragansett Bay is prompting continued applied research in order to support further assessment of public health risks.

Research has documented a general gradient of improving water quality in Narragansett Bay as one moves from north to south, down and away from the concentration of pollution sources in the urbanized Providence region.

Paddle Boarding on the Providence River
Photo: Providence Journal

Figure 10, Impaired Water Bodies in Rhode Island



Rivers and Streams

Rhode Island's land use development has impacted the condition of its rivers and streams. About 65%, or 917 miles, of the total river miles in Rhode Island were fully or partially assessed for the 2014 Integrated Report. Poor water quality affects both the recreational use and ecological health of the RI's rivers and streams. Elevated pathogens are the most common problem and are widely distributed through the State. Other pollution problems, including metals and nutrients, affect fewer streams and occur most frequently within the urban services boundary. Impaired biota identified by benthic macroinveterbrate assessments occur in 124.7 miles of rivers and streams – also located primarily in urbanized areas. The major probable sources of impairments in rivers were identified as urban stormwater discharges, wildlife (other than waterfowl), on-site wastewater treatment systems, pet wastes, and agriculture, as well as unknown sources.

Overall: Impairments – According to DEM in 2014, almost 39% of river and stream miles are impaired for one or more designated use.

- Recreational Uses (Swimming) - 33% of total river miles exhibit elevated levels of pathogens unsafe for recreational use; data is lacking for 39%.

- Fish and Wildlife Habitat -–42.6% of total river and stream miles were judged to have acceptable habitat conditions; about 22 % of river miles exhibit poor conditions for aquatic life; data is lacking for 38%. Habitat can be considered in poor condition based on biological data (macroinvertberates) or water chemistry (nutrients, toxics, etc.)

  Fish consumption - Elevated levels of mercury or other toxic compounds have been found in the tissue of fish collected form 44 miles of rivers and streams. This constitutes 3% of the total river miles, with data lacking on 96% of river miles in RI.

Lakes and Ponds

Rhode Island lakes and ponds exhibit both the effects of urbanization and the degradation of native habitat by invasive aquatic plants. Unlike the other types of waters, DEM has found the largest cause of impairment in lakes and ponds to be invasive species. Excessive growth of invasive plants are known to be problematic in lakes that otherwise exhibit good water quality. Additional significant causes of impairment are nutrients, mercury in fish tissue, organize enrichment/oxygen depletion and excess algal growth. In addition to invasive species, major probable sources of impairment are considered atmospheric deposition, urban stormwater discharges, as well as, internal nutrient recycling and waterfowl.

Overall: Impairments - According to DEM in 2014, 43% of lake acres are impaired for one or more designated use.

- Recreational Uses (Swimming) Most lakes have water quality that supports designated recreational uses. Elevated levels of pathogens have been found in 6 lakes located in urbanized watersheds. These constitute less than 2 % of the total lake acreage in the State.

- Fish and Wildlife Habitat –Fifty four lakes and ponds, or 23% of those tracked by DEM, are categorized as having habitat impaired by aquatic invasive species. However, invasives are more widespread having been found in 89 of 1148 lakes which constitute 57 % of the total lake acreage in RI. This suggests the problems associated with invasives are likely to grow worse without additional management intervention.

- Fish and Wildlife Habitat - –About 16% of the total lake acreage in RI exhibited poor habitat conditions due to elevated nutrients. 43 lakes covering 3,334.1 acres exhibited elevated phosphorus levels that can fuel algal blooms. Twenty-three lakes and ponds were documented to have blooms of cyanbacteria, also known as blue-green algae, based on data through 2015. Data availability is limited as the presence of toxics in lakes as they are not routinely monitored for in lakes and ponds.

- Fish Consumption - - Elevated mercury levels in fish tissues were found in about 12.7 % of lake acres. A large data gap exists with data unavailable for 82% of lake acres tracked by DEM.

<u>Groundwater Conditions</u>

Because of the generally localized nature of groundwater contamination, no groundwater monitoring network has been established in RI. As noted in Part 4, Water Quality Monitoring and Assessment, the best source of available information on ambient groundwater quality is the Department of Health's data on public drinking water wells that are regularly tested to ensure compliance with drinking water standards. *Water 2030*, SGP 121, has more detailed goals, policies and actions to protect groundwater used for drinking water.

Nitrate from OWTSs and fertilizer moves easily in groundwater, and it is often used as an indicator of human impacts to groundwater. Natural background concentrations of nitrate are less than 1 mg/l. Five mg/l of nitrate (1/2 the drinking water standard of 10 mg/l) has been established as the preventive action limit in RI state groundwater quality standards and is often used as a threshold for determining acceptable levels of impact from existing and proposed development.

The DOH data from public wells sampled for nitrate over the past eighteen years (Table 2) reveal that the annual percentage of wells that exceeded 5 mg/l averaged 3%. There is a decreasing trend as evidenced by the percentage of wells exceeding 5 mg/l averaged 4% from 1996 to 2004, but decreased to 2% from 2005 to 2013. Elevated nitrates tend to occur in specific areas affected by local pollution sources and are not documented to occur as widespread aquifer contamination.

Private drinking water wells are subject to the same contaminants as the public wells discussed above. Aside from the isolated cases of private well contamination from a specific activity that has caused a release of a hazardous chemical, the primary threat to private wells is area-wide elevated levels of nitrogen due to historical, dense residential development with onsite wastewater treatment systems. In some cases, due to proximity to agricultural activities.

Table 2. Nitrate in Public Wells
(Drinking water standard is 10 mg/L)

	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13
Nitrate Concentration	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
<=.2	177	197	184	166	183	183	165	166	140
.21-3	328	329	332	334	326	341	356	331	286
3.1-4.9	40	47	29	34	40	29	31	25	31
5.0-10.0	16	6	9	8	6	5	9	9	9
>=10.0	0	1	0	0	1	0	0	2	1
Total by Year	**561**	**580**	**554**	**542**	**556**	**558**	**561**	**533**	**467**

	FY 96	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04
Nitrate Concentration	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04
<=.2	72	87	84	72	208	181	169	181	181
.21-3	103	102	113	105	302	318	330	322	315
3.1-4.9	17	15	14	12	38	43	37	40	52
5.0-10.0	8	8	10	9	26	11	15	11	15
>=10.0	2	1	1	2	5	3	5	1	0
Total by Year	**202**	**213**	**222**	**200**	**579**	**556**	**556**	**555**	**563**

Volatile organic compounds (VOCs) are another often used indicator of groundwater quality conditions. Not all public wells are regularly sampled for VOCs as they are for nitrate, which makes annual comparisons for VOCs difficult. However, a review of the VOC data since 1995 reveals that annually 0-3 wells would have an exceedance of a drinking water standard for a VOC, but that since 2004 only one well has had an exceedance. Furthermore, the number of wells with a detection of a VOC annually has also decreased. The most commonly detected VOC continues to be methyl tertiary butyl ether (MTBE), which was a common gasoline additive (it is no longer used). Other VOCs from gasoline are also occasionally detected at low levels but at a reduced frequency due to the measures taken to remove older underground storage tanks and to regulate the design and installation of new tanks (See Part 6, Pollution Sources and Aquatic Habitat Management, Discharges to Groundwater.) Detections in public wells of VOCs used as solvents has also significantly decreased over the years due to more stringent controls on waste discharges and requirements for collecting hazardous wastes.

Aquatic Habitat Conditions

This plan benefits from the 2015 DEM RI State Wildlife Action Plan (SWAP) which discusses in detail the condition and threats to aquatic habitats and various wildlife species. The SWAP identifies Rhode Island's species of greatest conservation need (SGCN), key habitats and the threats to both in accordance with federal guidance from the United State Fish and Wildlife Service. With input from a large number of scientists and experts, the planning process produced a list of 84 key habitats considered important to the species of greatest conservation need. It is notable that 49 (or 58%) are aquatic or shoreline habitats and included thirty freshwater habitats and nineteen estuarine and marine. See Appendix G, SWAP Habitat Assessments. Each of these habitat types was assessed for its importance to biodiversity, current condition, degree of threat and vulnerability to climate change. This was done in the context of assessments that have been conducted at larger regional scales and work that identified the common threats included by Northeast states in their wildlife action plans. While acknowledging data limitations exist, the overall results emphasize the need for proactive and adaptive protection of aquatic habitats. Regarding the assessment of condition, key findings include:

- With the exception of marine habitats, most aquatic habitats already reflect some degree of degraded condition.
- Marine (off-shore) habitats, both bottom and open waters were considered in good condition.
- In contrast, estuarine habitats condition ranged for poor to fair.
- Most riverine habitats were categorized in fair condition; with some ranking as poor.
- Both shallow and deep lake habitat conditions were categorized as in poor condition.
- The majority of freshwater wetland habitats (17 of 20) were categorized as in fair condition.

The RISWAP also identifies specific threats to the key habitats. The Plan recognizes water quality as integral to healthy aquatic habitats and notes that changes in water quality and quantity pose serious threats to all northeastern aquatic systems. In addition to pollution from various sources, other types of stressors adversely affecting habitat condition in RI were identified. These are described in a manner consistent with the IUCN categories of threats that are commonly used by states in the region. Certain threats stand out as of higher concern to certain habitat types. Among 36 key freshwater and estuarine habitats, the most common threats identified can be grouped as follows in rank order were:

- Changes to the natural system- including climate change and hydromodifications (dams) (33)
- Invasive Species (33)
- Residential and Commercial Development (20)
- Pollution – from various sources (19)
- Agriculture and Forestry activities (11)

For rivers, lakes and wetlands, the impacts associated with development in areas adjacent to shorelines is a priority concerns for habitat. Conversion of land for development in close proximity to water resources results in fragmentation and loss of habitat that is important to wildlife that utilize aquatic habitats. While certain lands adjacent to rivers, lakes and wetlands have been protected by laws which restrict development in these "buffer" areas, many properties had been previously altered or developed before regulatory protection came into place.

The threat associated with invasives species was identified as affecting all types of waters resources. DEM data concerning aquatic invasive plants in lakes indicates they are widely distributed throughout RI with thirteen different species found. AIS were detected in about 59% of the lakes DEM had surveyed as of 2015 – a rate of detection that is similar to that experienced in both Massachusetts and Connecticut. DEM data collected from freshwater wetlands revealed the presence of an invasive species in 48% of all surveyed wetlands. Open emergent marshes were found to be particularly vulnerable to the spread of invasive plants such as the Common Reed (Phragmites), European Bittersweet and Purple Loosestrife. Phragmites is also commonly found invasive species in coastal pond and coastal wetland habitats. In coastal waters, the most problematic of invasive species to Rhode Island include the Asian Shore Crab, the Chinese Mitten Crab, several types of colonial tunicates, and the Oriental Grass Shrimp.

In rivers, the presence of dams is cited as a threat along with other hydromodification stressors. Dams and other obstacles prevent the free passage of fish and wildlife and therefore limit access to riverine habitat. As noted earlier, the industrial revolution in New England resulted in dams being installed on nearly all rivers in RI to supply power to mills. Dams have also impeded tidal flow resulting in the nearly total loss of the unique freshwater tidal marshes. While a portion of our dams created impoundments used for water supply or lakes valued for recreation and other benefits, most of RI's dams do not serve such purposes. Additional disruption of stream connectivity occurred as the road network expanded in RI resulting in the installation of culverts and altering many of rivers and streams. A statewide assessment of stream connectivity is not available; but information is available for several watersheds which documented the need to retrofit culverts due to interference with stream connectivity. Other hydromodification of natural hydrologic regimes due to manmade withdrawals of water are also identified as a concern with respect to freshwater wetlands including vernal pools.

Impacts of Climate Change on Aquatic Habitats

Climate change is recognized as a current threat to all aquatic habitats. Changes in temperature, precipitation patterns, hydrology and the frequency of intense storms may impact the physical and chemical characteristics and biota of aquatic habitats. The 2015 SWAP identified the following aquatic habitats as most vulnerable.

Degree of Vulnerability	Habitat Type
Highly Vulnerable	Brackish Marshes,
	Tidal Flats
Vulnerable	Salt Marshes
	Cold water Streams
	Emergent Marshes
	Vernal Pools
	Shrub swamps/wet meadows
	Red Maple (Hardwood) Swamps
	Atlantic White Cedar Swamps
	Floodplain Forests
	Cold water Ponds

It is generally agreed that coastal habitats, including salt marshes, are among the most vulnerable due to accelerating sea level rise. The CRMC and the watershed organization, Save the Bay, have documented that salt marshes are already being impacted by sea level rise. The Sea Level Affecting Marshes Model[30] (SLAMM) is projecting significant changes in the extent of salt marsh. As sea level rises, the model predicts initially there might be a gain in salt marsh due to migration inland that would come at the expense of displacing brackish marsh, tidal flats and freshwater wetlands. However, it also predicts the likelihood of marsh migration lessons as sea level continues to rise leading to net projected losses in acreage of salt marsh with 3 feet or more of rise. Existing salt marshes, tidal creeks, sea grass beds and coastal ponds are also vulnerable to damage from more frequent and intense storms.

Freshwater wetlands will be affected by climate change due to change in hydrology. Predicted changes in precipitation patterns may change spring seasonal flows and floods and produce drier summers that change groundwater levels and soil moisture. The hydroperiod of vernal pools may shorten affecting the breeding success of species dependent on this habitat such as amphibians. Changing conditions may result in shifts in the plant community as previously wetter areas dry out. For example, marshes and swamps may contract inward toward areas where water is deeper or more reliable. Larger wetlands may become fragmented. Floodplain forests may suffer damage from more frequent intense storms.

Coldwater streams are considered very susceptible to projected climate changes. Increases in air temperature will lead to a decline in suitability of coldwater streams as habitat for important species such as Brook Trout. Rising temperatures has ramifications for many important aquatic organisms that make up the dynamic food web within streams and adjoining terrestrial ecosystems.

[30] The Rhode Island Sea Level Affecting Marshes Model (SLAMM) Project, Summary report, CRMC , 2015

Part 3 Water Quality Management Framework

Key Points

- Water quality management is a shared responsibility among all levels of government, non-governmental organizations and individuals.
- RI's water quality management framework includes the following steps: monitor, assess, plan strategies, implement strategies, and evaluate results.
- State government has the primary authority for managing water quality in RI.
- Land use has major impact on water quality. Municipalities have the primary authority for managing land use.
- Water quality is most effectively managed on a watershed basis. Watershed plans provide a mechanism to align resources and coordinate actions within a watershed to accelerate progress.
- Collaboration and partnerships among those working on water quality and watershed management is necessary to advance progress toward clean water goals.
- Local watershed organizations play important roles in watershed management.
- Resource limitations justify prioritizing actions to protect and restore water resources within and among watersheds.

Management Approach

Rhode Island's water quality management framework is a systems management approach purposefully designed to address water resource protection and restoration in a holistic manner. It acknowledges the continuing implementation of established governmental programs to regulate various water pollution sources, protect aquatic habitat and facilitate water quality improvements. Building on these programs, it gives emphasis to the use of a watershed-based approach as a means to facilitate more effective management of our water resources. The aim is to *integrate* management activities related to water quality and aquatic habitats within a given watershed. The framework provides a process for government and other stakeholders to prioritize problems and work collaboratively on a watershed basis to optimize results in terms of both environmental outcomes and the other societal benefits associated with improved water quality and aquatic habitat.

The watershed-based approach is a means to facilitate more effective management of our water resources.

The Environmental Protection Agency (EPA) has described the benefits of taking a watershed approach this way: "operating and coordinating programs on a watershed basis makes good sense for environmental, financial, social, and administrative reasons. For example, by jointly reviewing the results of assessment efforts for drinking water protection, pollution control, fish and wildlife habitat protection and other aquatic resource protection programs, managers from all levels of government can better understand the cumulative impacts of various human activities and determine the most critical problems within each watershed. Using this information to set priorities for action allows public and private managers from all levels to allocate limited financial and human resources to address the most critical needs. Establishing environmental indicators helps guide activities toward solving those high priority problems and measuring success in making real world improvements rather than simply fulfilling programmatic requirements[1].

Using science as its foundation, the water quality management framework consists of a five step process -- Monitor, Assess, Plan, Protect/Restore, and Evaluate. This framework can be used to support statewide water resource programs as well as management applied at varying watershed scales. At the State level, the framework recognizes the on-going need for statewide assessments of water quality and habitat condition to provide information that drives the refinement and adaptation of state protection and restoration programs. At the watershed scale, the framework identifies watershed plans as the coordinating mechanism to strategically align water resource protection and restoration activities among all involved stakeholders.

The water quality management framework consists of 5 steps:

1) Monitor the quality and condition of water resources.
2) Based on an assessment of available data, characterize the condition of the water resource and identify stressors or causes of degradation.
3) Develop strategies_to restore and protect water resource conditions to achieve specified goals.
4) Implement the goals to protect and restore water quality and aquatic habitat.
5) Evaluate results and cycle through the process again using information to adapt management in light of new information.

Implementation of this framework and development of watershed plans requires active public engagement and stakeholder involvement. While the State may have a lead role in monitoring and assessing water resources, the participation of all entities most affected by management decisions is needed throughout the planning, implementation and evaluation steps in the process. This includes all levels of government (federal, state, local), quasi-governmental agencies, watershed councils and other non-governmental organizations, interested business and individuals. Effective public engagement ensures environmental objectives are well integrated with related economic, social and cultural goals which in turn builds support for implementation of needed actions. Challenges at each step in implementing this approach will be discussed in later sections along with proposed strategies.

Roles and Responsibilities

Everyone shares in the responsibility and duty to protect and restore RI's water resources.

Among the management principles underlying this plan is the tenet that we all share in the responsibility and duty to protect and restore RI's water resources. While acknowledging the State's important role in this management framework, this plan recognizes the meaningful roles of numerous public and private organizations as well as individuals in securing clean water and healthy aquatic habitats. This is especially true with respect to the implementation of the wide range of actions that are needed to achieve water quality goals. Given resource limitations, **collaboration and partnerships among those working on water quality and aquatic habitat management, are essential to enhancing progress.** The sheer number of entities actively involved dictates greater effort be invested in sustaining effective communication and coordination among the parties. While recognizing that the responsibilities and authorities of organizations change and evolve over time. This section provides a useful overview of the primary role that existing organizations currently play in water resources management in RI.

[1] USEPA, "Watershed Approach Framework", Office of Water Resources (4501F), EPA 840-S-96-001, June 1996

Federal Government - Federal agencies fulfill multiple roles in RI's management of water quality and aquatic habitats. The roles of agencies with significant involvement are described briefly below:

US Environmental Protection Agency (EPA) – Administers a number of pollution control statutes, including the Clean Water Act, by establishing regulations and policy to support their implementation. Sets minimum water quality criteria and delegates certain authority to DEM. Exercises regulatory authority and takes enforcement actions. Provides annual funding to DEM to implement water quality and other pollution control programs as authorized by Congress. Recently launched a new program known as the Southeast New England Program to promote restoration of coastal watersheds.

EPA also operates a research laboratory known as the Atlantic Ecology Division (AED) in Narragansett in proximity to the URI Bay Campus AED conducts sediment and water quality research in a variety of environments ranging from freshwater to marsh and estuarine to near-shore marine environments along the Atlantic coast from North Carolina to Maine.

US Geological Survey (USGS) –Operates a network of streamflow gages and monitors groundwater levels and water quality in large rivers pursuant to joint funding agreements with state agencies and other partners. Provides access to data via federal website. Carries out scientific research at national, regional and local scale; with local projects usually done in collaboration with partners.

US Department of Agriculture, Natural Resources Conservation Services (NRCS) – Promotes conservation of natural resources. Administers programs that provide funds and technical assistance to farmers and forest owners to implement best management practices for water quality management and habitat improvement. Administers a State Technical Team, which includes state agency participation, as a means to facilitate coordination and input from partners. Conducts mapping of soils.

National Oceanic and Atmospheric Administration (NOAA) – Administers federal statutes related to coastal zone management and marine fisheries. Operates the National Weather Service and the PORTS network of coastal observing stations under agreement with DEM. Operates the federal Northeast Fisheries Science Center located in Narragansett in proximity to the URI Bay Campus. Conducts research and provides services to state and local governments on a range of topics including coastal hazards. Provides funds for coastal habitat restoration. Provides annual funding to DEM and CRMC for related state programs.

US Fish and Wildlife Service (USF&W) – Administers a number of federal statutes related to fish and wildlife addressing threatened and endangered species, migratory waterfowl, fisheries, invasive species among other topics. Exercises regulatory authority and may take enforcement action. Provides annual funding to DEM for related state fish and wildlife programs. Provides technical assistance to state programs; e.g. expertise in fish passage. Provides funds for habitat restoration. Operates five national wildlife refuges in RI.

Army Corps of Engineers (ACOE) - Among its varied responsibilities, the federal Army Corps of Engineers has a wide range of responsibilities related to water resources. It administers environmental programs aimed at restoring degraded habitats, cleaning up contamination from past military activities, regulating waterways. It is also involved in finding solutions to flooding and coastal erosion concerns. Its activities include but are not limited to research, special projects, providing funding or technical assistance via partnerships with state and local governments, and regulation of wetlands in coordination with EPA and the states. Rhode Island is within the North Atlantic Division of the ACOE.

Rhode Island State Government - State government has the primary responsibility for managing water quality in Rhode Island. Through water quality management and related environmental programs, it carries out responsibilities assigned by both federal and state statutes. The responsibilities of state government in water quality management are:

- To coordinate monitoring of Rhode Island's natural environment, including its water resources, in order to generate information that supports effective management of our natural resources.
- To establish water quality standards and conduct assessments of water quality conditions on a statewide basis.
- To regulate the discharge of pollutants from various sources into or onto water, air and land.
- To protect wetlands by regulating land disturbances and other activities in and adjacent to these resources;
- To manage fish and wildlife including the operation of state owned forests, wildlife preserves and fish hatcheries;
- To provide leadership and opportunities for public engagement in planning for protection and restoration of Rhode Island's water resources;
- To adopt effective water quality management practices within its own operations; and
- To provide financial and technical assistance and partner with other governmental and non-governmental entities for water quality and habitat protection and restoration actions.

The two agencies with broad responsibility and involvement in natural resources management are: The Department of Environmental Management (DEM) and the Coastal Resources Management Council (CRMC).

Department of Environmental Management (DEM)

DEM is RI's largest environmental agency with a broad range of responsibilities for protecting water, air and land and managing natural resources. State Law designates DEM as RI's water pollution control agency to administer federal Clean Water Act programs under delegated authority from the EPA. Within the Environmental Protection branch, the DEM Office of Water Resources implements over a dozen regulatory and non-regulatory programs and is well positioned to reinforce watershed–based approaches to water quality protection and restoration. See box for the listing of OWR programs. Additional programs in this branch regulate solid and hazardous waste and air pollution, facilitate site remediation, respond to oil spills and other environmental emergencies and promote pollution prevention. DEM receives annual funding from EPA for many of these activities.

The DEM Natural Resource Branch houses programs dedicated to fish and wildlife management, forestry, agriculture and open space preservation. With respect to protecting and restoring aquatic habitats, RIDEM has statewide responsibilities for managing fish and wildlife through programs that encompass planning, protection, regulation and management, land acquisition and habitat restoration among other activities. This includes anadromous fish restoration. The DEM routinely receives federal funds from the United State Fish and Wildlife Service and NOAA for some of these activities. Both DEM branches administer programs that provide financial and technical assistance to local governments and other entities to advance water quality and habitat protection and restoration. These include distribution of both federal funds, state bond funds and facilitation of the major financing programs managed by the Infrastructure Bank.

DEM Office of Water Resources Programs and Activities

- Water Quality Standards – Surface Water and Groundwater
- Water Quality Monitoring and Assessment
- Nonpoint Source Pollution Management Program
- Water Quality Restoration Planning (TMDLs) and Watershed Planning
- Water Quality Certification Program
- Rhode Island Pollutant Discharge Elimination System (RIPDES) including stormwater management
- Wastewater System Planning and Design
- Wastewater Facility Operation and Maintenance Program
- Onsite Wastewater Management Program
- Groundwater Discharge Program (includes Underground Injection Control Program)
- Freshwater Wetlands Programs
- Shellfish Growing Area Management Program
- Financial Assistance Programs

Coastal Resources Management Council (CRMC)

Created in 1971, the CRMC is the lead management agency for coastal zone management in RI coastal watersheds. Its primary responsibility is for the preservation, protection, development and where possible the restoration of the coastal areas of the state via the implementation of its integrated and comprehensive coastal management plans and the issuance of permits for work within the coastal zone including all activities within tidal waters. Under State Law, CRMC has responsibility for freshwater wetlands protection in designated coastal areas and has the lead role in implementing programs related to dredging in marine waters, aquaculture and coastal habitat restoration with a focus on saltmarshes and the coastal ponds. CRMC receives annual financial support from NOAA.

The CRMC also has other important functions in addition to developing and implementing coastal management programs and policies. It coordinate and provides oversight for other state agencies and municipalities that do not inherently consider coastal zone management issues in their decision-making processes. It has a leadership role in identifying new issues and seeking their resolution. It sponsors coastal zone research that has led to new initiatives in public trust issues, coastal flooding, hazard mitigation, and special area management planning. And it provides the State with a continuing process of public rights-of-way discovery: an issue that is integral to all Rhode Islanders. Cultural features of historical or archaeological significance are also within the jurisdiction of the Council as required by the Federal Government. In addition to RIDEM and CRMC, a number of other state and quasi-state agencies have specific responsibilities that contribute in significant ways to the protection and restoration of our water resources. These are listed in Table 3, Other State and Quasi-state Water Quality Responsibilities.

Table 3, Other State and Quasi-state Water Quality Responsibilities

Agency Name	Program Activities Related to Water Quality Management
Department of Health (DOH)	Regulates public water suppliers to ensure drinking water provided meets EPA water standards; provides support for source water protection; licenses bathing beaches and monitors water quality at most public bathing beaches; advises the public concerning environmental health risks.
RI Infrastructure Bank (quasi-state)	Administers programs that provide financial assistance in the form of low interest loans for municipal wastewater and water quality improvement projects. (Formerly RI Clean Water Finance Agency)
Narragansett Bay National Estuarine Research Reserve (quasi-state)	Located on Prudence Island, DEM is the state host to this partnership program that preserves, protects and restores coastal and estuarine ecosystems of Narragansett Bay through long-term research, monitoring, education and training. One of 28 nationally designated research reserves.
Department of Administration, Division of Planning (DOP)	Creates long-term plans for the Sate's development and management of its natural resources via the State Guide Plan; administers requirements for local comprehensive planning. Coordinates the Statewide Planning Program for the State Planning Council.
Department of Administration, Division of Planning, Water Resources Board (WRB)	Oversees the management and use of drinking water resources: identifies potential sources, allocates drinking water supplies and administers financial programs to ensure adequate supplies of drinking water.
Emergency Management Agency	Provides hazard mitigation planning; floodplain mapping.
Department of Transportation (DOT)	Oversees stormwater management associated with State roads; storage and application of road salt and sand.
Narragansett Bay Commission(quasi-state)	Provides regional wastewater collection and treatment services in the Providence metropolitan region. Activities also include monitoring and public outreach.

Statewide Coordinating Entities– Water quality management in Rhode Island benefits from the following coordinating bodies - some of which have been established through State Law.

- State Conservation Committee –Under State Law, the Rhode Island State Conservation Committee was established within DEM to foster coordination of the activities of the three regional conservation districts (discussed below) with other federal, state and local entities regarding natural resources in RI. The Committee provides assistance and support to the three Conservation Districts in their efforts to assist local landowners and municipalities in the proper stewardship of our lands and waters. The Committee, with the three conservation districts and the Natural Resources Conservation Service are collectively known as the Conservation Partnership.
    - Regional Conservation Districts –Authorized by State Law, RI has three regional conservation districts organized with volunteer board of directors as quasi-public, non-profit organizations. The districts work both independently and share a mission of promoting proper stewardship of natural resources through the State Conservation Commission cited above. They carry out initiatives involving education and outreach, training, and various forms of technical assistance as well as project management support on projects involving non-point source pollution, wetlands and other topics.
- Rivers Council – R.I. Gen. Law §46-28 creates the RI Rivers Council[2] to help coordinate efforts to improve the quality of the State's rivers and their watersheds. The Council is charged with coordinating state policies to protect rivers and watersheds and strengthening local watershed councils as partners in river and watershed protection. The Council also designates official watershed council status to watershed organizations. (See watershed organizations.).
- Rhode Island Environmental Monitoring Collaborative (RIEMC) – R.I. Gen. Law §46-31 established the RIEMC to develop and, through its members, implement comprehensive environmental monitoring to support management of RI's natural resources. Chaired by the URI Coastal Institute, the RIEMC provides a forum for government agencies, university–based programs, non–governmental organizations, and volunteers, to collaborate on monitoring activities, determine monitoring priorities and identify critical gaps in data collection.
- Executive Climate Change Coordinating Council (EC4) – R.I. Gen. Law §42-6.2 establishes the EC4. The Council is charged with incorporating consideration of climate change into the powers and duties of all state agencies. It is responsible for setting specific greenhouse gas reduction targets, and planning for mitigation and adaptation to climate change. The Council, chaired by DEM, works with an advisory board and a science and technical advisory board.
- Regional Planning Commissions – Regional planning commissions are allowed under State Law. The two that have been formed serve Aquidneck Island[3] and the Washington County[4] region. While involved in a broader range of topics, these regional commissions have taken on projects related to water quality and watershed management.

[2] http://www.ririvers.org/
[3] http://aquidneckplanning.org/
[4] http://wcrpc.org/

Municipalities

There is a strong relationship between land use and water quality.

Municipal governments have a critical role to play in water quality management through the exercise of their authorities to govern land use and development. Municipal land use planning and zoning establishes the type and level of intensity of development on the landscape, which determines to a major degree the potential impacts to water quality. Development patterns, including poorly managed sprawl, have stressed our water resources. Changing land use planning and land use controls in RI can improve water quality and move us towards one of the goals of *Land Use 2025*, SGP 121:

> *"A sustainable Rhode Island that is beautiful, diverse, connected, and compact with a distinct quality of place in our urban and rural centers, an abundance of natural resources, and a vibrant sustainable economy."*

Municipalities have many tools available to comply with the goals and policies in *Land Use 2025* and this Plan that can reduce the impacts of development on water quality, such as:

- Using smart growth planning techniques such as conservation development to ensure development matches the capacity of the land and infrastructure available to support it.
- Acquisition of open space, primarily in drinking water source areas.
- Using Low impact development (LID) practices, which use site planning and design techniques to mitigate the impacts of stormwater and site disturbance on our water resources. LID practices include but are not limited to: (See also Part 6, Stormwater Section)
    - Riparian buffer standards
    - Site clearing and grading standards
    - Roadway and parking design guidelines
    - Landscaping guidelines and standards

In addition to their primary role in regulating land use, many municipalities implement local (See stormwater management programs and on-site wastewater management programs (See Part 6 and the Implementation Matrix) and may operate other programs that support water quality management including acquisition and management of open space and wellhead protection activities. Each municipality has a conservation commission and some have formed various other committees to support local environmental work; e.g. open space, groundwater protection etc. Municipal stormwater activities mandated by the federal Clean Water Act, involve mapping, inspection, operation and maintenance of storm drain systems, retrofitting of stormdrains to implement TMDL recommended actions as well as administration of local ordinances that govern pre and post construction best management practices (BMPs). Currently, local capacity to address stormwater management is variable with some communities not having readily available access to the expertise needed to be effective. In many communities, staffing limitations have constrained local projects requiring engineering services that respond to TMDL requirements for the retrofitting of stormwater systems to improve treatment. Building capacity to strengthen stormwater management at the municipal or regional levels is essential to fostering progress on abating this widespread source of water pollution.

Some municipalities also perform the function of public utilities. In RI, 16 municipalities own public wastewater systems with treatment facilities; while another 12 have responsibility for maintaining sewer lines within their communities. Appendix F contains a list of the DEM certified wastewater treatment plants.

Nineteen municipalities operate large, drinking water utilities. Collectively, these responsibilities are often burdensome to local governments which do not have the resources to address documented infrastructure needs – a situation considered a problem not just in RI but existing nationwide. Adoption of asset management approaches and integrated infrastructure planning strategies are tools that can be used to prioritize needs.

University of Rhode Island and Other Colleges and Universities

Higher education institutions make valuable contributions to water resources programs through research, technical assistance, public outreach and other activities. A statewide assessment noted that Rhode Island is particularly well-equipped to pursue research in life sciences, marine sciences and energy and environmental sciences[5]. Regular communication between State government and academic institutions is important to foster alignment of applied research to address State management priorities and challenges. Institutions or programs with long records of involvement in water quality topics or concentrations of certain expertise are highlighted below.

University of Rhode Island

UNIVERSITY OF Rhode Island

The University of Rhode Island has significant involvement in state water resource issues. Its programs, although they may change over time, collectively support state water quality management through the acquisition, mapping and dissemination of data, water quality monitoring, policy analysis, program development, scientific research, training and technical assistance, and public engagement and outreach. Several of the following programs have long records of involvement.

College of Life Sciences and Environment:

- Cooperative Extension– a function of URI's Land Grant mission, Cooperative Extension Water Quality Programs include the following four areas of activity:
  - New England Onsite Wastewater Training Program
  - RI Nonpoint Education for Municipal Officials (NEMO)
  - URI Home* A* Syst – information and training for homeowners
  - Watershed Watch – coordination of volunteer water quality monitoring ("citizen science")

- Environmental Data Center - The (EDC) is a Geographic Information System (GIS) and spatial data analysis laboratory. Major areas of research include spatial data modeling, ecological mapping, and data integration for environmental applications. The EDC hosts the RI Digital Atlas and a key partner in the RI Geographic Information System (RIGIS).

- Research Programs including oils, marine science, and new watershed hydrology laboratory –focused on research and education related to water quality and watershed processes, including nitrogen sinks.

[5] Rhode Island Science and Technology Advisory Council, "Accerlerating Innovation Through Collaboration in the Ocean State: Science and Technology Infrastructure Plan for Rhode Island", September 2009.

College of Engineering:

- RI Water Resources Center - research focus linked to United States Geological Survey per federal law.
- Research on water related topics.

Coastal Institute: advances knowledge and develops solutions to environmental problems in coastal ecosystems. Per State Law, chairs the RI Environmental Monitoring Collaborative.

Graduate School of Oceanography:

- Coastal Resource Center (CRC) – assists in development and implementation of coastal management programs in RI, the United States and countries worldwide including technical assistance on green infrastructure, sea level rise and other topics.
- RI Sea Grant Program– partnership program with NOAA that supports research, outreach and education focused on coastal communities and the marine environment.
- Office of Marine Affairs – public outreach
- Research laboratories focused on marine ecosystems, persistent organize contaminants, plankton ecology, and nitrogen and carbon cycling among others. Activities include long-term monitoring and surveys (Narragansett Bay).

Brown University

BROWN

Brown University has had a long involvement in bay monitoring (spatial surveys) in collaboration with STB and DEM. It also operates the:

- Center for Environmental Health and Technology which facilitates research to support improvements in environmental health and the identification and remediation of hazardous contaminants.
- Institute at Brown for Environment and Society which facilitates research, dialogue and collaboration on complex environmental and social processes.

Roger Williams University

Roger Williams University

Roger Williams University administers research, policy and legal programs which address water –related topics. Operates the RWU Center for Economic and Environmental Development which includes a focus on shellfish resources and aquaculture.

Watershed Councils and other Non-Governmental Organizations

Rivers Council Designated Watershed Councils 2016

- Blackstone River Watershed Council/ Friends of the Blackstone
- Buckeye Brook Coalition
- Friends of the Moshassuck
- Kickemuit River Council
- Narrow River Preservation Association
- Pawtuxet River Authority & Watershed Council
- Salt Ponds Coalition
- Ten Mile River Watershed Council
- Wood-Pawcatuck Watershed Association
- Woonasquatucket River Watershed Council

Watershed councils are non-profit organizations officially designated by the RI Rivers Council to represent watershed interests. They are important partners in river and watershed protection. The existing councils/organizations vary in capacity from those with paid professional staff to solely volunteer organizations. However, they all fulfill a critical stewardship role in their watersheds by raising awareness, coordinating and implementing projects and advocating for protection and restoration actions.

Other non-government organizations are active in water quality and watershed management including long established environmental groups such as Save The Bay, The Nature Conservancy and Audubon Society of RI. The number of active potential NGO partners has grown with the more recent formation of groups such as Save The Lakes, Clean Ocean Access and Clean The Bay. The role of the RI Natural History Survey as an important partner in gathering data on RI's natural communities and related work is acknowledged in R.I. Gen. Law §42-17.1-2 (33). Both DEM and CRMC have a long history of working productively in partnership with NGOs on various initiatives, including collaborations on open space acquisition, freshwater wetland and salt marsh monitoring, and fish passage to name a few. In some cases the collaboration is defined through written agreements or memorandum of understanding.

Pertinent Regional Programs Operating in RI

NARRAGANSETT BAY ESTUARY PROGRAM

Narragansett Bay Estuary Program - The Narraganset Bay Estuary Program (NBEP) is one of 28 programs authorized by EPA to foster collaboration to protect and restore estuaries designated by Congress as being of critical importance. Created in 1987, the NBEP is a bi-state program that engages stakeholders from across the watershed through its management and science advisory committees. A non-regulatory program, it is focused on advancing effective management through the application of science, collaboration and partnerships. The program is responsible for producing a status and trends report every five years. Other on-going activities include data analysis and synthesis, grant-making, public outreach, providing input to policy and program development and supporting strategic projects to advance stewardship.

Narragansett Bay National Estuarine Research Reserve – As noted earlier, the Narragansett Bay National Estuarine Research Reserve is a partnership program among NOAA and the State of RI, with DEM being the host agency. One of 28 nationally, its mission is to preserve, protect and restore coastal and estuarine ecosystems of Narragansett Bay through long-term research, education and training. Based on Prudence Island, the NBNERR conducts its own research, hosts other researchers, conducts monitoring and carries out public education and training programs. The manager of the Reserve serves on the Management Committee of the NBEP described above.

New England Interstate Water Pollution Control Commission - Established by an Act of Congress in 1947, the New England Interstate Water Pollution Control Commission is a not-for-profit interstate agency that supports the water resource management programs of its member states which includes RI. NEIWPCC serves and assists RI by coordinating activities and forums that encourage cooperation among the states, developing resources that foster progress on water and wastewater issues, initiating and overseeing scientific research projects and providing technical assistance and support on specific projects. NEIWPCC is the institutional host of the NBEP.

Atlantic States Marine Fisheries Commission – Approved by Congress as an Interstate Compact in 1942, the ASMFC has a mission to promote cooperative management of fisheries of the Atlantic Coast. In addition to fisheries management activities, including the data collection and research, the ASMFC has a goal to protect and enhance fish habitat and ecosystem health. Since 2006 it has contributed to the Atlantic Coastal Fish Habitat Partnership which fosters projects that conserve habitat for Atlantic coast diadromous, estuarine-dependent and coastal fish species. Rhode Island participates. This partnership operates under the purview of the National Fish Habitat Partnership.

Northeast Aquatic Nuisance Species Panel (NEANS Panel) - The mission of the NEANS Panel is to protect the marine and freshwater resources of the Northeast from invasive aquatic nuisance species through commitment and cohesive coordinated action. Established in 2001, it was the fourth panel approved by the federal ANS Task Force under authority of the National Aquatic Nuisance Prevention and Control Act of 1990 (as amended). The NEANS Panel represents all six New England states, the State of New York, and the Canadian Provinces New Brunswick, Nova Scotia, and Quebec. The Panel's members represent state, provincial, and federal governments; academia; commercial and recreational fishing interests; recreational boaters; commercial shipping; power and water utilities; environmental organizations; aquaculture; nursery and aquarium trades; tribal concerns; lake associations; and the bait industry.

Northeast Regional Association of Coastal and Ocean Observing Systems (NERACOOS)- NERACOOS is a non-profit organization formed in association with the federally authorized International Ocean Observing System (IOOS) – a federal partnership initiative managed by NOAA. Its focus is on developing a sustained regional observing (monitoring) system for the northeast US. Its activities include the design of a sentinel network to track climate variability in coastal and ocean waters.

Northeast Regional Ocean Council - The Northeast Regional Ocean Council (NROC) is a state and federal partnership formed in 2005 that facilitates the New England states, federal agencies, regional organizations, and other interested regional groups in addressing ocean and coastal issues that benefit from a regional response. Ocean and coastal ecosystem health is an identified area of focus.

Narragansett Water Pollution Control Association - Established in 1952, the Narragansett Water Pollution Control Association (NWPCA) is a non-profit organization created to promote the advancement of knowledge concerning wastewater management. The association works closely with DEM on the licensing and training of wastewater treatment plant operators among other topics.

Other Groups

- Land Trusts – A total of 45 public and private land trusts work in RI to preserve land. The majority are all volunteer organizations. Their collective efforts have conserved lands that include valuable riparian and aquatic habitat which contributes to the protection of water quality and benefits biological diversity. The Rhode Island Land Trust Council is a coalition of the state's land trusts that coordinates and supports activities of land trusts.

- Stakeholder User Groups – Good water quality and aquatic habitat is important to support the activities of numerous stakeholder groups including those representing the interests of commercial fisheries, marine trades, and various outdoor recreational pursuits (fishing and boating). These groups provide expertise, engagement and often serve as partners in water resource protection and restoration activities.

Setting Priorities

State Water Quality Priorities

The long-term goal for all Rhode Island watersheds is to achieve clean and healthy waters and aquatic habitats. This plan acknowledges that it is a priority to prevent pollution and degradation. Many regulatory programs that *protect* water quality and *prevent* pollution or degradation from a variety of stressors are administered equitably on a statewide basis across all watersheds. **It is federal policy and a management principle of this Plan that pollution should be prevented at its source whenever feasible.** However, given the extent of water quality and habitat degradation and limited resources, it's a strategic necessity to set priorities in order to optimize progress. Prioritization occurs for different purposes at statewide, watershed and subwatershed scales.

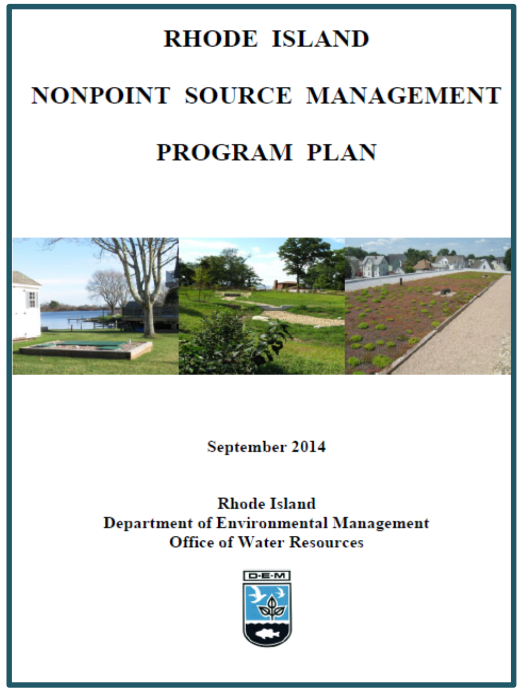
Water Quality Priorities

Priorities within the state water resources programs are influenced by federal and state law, federal funding guidance, state policy and information concerning environmental conditions. The Environmental Protection Agency requires frameworks for prioritization within the programs delegated to DEM associated with administration of the federal Clean Water Act. DEM has procedures to both establish and periodically review a common set of priorities which can be described in relation to water resource uses. Well-established priorities related to the use of surface and groundwaters have been incorporated into DEM statewide water quality programs including regulations which afford added protection to drinking water sources through tighter restrictions on activities that present pollution threats. These priorities, which emphasize protection of public health, are:

- Protection and restoration of drinking water supply source waters – both surface waters and groundwaters;
- Protection and restoration of shellfish growing area waters;
- Protection and restoration of waters used for public recreation including public beach waters;
- Restoration of waters degraded due to excess nutrients; and
- Protection and restoration of water quality to support high quality aquatic habitats.

These priorities are reflected in various aspects of state water quality programs. Water quality restoration priorities are reflected in the federally mandated 303d (d) List of Impaired Waters which establishes the State's TMDL development schedule and is updated every two years by DEM. There is also a subset of the 303(d) list of waters that are high priority for water quality planning for the near term with a 2-year planning horizon. Another primary way in which the priorities are expressed is through the direction of state financial assistance to water quality improvement projects. The priorities are reflected in both the ranking criteria for the priority project list associated with the Clean Water State Revolving Fund (SRF) and the scoring criteria in competitive federal and state grant programs. Criteria are periodically revised based on new understanding, including recognition of the important co-benefits of many water –related projects with respect to environmental, public health and safety (e.g. flood prevention), economic and societal goals.

As reflected in the 2015 Nonpoint Source Management Program Plan, DEM has also established a prioritization process for watershed planning. The process results in the selection of watersheds to be targeted by the State for planning every few years. In addition to the priorities articulated above, the process will take into account the willingness of local partners to participate in both watershed planning and implementation initiatives and the opportunities to leverage additional resources. This will allow the State to continue to be responsive to opportunities that lead to strengthened partnerships and enhanced local capacity. Water quality priorities within a particular watershed planning area will be based on the following:


RHODE ISLAND

NONPOINT SOURCE MANAGEMENT

PROGRAM PLAN

September 2014

Rhode Island
Department of Environmental Management
Office of Water Resources

- Priorities in watershed planning areas with less than 10% impervious cover and few surface water impairments will be pollution prevention and protection. These areas may support some of RI's cleanest waters and highest quality aquatic habitat, although there may also be scattered waterbodies that may also need targeted restoration;

- Priorities in a majority of designated watershed planning areas, with existing impervious cover up to 25%, will need to reflect a mix of protection and restoration actions. Water quality impairments are more prevalent within these watersheds/sub–basins that are more urbanized.

- The priority in a small number of watershed planning areas that have the highest extent of urbanization will largely be on restoration. These lie largely within the urban services boundary designated in the SGP Element 121, *Land Use 2025: State Land Use Policies and Plan* [6] *(see Part 2, Figure 9).* The emphasis in these areas is on restoring water quality with recognition these heavily developed watersheds will require sustained investment in retrofitting the existing landscape and infrastructure over many years in order to achieve water quality goals. Priorities need to be periodically re–visited to incorporate new information gained through updated water resource assessments and scientific research.

[6] http://www.planning.ri.gov/statewideplanning/land/landuse.php

Aquatic Habitat Protection and Restoration Priorities

Priority Aquatic Habitats

The State Wildlife Action Plan (SWAP) describes state priorities for conserving key RI habitats including aquatic habitats. As noted in Part 2, it identifies key aquatic habitats as priorities for conservation based in part on an analysis of species of greatest conservation need. It also notes that while conservation actions taken throughout the state can help fish and wildlife, focusing investments on priority landscapes can increase the likelihood of long-term success over larger areas, improve funding efficiency, and promote cooperative efforts over ownership boundaries. The SWAP identifies Conservation Opportunities Areas (COAs), depicted in Figure11, Conservation Opportunity Areas, RI State Wildlife Action Plan, 2015, as the areas in RI where broad fish and wildlife conservation goals can best be met. Not surprisingly, the inland COAs are concentrated in the more rural portions of RI less human disturbance has occurred. Of note is the fact that all marine state waters were designated as of high importance to biodiversity – a reflection of the value of the Narragansett Bay Estuary and nearby coastal ponds habitats. Aligning actions within these areas will increase effectiveness of conservation actions at larger scales than can individual projects scattered throughout the state. The SWAP notes that conservation of habitats via land acquisition can have greater impact when occurring near other conserved land and thus resulting in larger, resilient intact areas of habitat. Given data limitations in generating the initial COAs, updating of the COA map using new information is encouraged by the SWAP. In addition to COAs, habitat protection and restoration programs have identified state priorities around certain management issues. These include:

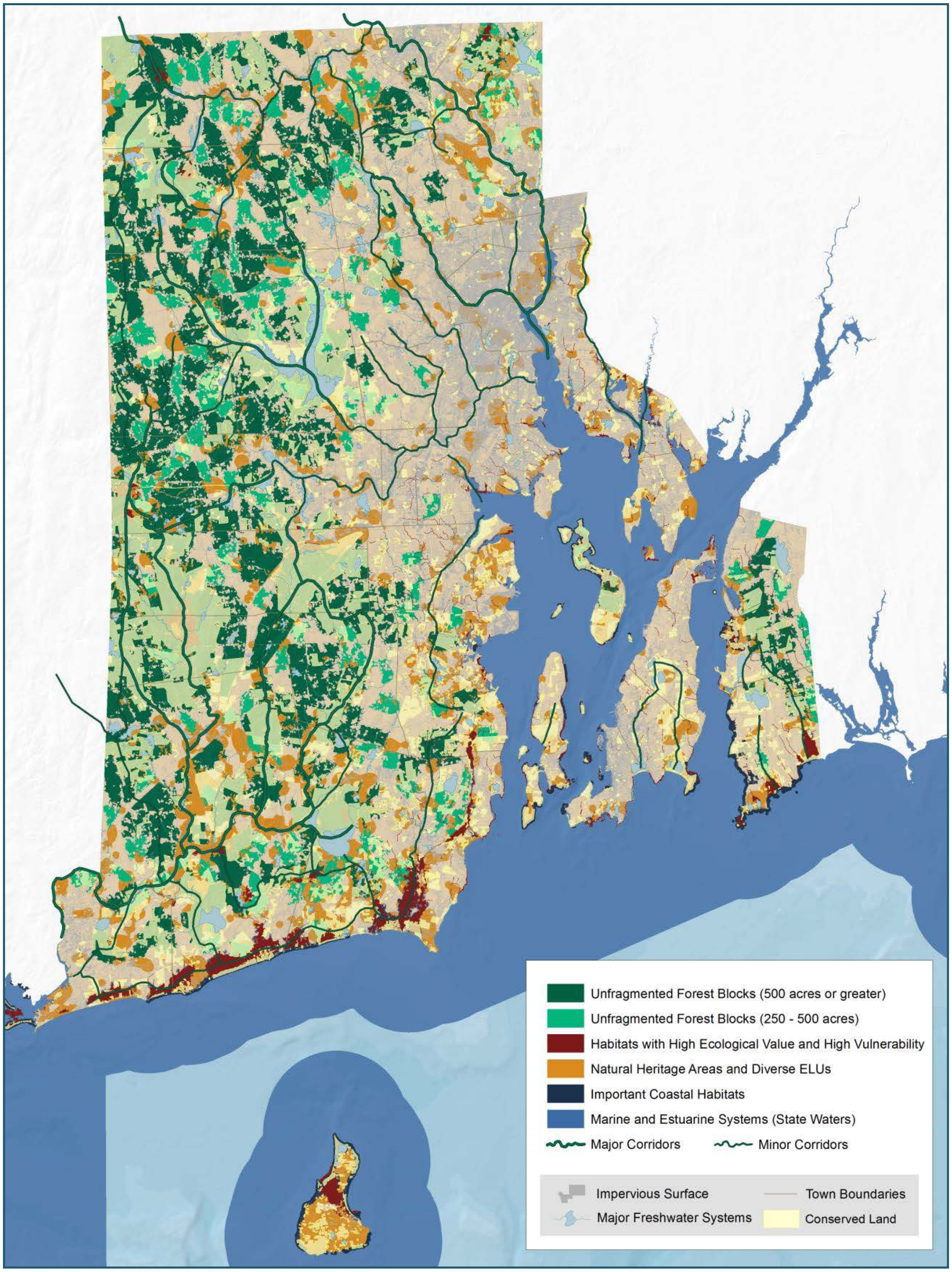
- CRMC Designation of Type 1 coastal waters serves to prioritize protection of shoreline habitats in a natural undisturbed condition. Human alterations in these areas are restricted in order to protect valuable habitats including salt marshes, shallow coastal ponds and eelgrass beds. Goals are to preserve and protect Type 1 waters from activities and uses that have the potential to degrade scenic, wildlife, and plant habitat values, or which may adversely impact water quality or natural shoreline types.

- Invasive species: given the technical challenges and expense involved in managing infestations of aquatic invasive species, the RI Aquatic Invasives Species Management Plan places a priority on actions to prevent the introduction and spread of AIS. It is much easier to intervene and contain an early infestation than attempt to abate and control a widespread, well -established population of aquatic invasive plants. Unfortunately, given the widespread occurrence of aquatic invasive plants in freshwater lakes and phragmites in both coastal and freshwater habitats, it is evident that active management of existing AIS is also a necessity and challenge.

- Freshwater Wetlands: Rhode Island has a well-established policy that the loss of wetland habitat should be avoid and minimized. This policy is aimed at achieving the goal of "no net loss of wetlands" which is also a national goal of federal agencies.

- Restoration of migratory fisheries: Working with partners, DEM-DFW planning work has provided a prioritization of fish passage locations relative to quantity and quality of habitat that would be accessed.

Figure 11, Conservation Opportunity Areas, RI State Wildlife Action Plan, 2015



Part 4 Water Quality Monitoring and Assessment

Key Points

- Water quality monitoring is essential for effective water resources management.
- The capacity of the State and its partners to sustain important monitoring programs is an on-going concern.
- Unlike the more extensive surface water quality monitoring efforts, Rhode Island lacks a long-term groundwater quality monitoring strategy.
- Stewardship of aquatic habitats requires monitoring to characterize the ecological health and functioning of the targeted habitat.
- Climate change reinforces the need for monitoring hydrology and in habitats that are most vulnerable to its impacts.

Comprehensive Environmental Monitoring

This Section describes how monitoring and assessment supports management decision-making and generates insight into progress towards meeting the protection and restoration goals and policies of this Plan. Despite its importance, monitoring is an activity that is often also taken for granted. Without an unwavering commitment to monitor our water resources and their uses, we will not be able to accurately characterize and respond to current and future threats to water quality in a changing environment. Rhode Island State law directly addresses the topic of environmental monitoring. Established in 2004 by R.I. Gen. Law §46-23.2, *Comprehensive Environmental and Watershed Monitoring Act*, the Rhode Island Environmental Monitoring Collaborative (RIEMC)[1] was formed to develop and coordinate implementation of a comprehensive environmental monitoring strategy to support management of Rhode Island's natural resources. Monitoring is carried out by the members of the Collaborative that includes federal and state agencies and sponsored programs, universities, non-governmental organizations and other monitoring practitioners. The RIEMC works to coordinate existing monitoring activities, establish statewide monitoring priorities and identify and address, as resources allows, critical gaps in data collection. It is also positioned to promote the voluntary adoption of common methods and metrics that achieve compatibility in data collection across different organizations. Given its very limited resources, a comprehensive strategy that integrates monitoring related to land use, water quality and habitats remains a work in progress. To date, the RIEMC has focused on development of strategies for monitoring the ambient environment in order to characterize resource status (condition) and in some cases track trends. In its 2014 Summary Report the RIEMC has described 20 priority monitoring programs, most of which involve monitoring water quality or aquatic habitats. All but one of these have been implemented. The active programs are listed in Table 4. These ambient monitoring activities are supplemented by other

[1]http://www.coordinationteam.ri.gov/envirocollab.htm

data collection efforts that serve additional objectives related to research, targeted studies and site specific pollutant sources (e.g., effluent monitoring, TMDL water quality studies).

While RI's small geographic size is an advantage in terms of achieving a comprehensive monitoring program, **the capacity of the State and its partners to sustain important monitoring programs is an on-going concern**. Annual reports of the RIEMC, highlight the need for additional investment in monitoring with over $2.7 million in needs identified in the 2014 Summary Report. Recent RIEMC reports, note that reductions in federal and state funding for environmental monitoring have eroded and continue to threaten the State's capacity to collect and manage the biological, chemical, and physical data essential for evaluating the condition of our water resources and guiding management decisions.

Table 4, Active Environmental Monitoring Programs
Source: RIEMC (2014)

Narragansett Bay and Coastal Waters	Lead Organizations
Narragansett Bay Fixed-Site Monitoring Network	DEM, URI-GSO, NBNERR, NBC
Narragansett Bay Spatial Dissolved Oxygen Surveys	Brown U., URI-GSO, STB, DEM
Shellfish Growing Areas	DEM
Saltwater Beach Water Quality	DOH
Shoreline Erosion, Accretion and Sediment Transport	CRMC, URI
Submerged Aquatic Vegetation - Eelgrass	NBNERR, STB, URI
Salt Marshes	CRMC, NBNERR, STB
Marine Fishery Surveys	DEM, URI-GSO
Ventless Lobster Trap Survey	DEM
Marine Aquatic Invasive Species Surveys	CRMC, DEM, NBNERR
Volunteer Monitoring – Coastal Ponds, Coastal Beaches	URI-WW
Freshwaters	
Large River Water Quality	USGS, DEM, NBC
Wadeable Rivers and Streams – Rotating Assessments	DEM
Freshwater Beach Water Quality	DOH
River and Stream Flows	USGS, DEM, WRB
Toxics in Freshwater Fish Tissue (Mercury)	DEM, EPA
Harmful Algal Blooms and Cyanobacteria	DEM, DOH
Freshwater Wetlands	DEM, RINHS
Freshwater Aquatic Invasive Species Surveys	DEM
Volunteer Monitoring – Lakes, Ponds, Rivers, Streams	URI-WW

<u>Surface Water Monitoring</u>

Rhode Island has an established strategy for the monitoring of surface waters. The Rhode Island Water Monitoring Strategy, first prepared by DEM in 2005, documents the surface water monitoring activities that are needed for the State to achieve its goal of comprehensively assessing its waters. The DEM has a leading role in implementing this strategy by both conducting monitoring programs and supporting monitoring by other entities. The EPA has recommended that RI's capacity be strengthened by designating a fulltime state monitoring coordinator. Collectively, the monitoring programs are aimed at gathering ambient data to assess water quality conditions, identifying water quality impairments and supporting management decision-making. Among many applications, the data generated are used in establishing and reviewing the State's water quality standards, measuring progress toward achieving the state and federal water quality goals, supplying information for use in developing permit limits for wastewater discharges and development of water quality restoration studies (TMDLs)[2]. A variety of monitoring strategies are employed to collect data from estuarine waters, freshwater rivers and streams, and lakes and ponds. This includes fixed-site networks, adoption of a 5-year rotational schedule for monitoring rivers and streams, targeted water quality surveys, and expansion of the use of biological indicators. The strategy is periodically updated to reflect changing conditions and priorities.

Despite limitations in capacity within state agencies, over the last decade progress has been made in reducing data gaps. A network of fixed sites in Narragansett Bay expanded from 5 to 13 locations between 2001 and 2008 although gaps remain in Mt. Hope Bay and the Sakonnet River. DEM's adoption of a rotating basin strategy for river and stream sampling targets a portion of the state's watersheds for monitoring from May to October each year on a five-year cycle. It has resulted in the creation of over 200 sampling stations statewide allowing water quality conditions in a majority of RI stream miles to be characterized (assessed). A collaborative effort is underway to collect fish tissue data from publicly accessible lakes. However, despite the progress, as noted in Part 2, Rhode Island's Water Resources & Trends, significant gaps in available water quality data remain. Priority gaps for public health include: the surveillance of potentially harmful algal blooms, fish tissue contamination data, risk-based monitoring of freshwater beaches, and monitoring of emerging contaminants of concern. Gaps in data also prevent or limit the assessment of water quality conditions in 26% of lakes acres, 35% of river miles and portions of RI's coastal waters including the Sakonnet River and certain embayments. Gaps also exist with respect to fully characterizing changes in aquatic ecosystems including biological responses, related to climate change and nutrient reduction. In addition, a lack of stable funding is a concern for several existing core state monitoring programs including the Narraganset Bay Fixed Site Network, the stream gage network, programs that monitor water quality in rivers and streams, and saltwater beach monitoring. These programs have historically been largely reliant on federal funding sources.

[2]http://www.dem.ri.gov/programs/benviron/water/quality/rest/index.htm

Assessment of Surface Water Quality

Monitoring data must be analyzed in order to translate it into meaningful information for state resource managers, other stakeholders and the public. This is accomplished through the use of indicators or criteria that support data assessment. In the case of water quality, data is assessed using criteria that are part of the state water quality standards established by regulation. DEM has established water quality standards/criteria and classifications for both surface and groundwater resources that provide a basis for assessment of water quality conditions.

Water Quality Standards and Classification

Surface Waters -The surface water quality standards, which are a part of the State Water Quality Regulations[3], are subject to approval by the EPA pursuant to the federal Clean Water Act (CWA) and may not be less stringent than federal requirements. The surface water quality standards consist of three basic elements:

- designated uses of the waterbody (e.g., recreation/swimming, drinking water supply, aquatic life, etc.)
- water quality criteria to protect the designated uses (numeric pollutant concentrations and narrative requirements), and
- an antidegradation policy to maintain and protect existing uses and high quality waters.

RI Water Quality Standards 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 R.I. Gen. Law §46-12.

All surface waters of the State are assigned to a classification. The classification is associated with specific designated uses. Every waterbody in the State is designated for swimming (primary and secondary recreational contact), fish consumption, and aquatic life (fish and wildlife habitat) uses. Some waters are also designated for shellfish consumption, or shellfish controlled relay and depuration, or drinking water supply uses. There are four freshwater (Class AA, A, B, B1) and three saltwater (Class SA, SB, SB1) classifications. Each classification is defined by the designated uses which are the most sensitive and, therefore, governing water use(s) which it is intended to protect. Surface waters may be suitable for other beneficial uses, but are regulated to protect and enhance the designated uses. In addition, the State has incorporated partial use classifications into the Water Quality Regulations for waters which will likely be impacted by activities such as combined sewer overflows (CSOs) and concentrations of vessels (marinas and/or mooring fields). Maps depicting surface water classifications can be found on the DEM website using the interactive active mapping tool[4].

Associated with each classification and use are water quality criteria which specify the conditions that will support the designed use. The criteria may be numerical, such as a concentration of a particular chemical compound, or narrative in which a description of the conditions is described. To maintain their effectiveness criteria are periodically updated in response to both federal guidance and improved scientific understanding. DEM is continuing work to refine

[3]http://www.dem.ri.gov/pubs/regs/regs/water/h2oq10.pdf
[4]http://www.dem.ri.gov/maps/index.htm

existing criteria in two areas: the development of numeric nutrient criteria and the development of biocriteria to describe aquatic life conditions.

To measure progress towards meeting the federal water quality goals, states are required to assess and report on the quality of their state's waters every two years pursuant to Section 305(b) of the Clean Water Act. In Rhode Island, this responsibility falls to DEM which assesses available data against established water quality standards and reports the results of this assessment in the State's Integrated Water Quality and Assessment Report (known as the Integrated Report). The water quality assessment process for surface waters results in a determination of whether or not the current water quality conditions in a specific waterbody fully support its designated uses (swimming, shellfish consumption, aquatic life, etc.). To evaluate the level of use support attainment, available water quality data is compiled and compared to the appropriate criteria for each designated use. A detailed description of the assessment methods is available in the document entitled "Consolidated Assessment and Listing Methodology". While existing water quality monitoring programs provide a sizable amount of information, data gaps exist and currently prevent a comprehensive assessment of all uses in all waters. The assessment process leads to an assignment of individual waterbodies or portions of waterbodies (assessment units) to one of five categories that reflect its attainment status. A significant outcome of the assessment process is the identification of those surface waters not meeting water quality standards and considered "impaired." These consist of waters listed in Category 4A, 4C and Category 5 of the Integrated Report[5].

Related Surface Water Classifications Systems

Coastal Resources Management Council (CRMC) Water Categories (Types)

Land in coastal areas is subject to coastal zone management classifications. The CRMC has established a use classification system for coastal waters within its jurisdiction that is directly linked to the characteristics of the shoreline. These classifications are based on both the water the property abuts and characteristics of the shoreline on or near the property. Coastal or shoreline features such as coastal barriers, dunes, and wetlands have specific regulations and protections under the CRMC. These regulations include structural setbacks, buffers, and rules pertaining to construction and renovating or remodeling older structures. The system has six categories that reflect varying intensities of human disturbance.

The waters along 70% of Rhode Island's 420 miles of shoreline are assigned to Type 1 and Type 2 waters by CRMC.

- Type 1 waters abut shorelines in a natural undisturbed condition and CRMC restricts most alterations in these areas.
- Type 2 waters are adjacent to predominantly residential areas, where docks are allowed but other more intensive use of the waters are not.
- Type 3 waters are dominated by commercial facilities that support recreational boating; e.g. marinas.
- Type 4 waters consist of the open waters of the Bay and Sounds where a balance must be maintained among fishing, recreational, boating and commercial traffic.
- Type 5 and Type 6 waters are assigned to ports and industrial waterfronts.

The DEM water quality classifications and the CRMC use classifications have been developed to be generally consistent with each other.

[5] http://www.dem.ri.gov/pubs/305b/index.htm

Rivers Council Classification Plan

The RI Rivers Council, in accordance with the requirements of RI General Law 46-28, established a classification system to promote the establishment of river, lake, pond, estuary, and adjacent land uses to protect and enhance the quality and use of rivers and other waterbodies. The designations must be consistent with the DEM water quality classifications so that uses are not promoted or proposed that could place public health or environmental integrity at risk. Differing from the DEM classification system, the Rivers Council attempted to classify the freshwater rivers of the State in a holistic approach by integrating water quality objectives with land uses and land use management. The classification of rivers, estuaries and watersheds is based on land use, habitat, open space values, historic and cultural values, as well as water quality. The Rivers Council established five freshwater classes (pristine, water supplies, open space, recreational, and working) and adopted the CRMC classifications for estuaries. These classifications are in Appendix A, Rivers Council Classification System 2004.

Groundwater Monitoring

Unlike the more extensive surface water quality monitoring efforts, **Rhode Island lacks an ambient groundwater quality monitoring strategy.** A strategy should be developed and integrated into the larger environmental monitoring strategy being prepared via the RIEMC. Given the limited resources and the localized nature of most groundwater contamination, it should be tailored to management needs, such as tracking conditions in aquifers known to have elevated nitrate concentrations. Currently, limited activities to measure both groundwater elevations and groundwater quality are ongoing and subject to limitations of funding. Measures are made by USGS under an agreement with DEM and WRB. Establishing more continuous monitoring to better meet data needs is currently under discussion. Groundwater quality monitoring presents particular challenges associated with the manner in which pollutants move in different aquifer settings. In general, groundwater moves very slowly (only inches to feet per day) compared to flowing surface waters. Once introduced into an aquifer, groundwater contaminants may form plumes that move very slowly, with very little mixing and at different depths depending on the topography, subsurface geology, contaminant and types of soils. It can be difficult to predict contaminant movement, particularly in some bedrock aquifers. Contaminants are known to persist in groundwater for decades. The result is that groundwater quality can vary greatly and is often localized, which presents challenges within the landscape when designing groundwater quality monitoring programs. Groundwater elevations provide hydrologic data that assists the state in managing water quantity. Efforts are underway to convert wells measured monthly to wells capable of providing continuous readings. This yields data that is much more useful in drought management situations.

Currently, the best source of available information on ambient groundwater quality is the Department of Health's data on the public drinking water wells that are regularly tested to ensure compliance with drinking water standards. The major public water supply wells serving municipalities and water companies are generally located in areas considered less susceptible to contamination due to acquisition and protection of land in the vicinity of such wells. However, the smaller public wells serving businesses (e.g., restaurants, hotels, schools, apartment complexes) and sometimes large developments are often located in fairly dense areas of development. Although these public wells may withdraw significant volumes of groundwater from a large area, diluting the impact of small pollution sources, the results are nonetheless used as representative of the local groundwater quality condition.

More than 150,000 Rhode Islanders drink groundwater supplied by a private well on their property. Homeowners dependent on a private, onsite drinking water well are responsible for testing their own water. They are encouraged to regularly test their well water quality. Until 2008, RI did not require any testing of private wells. These private wells are now required by the Department of Health to be sampled at the time of installation and when a property changes hands. This data is used by DOH to make recommendations for well testing. Homeowners are occasionally asked to test their private drinking water wells to assist in evaluating local groundwater quality, typically in areas of dense development dependent on OWTS where the groundwater quality is known or suspected to have increased levels of contaminants.

Assessment of Groundwater Quality

The DEM Groundwater Quality Rules classify all of the state's groundwater resources and establish groundwater quality standards for each class. Protection of drinking water sources is a primary objective of these rules. The four classes are designated GAA, GA, GB, and GC in accordance with the RI Groundwater Protection Act of 1985 (RI General Laws 46-13.1). Unlike surface waters. There is no federal requirement for establishing groundwater quality standards. Groundwater classified GAA and GA is to be protected to maintain drinking water quality, whereas groundwater classified GB and GC is known or presumed to be unsuitable for drinking water use without treatment. Greater than 90% of the state's groundwater resources are classified as suitable for drinking water use (i.e., class GAA and GA). Groundwater classifications are shown on Figure 12, DEM Groundwater Classification.

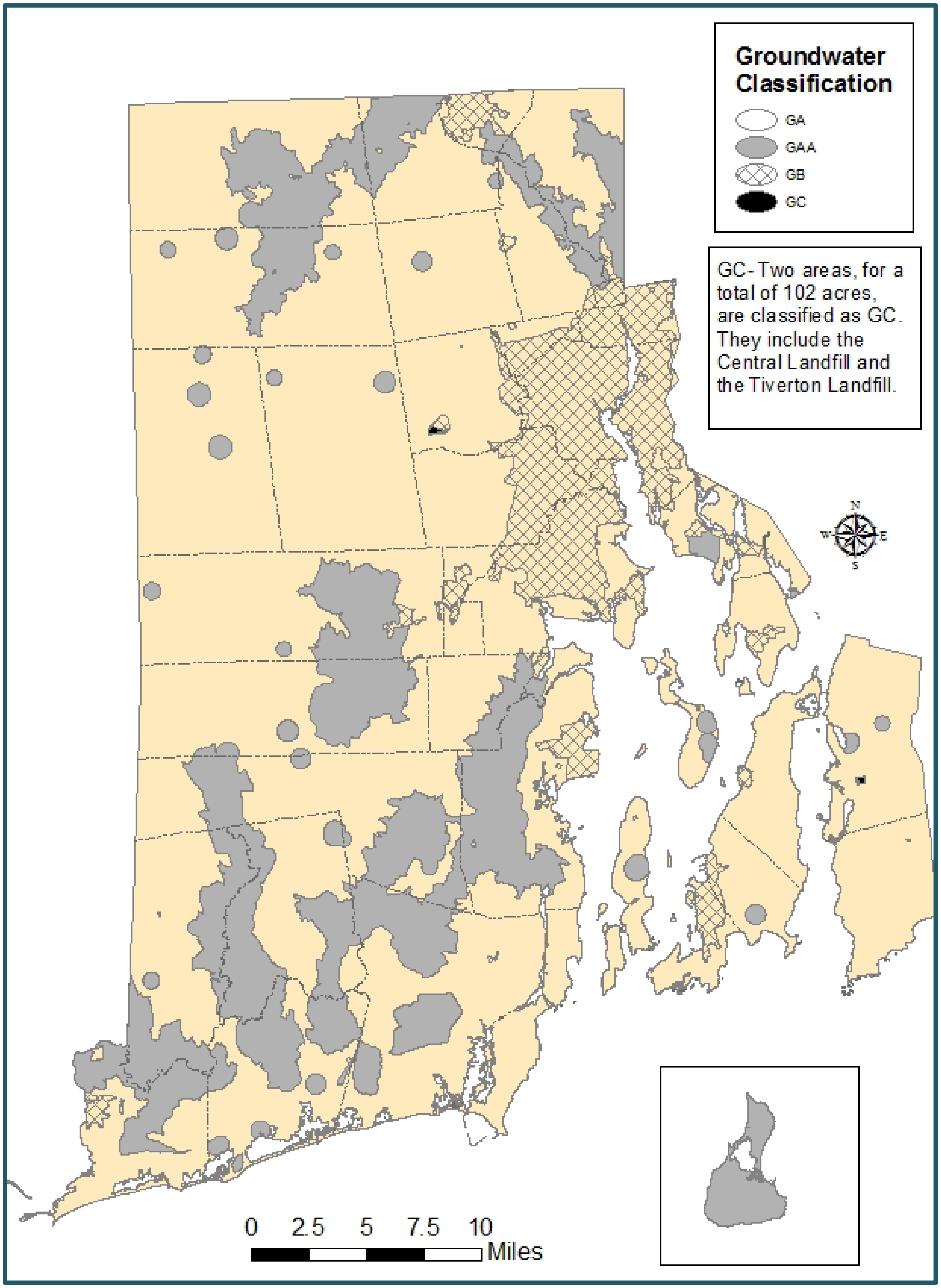
In addition, wellhead protection areas have been delineated for each of the State's 667 public wells which serve municipal systems, private water companies, businesses, schools, hotels, restaurants, etc. A wellhead protection area is the portion of an aquifer through which groundwater moves to a well. DEM is responsible for delineating a wellhead protection area for each of the public wells in the State. These wellhead protection areas are used in the same way as the groundwater classifications -- to establish facility design standards and to set priorities in DEM's regulatory and enforcement programs that address groundwater quality. As mentioned above, public water suppliers and their water provided are regulated by the DOH.

The GAA and GA standards are numerical and narrative in form. The numerical standards are derived from the federal drinking water standards with a few additional standards added for substances frequently encountered in RI groundwater for which federal maximum contaminant levels have not been adopted (naphthalene and MTBE). No pollutant shall be in groundwater classified GAA or GA in any concentration which will impair the groundwater as a source of drinking water or which will adversely affect other beneficial uses of the groundwater.

Greater than 90% of the State's groundwater resources are classified as suitable for drinking water use (i.e., class GAA and GA).

Groundwater classified GB and GC shall be of a quality that does not threaten public health or the environment; adversely impact current or future uses of property, groundwater, or surface water; or violate any surface water quality standards or surrounding groundwater quality standards. There is no goal to restore groundwater classified GB or GC to drinking water quality, however, groundwater remediation may be required in order to protect public health and the environment. Groundwater quality is assessed by comparing available data to the standards on a periodic basis. Assessment results are reported in a section of the Integrated Report described above in the discussion of surface waters.

Figure 12, DEM Groundwater Classification



Aquatic Habitat Monitoring

There are key gaps in available data on location and condition of aquatic habitats. More information is needed on the quality of pond and lake habitats, and data on amphibians including species potentially in decline. Work underway to address data needs include: statewide mapping of SAVs (eelgrass) and field surveys to better characterize bottom habitats in the urbanized upper Narragansett Bay to help prioritize future habitat restoration actions to enhance marine fisheries.

Stewardship of aquatic habitats requires monitoring to characterize the ecological health of the targeted habitat. The State Wildlife Action Plan (SWAP) discusses monitoring of both species and habitats, highlighting the regional context within which this work is carried out, given the often multi-state range and movement of wildlife. For freshwater habitats it notes that rivers and streams, freshwater wetlands, and lakes and ponds are habitats included in a regional monitoring and performance reporting framework developed for the northeast region states (NEAFWA, 2008). Northeast states also are collaborating on the use of common monitoring and survey protocols, which helps support regional assessments of species of greatest conservation need (SGCN) and their habitats. Eight strategies noted in the SWAP are primarily designed to collect data on the biological communities or physical traits of aquatic habitat. These include programs that collect data from freshwater wetlands and salt marshes, as well as populations of shellfish and finfish. The SWAP provides additional details on a wider range of monitoring programs among partners that contribute to the knowledge base about aquatic habitats. Examples include the DEM annual survey of nesting birds and a diamondback terrapin study. The methods employed and duration of monitoring of aquatic species or habitats vary from recently developed to long-established data collection programs such as finfish trawl surveys in estuarine waters, which have been carried out continuously since 1979, or fish community surveys in freshwaters which led to publication of the book *Inland Fishes of Rhode Island* in 2013. The objectives of the programs are to monitor the extent and conditions of certain habitat types to identify the stressors that may be degrading aquatic habitats and/or to track status and condition of biological communities, including fishery stocks.

Wetland Monitoring

In the case of wetland habitats, RI has adopted, but not yet fully implemented, a three-tiered monitoring approach that is consistent with national guidance from EPA. Under such an approach, data is collected at different scales with varying levels of detail: Tier 1- landscape scale, Tier 2, Rapid Assessment, of a site and Tier 3 intensive field data collection (site specific). Monitoring strategies have been refined for both freshwater wetlands and saltmarshes. Recent advancements in wetland monitoring have focused on Tier 2 methods and include:

- Development and refinement of RI Rapids Assessment Method (RIRAM 2.0) for evaluating freshwater wetland condition. As reflected in the RI Freshwater Wetland Monitoring Strategy (DEM 2006), this method involves field inspection of a wetland in order to document wetland characteristics to describe wetland condition. The method includes collection of data to identify landscape stressors, in-wetland stressors and measures of the integrity of wetland functions. Developed via a partnership between DEM and RINHS with support from EPA, the method has been validated with Tier 3 data. Overall, 281 wetland sites have been monitored with rapid assessment methods as of 2015.

- Development and refinement of Salt Marsh Monitoring Methods. The NBNERR, Save The Bay and CRMC in cooperation with DEM, have developed a tiered framework for assessing salt marsh condition and monitoring changes over time. Because RI salt marshes are exhibiting signs of degradation from accelerating sea-level rise and other stressors, a comprehensive strategy is needed to improve the coordination of long-term salt marsh monitoring. The tiered framework, builds upon existing work of partners and includes periodic mapping of salt marshes (Tier 1), use of rapid assessment methods (Tier 2) and intensive monitoring annually at a smaller number of sites[6].

Aquatic Invasive Species Monitoring


Invasive Water Chestnut - Central Pond

The RI Aquatic Invasive Species (AIS) Management Plan (2007) includes monitoring as a key component of its framework. It acknowledges the need to monitor the introduction and spread of aquatic invasive species (AIS) in both freshwater and coastal habitats. In addition, it recommends greater monitoring of known AIS vectors including ballast water, recreational boating/fishing, aquarium/pet trade, and nursery/water garden trade, among others. In response to growing public concern, DEM instituted seasonal surveys in 2007 which documented that aquatic invasive species (primarily plants) are a widespread concern in freshwater lakes. DEM also integrated surveillance of AIS into its ambient river and stream monitoring program. Resources to continue surveys are very constrained and primarily support confirmation of the presence of an AIS in a waterbody. The data needed to more fully evaluate the effectiveness of management interventions is not currently being uniformly collected and presents a limitation when trying to discern trends in condition.

In coastal waters, CRMC has taken a lead role in coordinating monitoring for marine invasives and collaborates with partners to conduct rapid assessment surveys (RAS) periodically (every three years). The strategy involves monitoring floating docks for the presence, abundance and spread of AIS in RI waters; looking for the presence of Chinese Mitten crab in estuarine rivers; and monitoring for invasive grass shrimp at various sites in coastal waters. It is coordinated with similar efforts in the New England region. DEM also identifies non-native species in its marine monitoring surveys. Some species may simply constitute visitors to RI waters that do not establish reproducing populations. The presence of others may reflect an expanded range for an aquatic species that may be associated with changing conditions (e.g. water temperatures). With respect to wetlands, the rapid assessment methods for both freshwater wetlands and saltmarshes described above include the identification of invasive species as part of the field inspection.

Aquatic Habitat Assessment

In contrast to water quality, the assessment of aquatic habitats is generally undertaken as a non-regulatory component of state management programs. Part 2 describes the assessment of condition and threats to priority key aquatic habitats documented in the RI State Wildlife Action Plan (SWAP). The SWAP further notes several freshwater habitats are included in a monitoring and performance reporting framework developed by the Northeast Association of Fish and Wildlife Agencies (NEAFWA) of which DEM is a member. Table 5 reflects the proposed indicators for these habitat types. Data collection is ongoing for some but not all of the indicators with frequency of data collection variable (e.g., impervious cover data derived from aerial photography interpretation is generated only every 3 to 5 years.). The SWAP recommends working with partners to design projects that help address data gaps.

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[6] Raposa, K. et al , "A Strategy for Developing A Salt Marsh Monitoring and Assessment Program for The State of Rhode Island", NBNERR, Save The Bay, CRMC, in draft – March 2016

Table 5, List of Conservation Targets and Proposed Indicators

Conservation Target	Proposed Indicators
Freshwater Streams and River Systems	• Percent (%) of impervious surface • Distribution and population status of Eastern Brook Trout • Stream connectivity (length of open river) and number of blockages • Index of biological integrity • Distribution and population status on non-indigenous aquatic species
Freshwater Lakes and Ponds	• Percent (%) of impervious surface • Shoreline integrity - % shoreline developed • Overall productivity of Common Loons
Freshwater Wetlands	• Size/area of freshwater wetlands • % of impervious surface flow • Buffer area and condition (buffer index) • Hydrology – upstream surface water retention • Hydrology –high and low stream flow • Wetland bird population trends • Road density

For some aquatic habitats types, a basic assessment is made by measuring its extent or the biological communities present. For example, a partnership exists to track the presence of SAVs and quantify changes in their extent over time. Relying on aerial photography interpretation, such work is only done periodically; e.g. every 3-5 years. Beyond mapping the extent of resources, managers are interested in the understanding habitat condition. For certain habitats, methods exist to develop metrics that can be applied to assess condition. In general, the methods involve the collection of physical and biological information that in combination can be interpreted to characterize a range of condition. Such methods are typically developed and applied to specific categories of habitats. Individual metrics may be combined into indices of biological integrity (IBI) which is another indicator tool that is useful in describing habitat condition and discerning trends over time. Similar to neighboring states, RI has developed a multi-metric index for wadeable rivers and streams that utilizes macroinvertebrate data to characterize condition. There is interest in developing a fish IBI using available data on freshwater fish assemblages in rivers. In RI, these metrics or IBIs generally have not been formally adopted into regulations, but are used to advance scientific understanding and resource management.

State Monitoring Policies:

Monitoring Policy 1: State water resource management should include monitoring as an essential component.

Monitoring Policy 2: State supported monitoring programs should continue to produce data that is useful to state management.

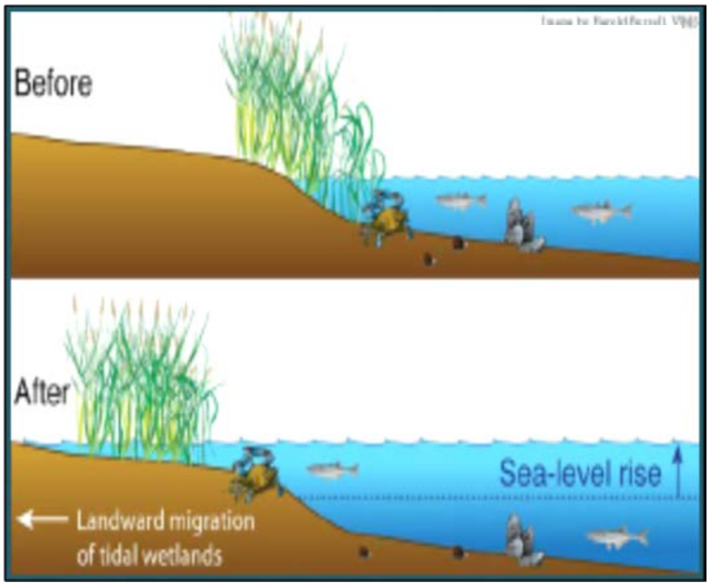
Monitoring Policy 3: Monitoring data should be accessible to users for decision-making at all levels.

Monitoring Policy 4: Provide benefits to monitoring efforts through coordination.

Monitoring Policy 5: Align monitoring programs with regional data collection strategies relating to climate change, aquatic ecosystems and water quality.

See Part 7, Implementation Matrix for all Recommended Actions.

Climate Change



As noted in Part 2, climate change can have a variety of impacts on water quality and aquatic ecosystems. This reinforces the need for long-term monitoring in waters and habitats that are most vulnerable to its impacts. Currently, state agency managers are particularly concerned with impacts to coastal ecosystems in estuaries, marine waters, and saltmarshes, due to sea level rise, other physical changes, and species composition. Managers will need to adapt current monitoring programs, including those collecting meteorological and hydrologic data, in order to be able to distinguish and understand changes in our water resources that are resulting from the influence of climate change. The data is needed to understand ecological impacts as well as support decision on adaptation of water pollution control infrastructure, including wastewater and stormwater systems. Rhode Island monitoring programs will benefit from alignment with regional initiatives concerning climate change. Significant analysis and planning has led to recommended regional plans for sentinel monitoring networks for wadeable streams (EPA) and coastal estuaries (NERACOOS). Additional resources will be required to implement these networks in RI.

Water Quality Assessment Policies:

Water Quality Assessment Policy 1: Water quality standards and criteria should protect the quality of RI waters and aquatic habitats.

Water Quality Assessment Policy 2: Protective Water quality standards and criteria include new scientific understanding when needed.

Water Quality Assessment Policy 3: Biological criteria and metrics are a valuable tool for assessing the effects of multiple stressors on aquatic ecosystems.

See Part 7, Implementation Matrix for all Recommended Actions.

Part 5 Planning

Key Points

- The watershed is the best area to use as the basis for water quality planning.
- Watershed management is the management of land use, water use and human activities in a comprehensive manner to protect and restore water quality in a watershed.
- Plans for portions of a watershed (sub-watershed) or specific water resources (e.g., lakes) are often necessary to achieve water quality goals.
- Land use planning must incorporate water quality goals.
- Targeted action plans (e.g., restoration plans, invasive species control, and riparian buffer plans) play a key role in implementing a broader watershed plan.
- Successful plans are those that incorporate local input, engage stakeholders and lead to action.
- Planning process is ongoing – plan implementation must be evaluated and the plan regularly updated.
- Land use decisions occur at the municipal level in Rhode Island, therefore effective communication is needed between all levels of government for successful watershed scale planning.

Watersheds as a Basis for Planning and Management

Water quality is best managed on a watershed basis. This concept is not new but has been embodied in several State Guide Plan Elements and has been a long-standing state goal. It has evolved into a core management principle that is reflected in the work across both governmental and non-governmental water related programs. For over forty years DOP, DEM, and CRMC have been carrying out work that recognizes the importance of watersheds and that is organized to support the watershed approach. Examples include:

- Design of state water quality monitoring programs for rivers and streams which are carried out on a watershed basis.
- Permits for wastewater discharges into rivers are derived from watershed-based water quality models that take into account upstream conditions and downstream impacts.
- Water quality restoration studies (TMDLs) are developed taking into account pollution sources located throughout the watershed of the impaired surface water.
- Special Area Management Plans are often aligned with the watershed boundary of the coastal resources targeted for protection; e.g. Greenwich Bay, and the coastal ponds
- Water Supply System Management Plans, prepared by major water suppliers, address water quality protection in drinking water supply watersheds.
- Water withdrawals are evaluated based on the effect it will have on watershed hydrology.
- Targeted water quality protection initiatives, such as requirements for advanced onsite wastewater treatment systems have been implemented on a watershed basis in the Salt Pond and Narrow River watersheds.
- Oversight of a state certification program for municipal comprehensive plans which include natural resource and water quality issues.

Why use a watershed approach?

- Water resources flow through multiple municipalities (and sometimes states) necessitating a broader approach beyond political boundaries.
- Decisions can be based on scientific analysis of specific needs in a watershed.
- The watershed is the unit within which physical, chemical and biological processes operate to determine water quality and health of aquatic habitats.
- Provides a basis for building partnerships and focusing actions to achieve substantive results across municipal and state boundaries.
- Recognizes that what happens upstream will impact downstream.

This Plan outlines strategies and actions that will strengthen the implementation of watershed-based management in RI. One of the primary goals is the generation of watershed specific plans throughout the state. Previous attempts to do this were not sustained due to a loss of resources among other factors. Drawing upon lessons learned from these experiences, this Plan emphasizes the value-added role that watershed plans can serve as a coordinating mechanism to share water quality information among entities in the watershed, identify priorities, and align resources to drive forward implementation of needed actions. As described further in the 2015 RI Nonpoint Source Pollution Management Program Plan, DEM will exercise a leadership role in fostering the development of plans.

A watershed plan serves as a mechanism to integrate the full range of actions recommended for protecting and restoring water quality and aquatic habitat within a given watershed. The watershed plan provides an opportunity to identify partners and to collaborate across all levels of the public and private sectors to determine and implement actions that are supported by sound science. As reflected in Figure 13, actions or initiatives from other plans and reports can be compiled into one unifying vision and action plan for the watershed. The other plans will be referenced for those who want to or need to delve deeper on a particular topic or strategy. The goal for the watershed plan is to:

4Rs Premise: providing the right information to the right people in the right manner will result in the right actions.

- Describe the water resources and their status.
- Describe the current management actions in the watershed by all parties.
- Create an Action Plan that identifies specific actions to protect and restore water quality and aquatic habitat and the responsible entity and timeframe. Actions identified in other plans will be compiled herein with additional actions added as necessary.
- Establish coordinating mechanisms between towns and others for plan implementation.
- Promote public understanding about the values of clean water and the actions necessary to achieve clean water goals.

The planning process should be on-going. Once a plan is adopted, success toward implementing the plan is regularly evaluated and the plan must then be updated accordingly. Although watershed boundaries usually extend beyond local and/or state boundaries, much of the actions called for in a watershed plan will be municipally based. In RI, authority lies at the municipal level for managing land use and for taking many other steps to improve water quality. Much of this Element’s implementation strategy depends on municipal involvement. Therefore, it is necessary that the watershed plan be closely integrated into the local comprehensive planning process. Because this WQMP is an Element of the State Guide Plan, this WQMP sets forth goals and policies that must, under State Law, be embodied in future updates of comprehensive community plans. The watershed plan can take a holistic approach by integrating water quality planning with land use planning and planning for activities such as recreation and habitat preservation. For example, the creation of greenways in the watershed, which improve water quality, provide recreational resources and vital habitat.

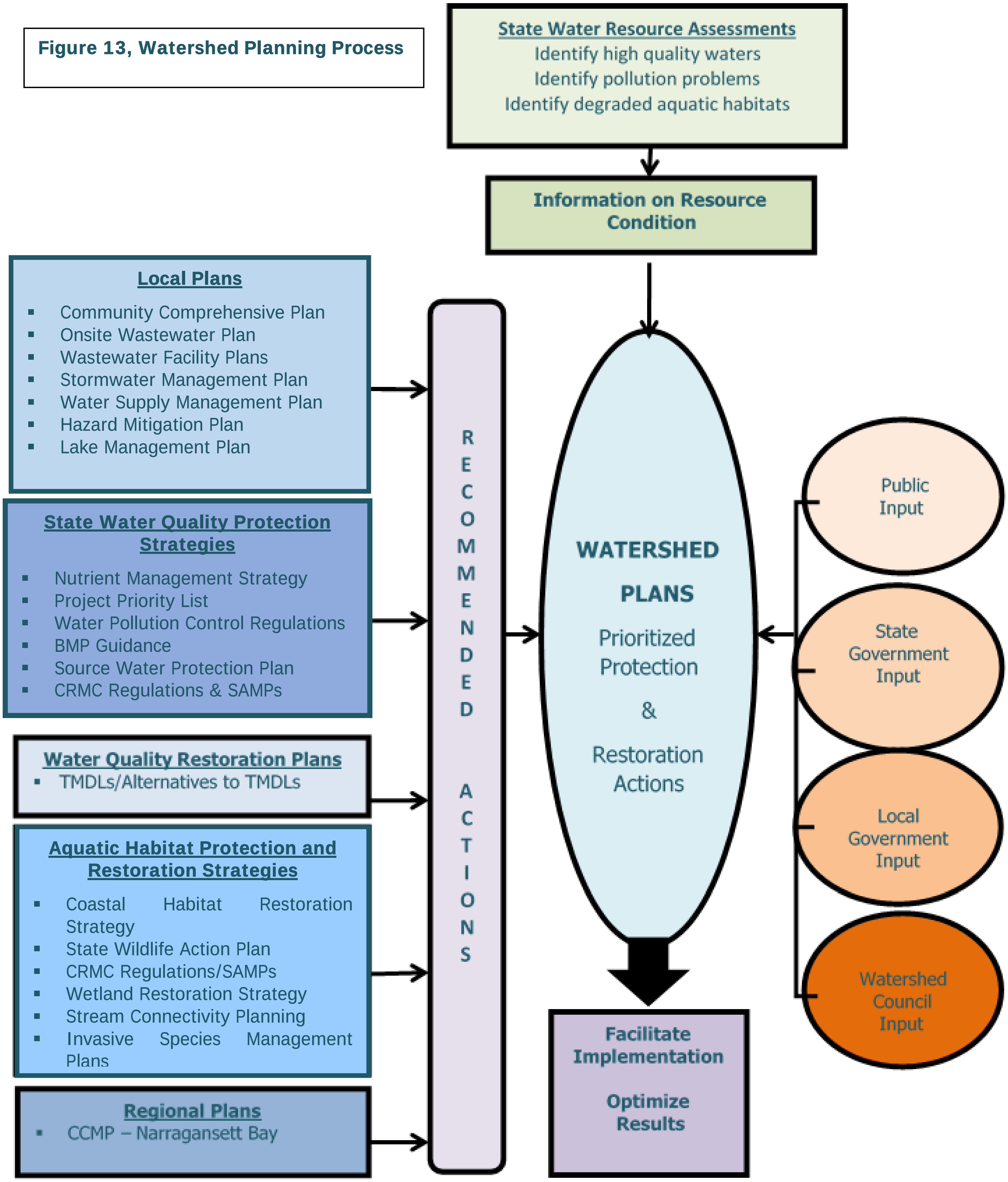
The "best" plans – ones that will be successfully implemented – are created with significant input from the people living, working and playing in the watershed. This will require active engagement of stakeholders to develop a shared understanding the needs within a watershed and build consensus on priorities. To be holistic in its approach, the process needs to consider and integrate both mandates (e.g. water pollution control actions that are required by a permit or rule) as well as voluntary, pro-active actions that stakeholders consider priorities (e.g. restoring buffers along a portion of a riverine corridor). Active watershed associations can play a critical role in the process by educating the public and facilitating local engagement, or in some cases perhaps leading a planning effort.

Rhode Island State government has carried out various watershed initiatives in the past. Several excellent watershed plans have been produced over the past two decades for some of Rhode Island's watersheds. Sustaining momentum has often been a challenge. Lessons learned from prior experience suggest a renewed watershed planning process will require leadership and sustained support to be successful. As resources allow, actions State government can pursue to support the process, include:

(1) building a more dynamic means for sharing value-added information on a watershed basis; e.g. websites, dashboards
(2) improving capacity to regularly exchange updated information on the status of protection and restoration action within a watershed
(3) refining policies to support integrated planning of infrastructure improvements, taking in to account evolving EPA policies
(4) expanding technical assistance to advance implementation actions using a variety of tools
(5) allocating funding to implementation of priority actions, and
(6) periodically evaluating and reporting on progress.

To prevent plans from languishing on the shelf, the planning process should aim to build capacity for local implementation among all stakeholders including fostering stronger partnerships that can successfully leverage additional funding.

Figure 13, Watershed Planning Process

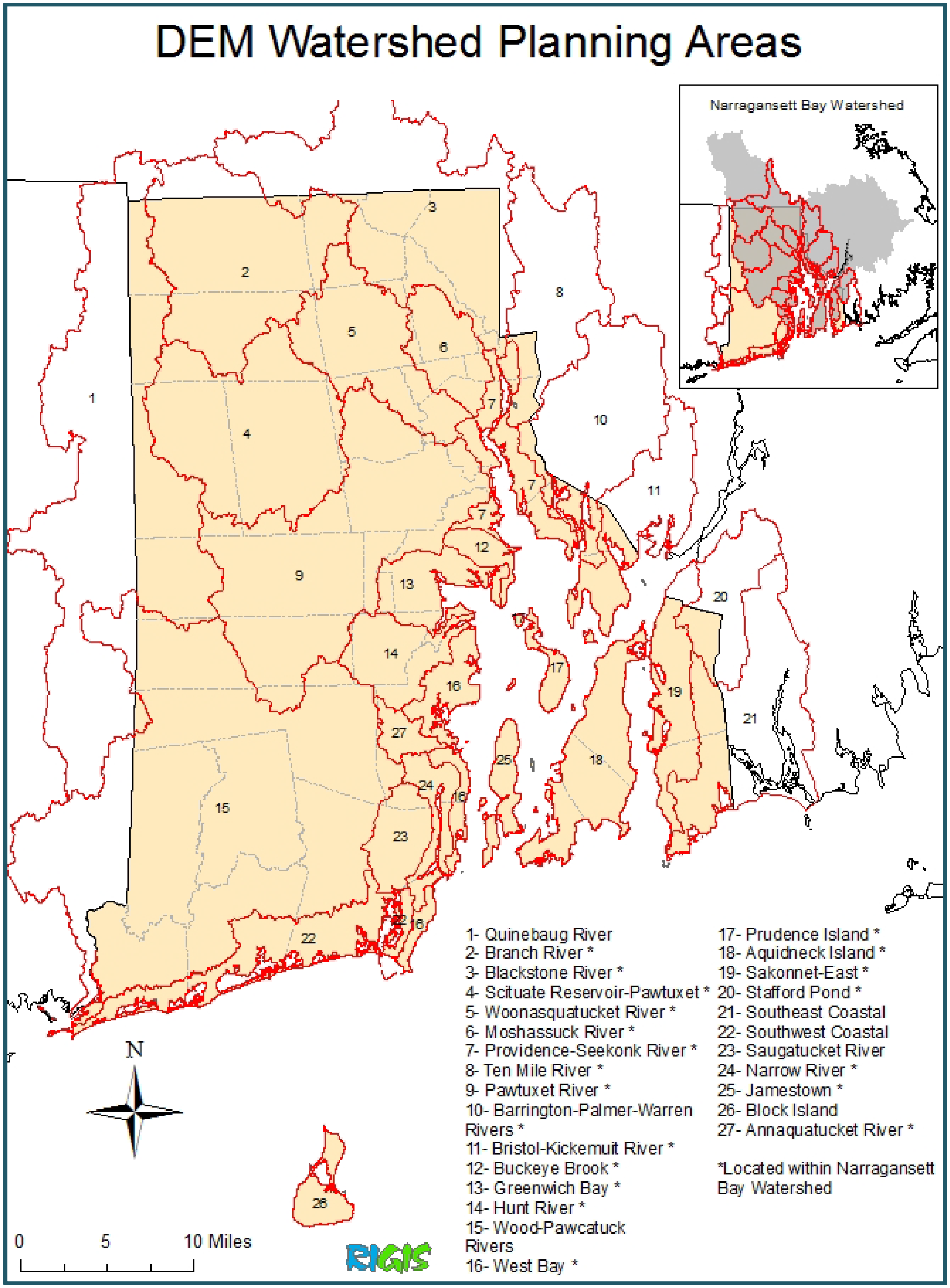


Appropriate Scales for Watershed Planning

The choice of scale for watershed delineations should be appropriate to serve the purpose for its use. Attempts have been made over the years to standardize the nomenclature and scale for watershed delineations. The approach most commonly used by hydrologists and regional planners is the USGS Hydrologic Unit Code (HUC) system[1]. These delineations were the starting point from which DEM delineated 27 watershed planning areas determined to be best suited for the development and implementation of watershed plans by taking into account: watershed size, uniqueness or similarities of particular watersheds, water quality management issues of concern in a watershed, and level of local citizen involvement as demonstrated by River Council designations. Twenty-one (21) of the 27 watershed planning areas in RI shown in Figure 14, DEM Watershed Planning Areas, are part of the larger Narragansett Bay Watershed. **However, it must be stressed that there is no one right watershed planning scale.** Despite the determination of the 27 watershed planning areas that will be used by DEM, smaller "sub-watershed" plans can potentially be more effective because they can be more specific and targeted, thus focusing limited resources on key areas in a larger watershed.

[1]http://water.usgs.gov/GIS/huc.html

Figure 14, DEM Watershed Planning Areas



Integrating Planning Activities

As noted in Figure 13, Watershed Planning Process, water-related planning activities occur on different scales (regional, state, local) and for varying purposes. These plans provide direction to enhance the development and coordination of statewide and watershed-wide programs and activities. Where sufficiently specific, they may also reflect actions appropriate for inclusion in watershed-based plans. Described below, these plans, typically prepared with a specific focus, can contribute content related to the protection and restoration of water resources. These plans often serve as a source of watershed specific recommended actions that should be reflected in a watershed plan.

Water Quality Management Planning

Water Quality Restoration Plans[2] (TMDLs) - DEM administers a federally mandated program for the development of water quality restoration studies and plans that are referred to as a total maximum daily load analysis (TMDL). The goal of this program is to develop and implement water quality restoration plans aimed at restoring impaired waterbodies to an acceptable condition that meets water quality standards and supports the waterbodies' designated uses (e.g. fishable and swimmable condition). Through the TMDL development process, which follows EPA guidance, water quality conditions are thoroughly characterized for the pollutants triggering the impairment and pollution sources are identified providing the technical basis for the pollution abatement actions specified. TMDLs are subject to EPA approval. There are several steps that are common to the development of most TMDLs:

- Compile and review available data and information on the impaired waterbody and its watershed.
- Identify interested stakeholders.
- Identify data and information gaps and if needed, collect additional data.
- Characterize water quality and pollution sources including estimates of the current amount of point and non-point sources entering the waterbody.
- Establish the TMDL water quality target (typically the applicable water quality standard) and estimate the allowable load of the pollutant that the waterbody can receive and still meet water quality standards (i.e., the total maximum daily load).
- Allocate allowable loads between point and non-point sources, and a margin of safety.
- Develop an implementation plan identifying the specific actions necessary to achieve the waterbody's water quality target(s).
- Conduct public meeting(s) and formally solicit and respond to public comments.
- Submit the draft TMDL to EPA for formal approval.

Public participation is vital to the success of any water quality restoration effort. Wherever possible, DEM utilizes a "watershed approach" in developing TMDLs - evaluating watersheds as a whole, and partnering with local officials, environmental organizations, and others to identify problem areas, collect relevant water quality data, and identify potential pollution sources and solutions. DEM seeks input from stakeholders at key points in the TMDL development process. In the initial stages of developing the TMDL, stakeholders can play an important role by contributing both water quality data and their in-depth local knowledge of the watershed. This information helps DEM to better characterize conditions in the waterbody and more easily identify pollution sources in the watershed. At the midpoint of the process, typically after supplemental water quality monitoring has been completed, DEM may host a meeting to discuss the monitoring results and to identify potential pollution sources and possible solutions. Finally, once a draft TMDL document is completed, it is made available for public review and comment for a 30-day period, and

[2] http://www.dem.ri.gov/programs/benviron/water/quality/rest/bkground.htm

a public meeting is held to present the TMDL report and to seek public input on the report's findings and implementation plan.

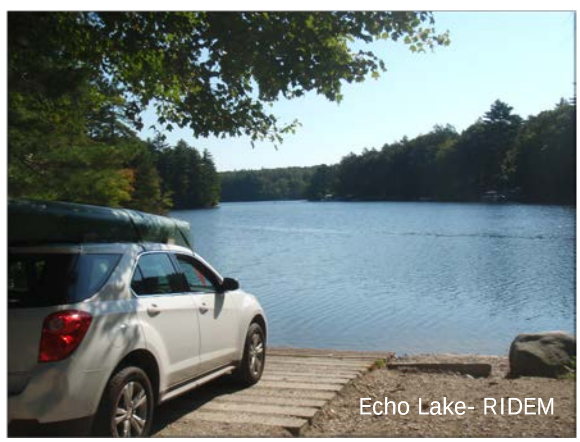
In Rhode Island, stormwater from urbanized areas is commonly found to be contributing to the water quality impairments addressed by TMDLs. As a result of the TMDL findings, municipalities (and the RI DOT) responsible for managing these stormwater systems may be required to implement enhanced maintenance measures (such as more frequent street sweeping or catch basin cleaning) and/or structural retrofits of their drainage systems to reduce runoff volumes and/or pollutants discharged to the affected receiving waters.

Based on 2014 Integrated Monitoring and Assessment Report information, DEM has completed TMDLs addressing a total of 203 impairments/causes on 148 distinctly named waterbodies. Ninety-six named waterbodies remain on a schedule for TMDL development which extends through 2022. These include 55 rivers or river segments, 31 lakes and 35 coastal water areas.

Special Area Management Plans (SAMPs)

The Coastal Resources Management Council prepares comprehensive plans that provide for natural resource protection and reasonable coastal-dependent economic growth in policies and actions set forth for a specific coastal area of the State. Protection of water quality is a key component of SAMPs. The CRMC coordinates with local municipalities, as well as government agencies and community organizations, to prepare the SAMPs and implement the management strategies. The following SAMPs have been prepared: Metro Bay, Greenwich Bay, Aquidneck Island West Side, Narrow River, Salt Ponds Region, Pawcatuck River, Ocean, and Shoreline Change (BEACH).In addition to the strategies to protect water quality, the SAMPs, in conjunction with the CRMC coastal management program, direct allowable land uses and activities within the coastal zone jurisdictional area. The CRMC coordinates with local municipalities, as well as government agencies and community organizations, to prepare the SAMPs and implement the management strategies. The Rhode Island Shoreline Change Special Area Management Plan (SAMP)[3]provides guidance and tools for state and local decision makers to prepare and plan for, absorb, recover from, and successfully adapt to the impacts of coastal storms, erosion, and sea level rise. The intended audience for this SAMP, in addition to CRMC members and staff, are decision makers, planners, boards and commissions in Rhode Island's 21 coastal communities.

Lake Management Plans - Stronger management of lakes is needed in RI both to prevent further degradation of lake conditions and restore lakes currently in poor condition[4]. While lacking a formally organized lake management program within state government, DEM has encouraged the development of lake management plans that integrate topics related to water quality and aquatic invasive species while taking into account the larger watershed within which the lake is located. A lake management plan provides the framework for fostering more effective management by identifying the threats to water quality and habitat conditions, and the actions needed to prevent degradation and restore and manage existing


Echo Lake- RIDEM

[3]http://www.beachsamp.org/samp/
[4] DEM Lakes Report

conditions. Actions commonly reflected in a plan include but are not limited to strategies to control invasives plants, to reduce phosphorus and other pollutant loadings (promote proper maintenance of OWTs, upgrades of cesspools, fertilizer practices, stormwater BMPs), to protection of lake shoreline vegetation (riparian areas) and manage hydrology (dam operations). At present, a minority of public lakes are being managed in accordance with well- developed, documented lake management plans. Depending on specific circumstances, various entities may be responsible for planning and leading lake management. These might include state and local governments, watershed associations, lake associations, dam associations, lake civic groups or private parties. During the last decade, several lake associations have taken steps toward developing plans. Lake management plans were prepared for two lakes in Glocester in 2010 using state and federal funds as a pilot project (Bowdish Lake and Smith and Sayles Reservoir).Local groups would benefit from greater technical and financial assistance to complete needed lake management planning. Additional capacity is needed at both the state and local level to advance progress. Both the Rhode Island Aquatic Species Management Plan and 2012 DEM lakes report recommend establishment of a lake management program.

Water Supply System Management Plans- Water Supply System Management Plans are required by the Water Resources Board for the 29 large suppliers -- those supplying greater than 50 million gallons of water per year. These management plans include information on the water supply infrastructure and water use which is relevant to watershed hydrology and watershed plans. The plans have a water quality protection component wherein the supplier is required to identify actions for protecting water quality in its source water protection area (reservoir watershed and/or wellhead protection area). Plans must be updated every 5 years.

Source Water Protection Assessments/Plans (Large suppliers)-- These plans were prepared by the Department of Health for the 29 large water suppliers in RI in 2003 as required by the Safe Drinking Water Act. Plans included an assessment of the vulnerability of the water supply based on water quality data and activities in the source water protection area and recommendations to protect the water supply. Since there are no requirements to update these plans, any source water protection planning for the large suppliers should be integrated into the Water Supply System Management Plans.

Source Water Protection Plans (Small supplier)-- Source water protection/supply system plans for the smaller public water suppliers (all those not subject to Water Supply System Management Plan requirements) are not required, but are strongly recommended. A number of plans have been prepared for willing suppliers using state and federal resources as they become available.

Water Related Infrastructure Planning

Land Use 2025, State Guide Plan Element 121, envisions Rhode Island as a unique and special place, retaining its distinctive landscape, history, forests, and natural beauty, while growing to meets its resident's needs for a thriving economy and vibrant places to live. The Plan contains four goals with objectives and strategies to achieve this vision. It identifies an Urban Services Boundary (USB), based upon a detailed land capability and suitability analysis that demonstrates the capacity of this area to accommodate future growth based on the availability of public water, sewers, etc. The Plan recommends that the State and communities concentrate growth inside the Urban Services Boundary and or within locally designated centers, and to pursue different land use approaches for urban and rural areas such as smart growth and conservation development.

Wastewater Treatment Facility Plans (WWTF) – Wastewater treatment facility plans are long-term (20-year) plans that document the needs of wastewater treatment systems. They identify needs related to enhanced treatment, system capacity and existing and future service areas. Facility plans are prepared by the operators of WWTFs and certain municipalities that have responsibility over portions of a sewer collection systems but not treatment facilities. Consistency with a facility plan is a pre-requisite for decisions by DEM to authorize modifications to existing wastewater infrastructure. It also is a factor in determining projects as qualifying for funding via the Clean Water State Revolving Fund.

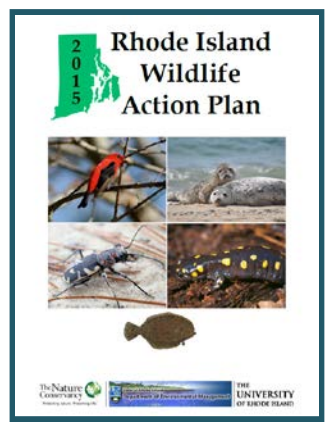
On-Site Wastewater Management Plans - Local communities that rely on on-site wastewater treatment systems (OWTSs) have been encouraged to develop local on-site wastewater plans and programs. The plans identify specific actions a community expects to carry out to promote proper operation and maintenance of OWTSs. The plans also identify actions that would enhance local programs. DEM approval of an onsite plan is necessary for a community to receive funds to lend to homeowners for system repair or cesspool removal under the Clean Water State Revolving Fund's Community Septic System Loan Program (see Part 6)

Stormwater Management Plans - Most RI municipalities have developed local stormwater management plans which outline actions needed to prevent and abate impacts to water quality from stormwater runoff. The plans identify actions municipalities want to take to enhance locally administered programs, such as pre- and post – construction oversight of stormwater BMPs, as well as specific projects that are needed to retrofit existing infrastructure in support of water quality restoration goals. These stormwater plans are required under the DEM stormwater permitting program for municipalities (see Part 6).

Land Use Planning for Water Quality

Comprehensive Community Plans - Rhode Island cities and towns are required by R.I. Gen. Law § 45-22.2-1 to have a community comprehensive plan (CCP) that must be updated at least once every 10 years. The CCP are required to be consistent with the goals and policies within the State Guide Plan. In turn, State agency projects and activities are to conform to local plans that have received State certification of consistency. The Act specifies required topics for the Plans with many opportunities to include provisions for the protection and restoration of water quality. The CCP serves as the basis for all municipal land use, zoning, and development review decisions and ordinances. For more information see The Division of Planning website[5].

Planning for Habitat Protection and Restoration



State Wildlife Action[6] Plan - Rhode Island has prepared a State Wildlife Action Plan that is part of a national program created by Congress in 2000 to address the longstanding need to fund actions to conserve declining fish and wildlife species before they become threatened or endangered. The plan, subject to USFW approval, allows RI to remain eligible for matching grants. DEM updated the plan in 2015. Intended to be proactive, the SWAP assesses the health of the State's wildlife and habitats, identifies the problems they face, and outlines actions needed to conserve them over the long term. It encompasses both marine and freshwater habitat types and provides recommended actions on conservation relevant to watershed plans. It describes and cross-reference planning activities related to restoring fish passage and improving stream connectivity.

Coastal Habitat Restoration Strategies - The growing interest in habitat restoration has prompted a commitment by CRMC and DEM to update and further develop habitat restoration strategies. DEM, in collaboration with NBEP, will produce an updated statewide plan for fish passage to support anadromous

[5]http://www.planning.ri.gov/
[6]http://www.dem.ri.gov/programs/bnatres/fishwild/swap15.htm#swap

fish restoration that includes site specific recommendations for dam locations on coastal tributary rivers and streams. CRMC is leading an initiative to develop a restoration plan targeting saltmarshes.

Aquatic Invasive Species Management Plan - In response to the growing concerns about aquatic invasive species, Rhode Island prepared its first statewide management plan for aquatic invasive species, which was approved in 2007. It was created under the auspices of the federal Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, as amended by the National Invasive Species Act of 1996, and the resulting regional panel – Northeast Regional Nuisance Species Panel (NEANS). The plan qualifies RI for a limited amount of federal funding provided through USFW. The plan identifies AIS documented in RI or considered a threat for introduction to RI. The plan also outlines objectives and needed actions in the categories of coordination and communication, monitoring, education, outreach and training, research and development, planning, assessment, prevention and control, legislation, and regulation.

Riparian Buffer Protection and Restoration Plans

One means of promoting healthy watersheds is through the restoration of riparian buffer areas located along rivers, streams and ponds. Riparian buffer plans are typically prepared for a watershed or sub-watershed in order to identify and prioritize opportunities to restore land areas immediately adjacent to a waterbody to a naturally vegetated condition. While appropriate for all watersheds, few such plans have been completed in RI and as such it constitutes a second gap in planning capacity affecting watershed management. As part of DEM's prior sustainable watershed initiatives, buffer restoration plans were completed for the Greenwich Bay and Buckeye Brook watersheds (2005) and Woonasquatucket River watershed (2001, 2003). These watershed plans help to identify sites and may also involve assessment of both the feasibility and potential benefits of buffer restoration for a given site. In the Woonasquatucket watershed, one plan documented a total of 239 potential buffer restoration sites over ninety percent privately owned. The need to work with many landowners to achieve buffer restoration along either a river or pond is recognized as a challenge. Never the less, with growing recognition of climate change impacts on riverine systems and floodplains, it is appropriate to focus more attention on riparian buffers as one means to promote resiliency. This type of planning work should aligned with related flood prevention and mitigation activities occurring on the local and state level. Building capacity to advance planning in this area is a current need.

Planning Policies

Planning Policy 1: Support, promote and facilitate sustainable land use practices and planning that protects water quality from new development and improves water quality upon redevelopment.

Planning Policy 2: Watershed-based plans will provide a sound basis for implementation of water quality management actions at the state and local level.

Planning Policy 3: Ensure planning for water quality protection and restoration is effectively coordinated to maximize efforts.

Planning Policy 4: Build state and local capacity to address key gaps in planning that currently limit effective lake management and riparian buffer protection and restoration.

See Part 7, Implementation Matrix for all Recommended Actions.

Part 6 Pollution Sources and Other Aquatic Habitat Stressors

Key Points

- There are 24 identified water pollution sources ranging in size and impacts, including large sources such as wastewater treatment facilities to smaller impacts from pet waste.
- Invasives species are a threat to conditions in all types of aquatic habitat.
- Individuals are responsible for their actions. Everyone should try to prevent pollution.
- There are 4 water cross-cutting resource management topics: climate change, pollution prevention, compliance and enforcement, and data management.

Overarching Management Issues & Policies

There are four cross-cutting water resource management topics that extend beyond the specific pollution source/programmatic discussions later in this section. They are climate change, pollution prevention, compliance and enforcement, and data management.

1. Climate Change: As discussed in Part 2, all aquatic ecosystems are likely to be affected over time by changing climate. Evidence of change has already been documented in salt marshes which are being impacted by sea level rise. Other changes to water quality or aquatic habitats are less certain as one tries to project out to 2035. What is known is that it is realistic to anticipate a variety of potential impacts to aquatic ecosystems, water quality and the functioning of the water pollution infrastructure we rely on to help keep our waters clean. Droughts, changing patterns of precipitation and snowmelt, and increased water loss to evaporation as a result of warmer air temperature may result in hydrologic changes that could result in the loss of wetlands, changes in stream flows and water quality. Increased frequency of intense storms may overwhelm existing stormdrains. Temperature change will drive other changes in natural environment processes that in turn affect the quality and quantity of our water resources and the hydrological communities that inhabit them. In some places in the State, sea level rise and salt water intrusion will present management challenges. Specific issues of concern related to climate change are included in the descriptions of the pollution sources and habitat stressors that follow. Water resource managers and communities need to continue to access emerging climate change information, evaluate potential impacts of climate change on water quality programs, and identify and implement needed adaptation responses as climate change impacts are happening now.

2. Pollution Prevention- Pollution prevention is putting into practice the common sense idea that the best way to manage waste is to avoid generating it in the first place. It is any practice which reduces the amount of any hazardous substance, pollutant or contaminant entering any waste stream or otherwise released into the environment prior to recycling, treatment or disposal. Pollution prevention focuses attention away from the traditional end-of-pipe treatment and disposal of waste, toward eliminating or reducing substances used in the production process itself. Pollution prevention practices include the cost effective use of resources through source reduction, improved housekeeping, energy efficiency, reduced water consumption, and reuse of input materials during production. DEM Office of Customer and Technical Assistance, as part of its pollution prevention efforts, has developed evidence-based, self-certification programs aimed at improving environmental performance in the automotive refinishing, underground storage tank, construction site management (storm water runoff) and auto salvage yard facility sectors. In addition, the Office has established green certification programs for the RI hospitality industry, higher education facilities, golf courses, landscapers and has worked with CRMC on the Clean Marinas Program

(See the Boating and Marinas sub-section later in this Part.) Collectively, these Environmental Results Programs have shown statistically significant improvements across a range of human health and environmental indicators leading to better outcomes at less cost. A variety of tools can be used to promote voluntary compliance but experience shows that effective enforcement activities will be needed as well.

3. Compliance and Enforcement - Many of the pollution sources identified below are managed by federal, state and local regulatory programs. The regulations are only as good as the programs in place to enforce them. Protecting and restoring water quality requires effective enforcement of the regulations. The public expects that the laws and regulations are being followed to protect the resources they care about. Businesses expect to operate on a "level playing field" where competitors do not gain an unfair advantage by not complying with water quality laws and regulations.

4. Data Management – The various entities involved in water resource management have shared interest in data that is held across programs. State agencies and a variety of other entities generate environmental data that helps to characterize water quality and aquatic habitat conditions. In addition, any particular site (location, property, and facility) may be subject to permitting and compliance with one or more of the regulatory programs discussed in detail in this section. Improving the capacity of state programs to improve management and integration of data systems to provide ready access to desired information would greatly enhance agency program coordination, tracking and reporting. In addition, improved data systems would support synthesis of the large volumes of ambient water quality and aquatic habitat data and yield insights useful to management. Any improvements in state and federal data management must be done with the complementary goal of improving the public's access to the data.

Educate – Regulate – Enforce

Pollution source management is built on 3 primary elements:

Educate – inform the public and businesses of the actions (voluntary and required) to take to prevent pollution.
Regulate – implement regulatory programs to set standards and specify required actions for water quality and habitat protection.
Enforce – regulatory programs must be adequately enforced to ensure protection.

Overarching Policies

Climate Change Policy: Ensure management of water quality and aquatic habitats is adapted to minimize adverse impacts associated with a changing climate change.

Pollution Prevention Policy: Prevent water pollution whenever possible.

Compliance and Enforcement Policy: Ensure compliance with federal, state and local regulatory programs for water quality protection and restoration.

Data Management Policy: Ensure that integrated, well supported data management systems are available for water resource protection and restoration program management.

See Part 7, Implementation Matrix for Recommended Actions.

Pollution Sources & Policies

Wastewater Discharges to Surface Waters and Collection Systems (Sewers)

Pollutants: pathogens, nutrients, organic wastes, toxic contaminants, pharmaceuticals, and personal care products (and other contaminants of emerging concern).

Challenges:

- Untreated discharges from combined sewer overflows must be eliminated to restore water quality in Providence and Seekonk Rivers and Narragansett Bay.
- Although pollutant loadings have been reduced through advanced treatment, WWTFs continue to be a major source of nutrient pollution in RI waters.
- Planning for expansion of wastewater systems should be strengthened and aligned with statewide land use and economic development plans and policies.
- Ongoing investment in the repair, replacement and maintenance of aging public wastewater infrastructure is necessary to sustain the gains achieved in water quality.
- Wastewater infrastructure capital investment needs far exceed the current capacity of financial assistance programs.

Water Quality Concerns: Most Rhode Islanders (~70%) rely on public sewer systems to handle residential and commercial wastewater flows. Over 140 million gallons per day of wastewater is collected via sewer systems and treated by Rhode Island's nineteen major wastewater treatment facilities. Over 75% of this treated wastewater is discharged by thirteen major wastewater treatment facilities (WWTFs) directly into coastal waters, including the state's largest WWTF at Fields Point operated by the Narragansett Bay Commission. The remaining six major WWTFs discharge into four freshwater rivers: the Blackstone, Clear, Woonasquatucket and Pawtuxet Rivers. No sanitary wastewater is authorized for direct discharge into lakes in RI.

As part of their operations, the major WWTFs operate 13 septage receiving facilities which accept over 40 million gallons of septage waste annually from OWTS delivered by licensed haulers. WWTFs also generate sludge, 27,000 dry tons per year, which is most often disposed of off-site, with the majority going to RI's Central Landfill in Johnston. While progress has clearly been made in reducing water pollution associated with wastewater infrastructure, not all water quality concerns have been addressed. Current areas of significant focus are further controlling nutrient pollution, continuing to abate the discharge of combined sewer overflows (CSO), ensuring proper operation and maintenance, exploring solutions to long-term financing needs and addressing the vulnerability of WWTF to climate change.

Controlling Nutrient Pollution

As described in Part 2, WWTF discharges have been identified as a major source of nutrient pollution to certain Rhode Island waters including upper Narragansett Bay. Over the last fifteen years, investment of $275 million in WWTF upgrades to advanced treatment has proven successful in significantly reducing loadings of both nitrogen and phosphorus. With respect to the upper Narragansett Bay region, the interim goal in the 2005 DEM nutrient reduction strategy that targeted eleven RI WWTFs to achieve a 50% reduction in the summer seasonal nitrogen loadings into upper Narragansett Bay over levels from 1995-1996 was met by the end of 2014. Full implementation of all WWTF upgrades targeted in this strategy is expected to occur in 2017 when construction of improvements at the Woonsocket WWTF are completed.

Management attention has turned to monitoring the response in Narragansett Bay. Preliminary indications of improvement at certain monitoring stations will need to be confirmed by multiple years of data collection due to the variability that occurs in conditions year to year. It is important to sustain monitoring during this anticipated period of change in conditions. Based on prior technical evaluations, it is not expected that the completed WWTF upgrades will *fully* restore degraded areas to compliance with state water quality standards. Rather it is expected that additional reductions in pollutant loadings would be required. Researchers and managers are continuing to collaborate on the development of new water quality models that may prove useful in evaluating the most appropriate course of future pollution control actions.

Combined Sewer Overflows (CSO):


Photo: Narraganset Bay Commission

The primary sources of bacteria in upper Narragansett Bay and Providence and Seekonk Rivers are combined sewer overflows (CSOs) that discharge a combination of untreated sewage and stormwater when it rains. As described in Part 2, the Narragansett Bay Commission (NBC) has completed the first two phases of a three phase CSO abatement strategy that established a goal of reducing annual CSO volumes by 98% and achieving an 80% reduction in shellfish bed closures. This initiative, costing about $588 million for Phase I and II, It is recognized as Rhode Island's largest and most expensive public works project to date. Prior to initiating Phase 3, the NBC led a re-evaluation of its options for CSO controls in the Blackstone River area utilizing a stakeholder process. Among the options considered was greater use of "green infrastructure" to capture stormwater from the landscape. The technical analysis concluded that such an approach by itself would not be sufficient to address the remaining CSO discharges. In 2015, NBC approved a multi-part plan for Phase 3 that specifies the use of "green stormwater infrastructure" (GSI), but also includes a deep rock tunnel in Pawtucket, new interceptors and related conveyance system improvements including sewer separation in the Blackstone River Valley region. NBC's plan for Phase 3, which is subject to DEM approval, indicates full implementation will be complete in 2038. It is estimated to cost $815 million.

Newport has the only other wastewater system in RI that involves CSOs. The City is planning enhancements to its existing two CSO facilities. A Collection System Capacity Assessment & System Master Plan (SMP) has been submitted to DEM and EPA. This Plan is the City's long-term plan to address CSOs. The SMP development took 2½ years to develop and is based upon system specific data, priorities of the City from feedback of a stakeholder workgroup and projected improvements as determined through the use of a hydraulic model. The City has proposed implementing the program over a 20-year implementation period which has regularly scheduled assessment periods to determine if targets are being met and to make adjustments to the program if necessary. The 20-year program has an estimated cost of $100 million.

<u>Minimizing Impacts:</u>

Within its comprehensive program for wastewater, DEM exercises oversight of the planning, design, construction and operation of wastewater facilities. With authority delegated by the EPA, DEM administers the Rhode Island Pollutant Discharge Elimination System (RIPDES) permitting program for discharges to surface waters. All major WWTFs and most minor permittees now operate with water quality-based permits that reflect effluent limits developed using water quality assessments of their receiving waters and corresponding wasteload allocations. Thirteen of 19 major WWTFs have effluent limits for ammonia, nitrogen and/or phosphorus which require advanced treatment. Effluent monitoring data is collected monthly, reported to DEM and shared with EPA. As part of an adaptive management approach, permits are periodically re-issued allowing advancements in scientific understanding to be incorporated into discharge permits as necessary.

In RI, public wastewater systems are developed in accordance with facility plans that provide the technical basis for planning and design. The plans identify areas that should be serviced by sewers and provide estimates to properly size the collection system, pump stations and treatment facilities. Currently, DEM does not require that facility plans be updated on a given schedule. The practice has been to update plans when the need arises including applications for funding assistance through the Clean Water State Revolving Fund (CWSRF). Disadvantages of this approach include the difficulty of aligning local land use plans, which must be regularly updated, with facility plans that may be considered outdated. In addition, occasions may arise in which an outdated facility plan may be considered a short-term obstacle to the pursuit of economic development; e.g. approval to extend sewers to an area is withheld because of inconsistency with a facility plan. Strengthening facility planning by ensuring regular updates to keep plan reasonably current would be beneficial to both wastewater management and local comprehensive land use plans.

Ensuring WWTF effluent limitations are met requires controlling the flows into WWTFs. Through oversight of wastewater facility plans, expansion of sewer service districts and other system modifications, DEM works with the WWTFs to ensure plants operate within their design flows. This oversight, coupled with state mandated operator certification and training, and state inspections has resulted in a high level of compliance with WWTF effluent limits around Rhode Island. However, as more plants are upgraded and treatment systems become more complex, continued training for operators will be important to sustain the overall excellent performance of Rhode Island's WWTFs.

While there has been significant recent investment in WWTF plant upgrades, the age and condition of the sewer collection system infrastructure remains a significant management challenge. RI does not have an inventory to accurately characterize the age of the over 2,600 miles of pipes associated with the 19 major systems, but is aware that portions of such systems are decades old or known to have been constructed in a manner that leaves them vulnerable to leakage and breakage. DEM receives reports of dozens of sewer system overflows (SSOs) annually and is encouraging WWTFs to adopt or expand asset management approaches to the operation and maintenance of their collection systems. NBC is one system that has been actively reducing the number of SSOs in its system through implementation of an Asset Management Program, by eliminating CSO discharge points, reconstructing regulator pipes and by instituting inspection and monitoring initiatives.

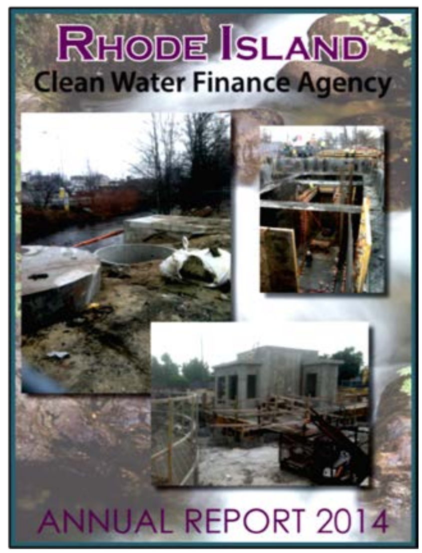
Oversight of industrial and smaller wastewater discharges is also an important component of RI's overall wastewater management program. Additional permitted discharges into rivers or coastal waters include 4 major industrial facilities with non-sanitary wastewater, 54 minor facilities including minor sanitary wastewater treatment facilities, aquaculture facilities, bulk fuel terminals, drinking water treatment plants and various other industrial facilities, 11 non-contact, cooling water discharges and discharge of treated contaminated groundwater. Among these, the largest is a cooling water discharge from electrical generation at the Manchester Street Power Plant in Providence. Over time there has been a downward trend in the number of minor sanitary surface water discharges due to shifts to alternate means of disposal; e.g. inground or public sewer connection. Progress continues to be made towards having minor permitted facilities meet applicable water quality-based limits. Typically, these efforts have focused on water quality-based limits for toxic pollutants, usually metals.

Incorporating Sustainability into Wastewater Management

Another area of growing attention for wastewater facilities has been energy efficiency and sustainability. Energy is often the second largest expense behind labor in running a WWTF. Advanced treatment processes at WWTFs consume even more electricity. In many municipalities, wastewater treatment facilities are the largest municipal user of energy (EPA, 2008). EPA, through its energy challenge program, is offering technical assistance to encourage the adoption of energy efficiency measures that often present major operating cost savings. Four RI communities to date have chosen to participate. One noteworthy project is the installation of 3 wind turbines at Field's Point for the NBC. The Project Priority List is generated and maintained by DEM in accordance with EPA regulations. Energy efficiency and sustainable infrastructure practices are now considered on applications for funding requests. Sustainability goals are also served when WWTFs adopt operational practices that reduce the utilization of toxic chemicals.

Climate Change: By their design and function, a wastewater treatment facility is typically located downgradient from the majority of its service districts. This places them in low-lying areas adjacent to the waters to which they discharge. As a result, wastewater infrastructure is vulnerable to climate change impacts associated with both sea level rise and changing precipitation. For example, during the Spring of 2010 flooding from the Pawtuxet River overtopped the Warwick Wastewater Treatment Facility causing it to shut down. Assessments of each system are underway as part of a statewide vulnerability assessment study being coordinated by DEM. The study is incorporating model predictions of coastal inundation due to sea level rise, storm surge as well as riverine flooding. The results will lead to prioritization of adaption measures that minimize impacts on the functioning of public wastewater infrastructure.

Wastewater Infrastructure Financing



In 1990, the Clean Water State Revolving Loan Fund (CWSRF) program[1] replaced the construction grant program. Established under Title VI of the Federal Clean Water Act and Chapter 46-12.2 of the Rhode Island General Laws, the Fund is a subsidized loan program for local government units to finance wastewater infrastructure projects. The purpose of this program is to provide financial assistance to local governmental units for water pollution abatement projects in the form of loans with below market interest rates or interest rate subsidies which reduce the cost of financing these projects by at least 33%. Co–managed by DEM and the RI Infrastructure Bank (formerly the Rhode Island Clean Water Finance Agency) the CWSRF has awarded over $1 billion in below-market interest rate loans for projects that were primarily related to wastewater in 27 communities and it remains the state's largest financial assistance program. In order for a project to be eligible for funding, the project must be on DEM's Project Priority List (PPL) and have a Certificate of Approval (CA) from DEM. The PPL is updated on an annual basis. Since the inception of the CWSRF, loans have been made to various municipalities and NBC. Funding for the program is available from four sources: federal capitalization grants, state match monies, Agency revenue bonds, and revolved capital. The program works as follows: Federal Capitalization Funds. Federal funds are made available under Title VI of the Federal Clean Water Act that established the loan program. A State match of 20% of the total grant award is required and has typically been satisfied by voter approval of state environmental bonds. The annual grant award to the State is based on a specific percentage of the total made available by Congress for the program. It is not based on project needs in any given year. The Agency has two years to apply for a federal grant after the funds have been appropriated. The Funds can be drawn down over a ten-year period of time.

The capacity of the CWSRF and limited other financial assistance programs is far exceeded by the long-term wastewater infrastructure needs documented on the RI Priority Project List and in the 2012

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http://www.ricwfa.com/programs/clean-water-state-revolving-fund/

Clean Water Need Survey (CWNS). Both indicated total wastewater needs exceeding $1.44 billion while the annual capitalization grant awarded from EPA to the State in recent years has been $9-10 million.

Fortunately, in the past the CWSRF has generally been able to provide financing to those wastewater projects ready to proceed. However, future projections suggest there could be constraints to doing so in the future. This heightens the need to continue to seek innovative means of addressing wastewater financing needs. Approaches used in other jurisdiction include public-private partnerships. As part of the administration of the CWSRF, DEM compiles a project priority list (PPL) annually based on submittals from WWTFs and municipalities. The 2015 list, which includes projects for both point and non-point source pollution, reflects $1.64 billion in projects associated with 23 municipalities, NBC and the Providence Water Supply Board.

The CWNS is a comprehensive assessment of the capital costs (or needs) to meet the water quality goals of the CWA and address water quality and water quality related public health concerns. Conducted nationally every four years, information is compiled about: (1) publicly owned wastewater collection and treatment facilities; (2) Stormwater and combined sewer overflows control facilities; (3) nonpoint source pollution control projects and (4) decentralized wastewater management. In RI, the survey is coordinated by DEM in accordance with EPA requirements. The 2012 survey identified total qualifying needs of $1. 921 billion. Of this, 97% or $ 1.86 billion were estimated costs related to wastewater infrastructure needs involving 25 communities in addition to NBC. Building off a foundation of facility planning, asset management and system capital planning, the needs survey provides a reasonable estimate of overall needs related to wastewater infrastructure. The needs related to CSO abatement represent almost 44% of the total ($816 million). Work on other aspects of the sewer conveyance systems are equally important with needs estimated at $605 million for repair and replacement and $108 million to address infiltration problems. Finally, the needs related to treatment facilities was estimated at $332 million. The Infrastructure Bank also administers additional programs to assist public wastewater systems. These include the Facility Plan Loan Program and the RI Pollution Control Revolving Fund.

Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policies:

Policy 1: Ensure that the planning, design, and construction of wastewater systems will protect public health and water quality and that the facility planning process considers climate change and guides the expansion and use of public wastewater systems.

Policy 2: Ensure discharge permits to surface waters will protect water quality.

Policy 3: Encourage and support efforts to achieve effective control of upstream wastewater discharges in MA which affect downstream water quality in RI.

Policy 4: Ensure that toxics and other substances are not introduced into wastewater systems in quantities that may cause disruption of desired treatment processes.

Policy 5: Continue to ensure wastewater systems are operated and maintained to provide effective wastewater treatment.

Policy 6: Continue to improve coordination of wastewater management planning for OWTSs and sewered areas.

Policy 7: Continue to reduce nutrient pollutant loadings from wastewater treatment facilities.

Policy 8: Continue to minimize untreated discharges from Combined Sewer Overflows.

Policy 9: Continue to reduce discharges that result from sewer system overflows.

Policy 10: Ensure necessary financial resources are available for wastewater systems.

See Part 7, Implementation Matrix for all Recommended Actions.

Onsite Wastewater Treatment Systems (OWTSs)

Pollutants: pathogens, nutrients, pharmaceuticals and personal care products (and other contaminants of emerging concern), household hazardous materials

Key points:

- Alternative OWTSs provide opportunities for improved treatment, but they require greater oversight, therefore strategies must be implemented to ensure their proper operation and maintenance.
- Local government must play a major role in ensuring OWTS maintenance.
- Local planning for wastewater facility systems and OWTSs should be integrated into one local wastewater plan.

Water Quality Concern: Wastewater from any structure not served by a sewer system is disposed of onsite using an onsite wastewater treatment system (OWTS, also referred to as a septic system). This is a system of pipes, tanks, and chambers used to treat and disperse sanitary wastewater into the soil (rather than into a river, bay or the ocean as with a sewage treatment plant). Sanitary wastewater is water from toilets, sinks, showers and baths. Wastewater from commercial and industrial processes (non-sanitary wastewater such as car washes, cooling waters, etc.) that is disposed of onsite where there is no sewer system is regulated as a Groundwater Discharge (See also the Discharges to Groundwater Non-OWTS Section.)

An OWTS most commonly serves an individual building (residence, business, industry or institution) and is located entirely on a single lot. One system may also be designed to serve groups of buildings or even a neighborhood. There are approximately 154,000 OWTS in Rhode Island, serving about 36% of the state's population and 80% of the state's land area.

Wastewater from an OWTS moves downward through the soil into groundwater carrying with it bacteria and viruses, nutrients (nitrogen and phosphorus), pharmaceuticals and personal care products and other possible contaminants that may be improperly disposed of into the system. The level of treatment provided depends on many factors – system design and installation, system use and maintenance and the onsite soil characteristics. A properly sited, designed, installed and maintained OWTS will provide decades of use and provide treatment such that the system does not adversely impact public health or the environment. The property owner is responsible for the proper maintenance of the OWTS, and the property users are responsible for what goes into the OWTS. It is important that these private individuals are aware of the proper use and care of the OWTS.

In many areas of the State, it is not cost-effective or desirable to extend public sewer service. In addition, *Land Use 2025* discourages the expansion of sewer service outside of the State's designated Urban Services Boundary for multiple reasons. Therefore, communities dependent on OWTS will continue to use them to treat their wastewater into the foreseeable future. The exception to this are the limited areas where existing, historical development of areas unsuitable for onsite wastewater disposal has led to frequent failures which endanger the health and safety of the public. Such areas are targeted for future sewer service in facility plans prepared for public wastewater treatment systems.

Minimizing Impacts: All OWTS are regulated and permitted by DEM through implementation of the DEM "Rules Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Onsite Wastewater Treatment Systems." These rules set prescriptive standards for the OWTS components, size of systems based on intended use and soil conditions on each site, and the location of systems based on maintaining minimum separation distances from drinking water wells, wetlands and waterbodies, property lines, and other structures. Design flow from OWTS range from 345 gallons per day for a 3 bedroom residence to greater than 20,000 gallons per day for some schools and other institutions. Private sector professionals are licensed by DEM to conduct an evaluation of the proposed site soil conditions, and to design and install the systems.

In addition to conventional system designs specified in the Rules, DEM has established a procedure for approval of alternative or experimental OWTS technologies and drainfields. As of January 2015, 20,827 systems with alternative or experimental technologies and drainfields have been installed in the State. These are more complex systems that require a greater level of oversight to ensure they operate as designed in order to achieve the desired level of treatment.

Alternative systems are used on difficult sites where a conventional system cannot be installed due to site limitations (e.g., high water table, small lots, nearby private wells). The alternative system can be installed with a smaller footprint or provide a higher level of treatment, resulting in an equivalent or better environmental condition than a conventional system on an acceptable lot with no site constraints. An acknowledged concern with this approach is the inevitable development of sites formerly considered undevelopable due to new OWTS technologies. The approval of the OWTS allows the lot to be developed, creating impacts not related to OWTS, such as stormwater runoff. Municipalities should be prepared for this and plan for development accordingly. Alternative systems are also used in sensitive areas to meet water quality objectives as demonstrated by the requirement for denitrification systems in the Salt Pond and Narrow River watersheds for any new or repaired system.

Cesspools are an older substandard method for wastewater disposal into the ground. They are essentially just a hole in the ground that is more likely to fail and which does not provide an acceptable level of treatment. As of 2015, DEM estimates there are approximately 25,000 cesspools still in use in RI. All cesspools in the state pre-date 1968, the first year regulations for septic systems took effect. Rhode Island Gen. Law 23-19.15, *RI Cesspool Act of 2007*, requires cesspools within 200 feet of the coastal shoreline, public drinking water wells and drinking water reservoir impoundments to be removed from service by January 1, 2014. Of the cesspools subject to the Act, as of February 2015, 526 cesspools have been replaced, 148 have connected to a sewer system, and 361 have been identified that need to be replaced. In addition, the use of large capacity cesspools (those serving any non-residential facility that has the capacity to serve greater than 20 people per day or serves any multi-family residence or apartment building) is prohibited statewide by state and federal rules. Phasing out the use of cesspools has been a major initiative of state and nongovernmental organizations, and in 2015 the RI General Assembly passed amendments to the Cesspool Act requiring cesspools statewide to be replaced within one year of the time of property sale or transfer.

Operation and maintenance of existing systems is the responsibility of the property owner. All OWTS, both conventional systems and alternative treatment systems with pumps and other electronic components, require periodic maintenance to achieve expected levels of treatment performance. Lack of maintenance is considered to be the primary cause of system failure causing health and water quality concerns as wastewater backs up onto the land surface and flows directly into surface waters, stormwater collection systems or moves untreated into groundwater. Eighteen towns in RI have adopted onsite wastewater management plans to encourage or require maintenance activities such as system inspections and pumping of septic tanks (as enabled by RI General Law Chapter 45-24.5). These plans make the towns eligible for the Community Septic System Loan Program (CSSLP), in which the towns can access funds from the Clean Water Revolving Loan Fund for low interest loans to homeowners for OWTS repairs. As of December 2014, 41 loans have been issued to 14 towns over the past 16 years totaling $11,500,000. The 2016 DEM Project Priority List included $7 million in financing needs related to local on-site wastewater management loan programs for OWTS repair or sewer tie-on in 19 communities. This reflects a continuing interest in CSSLP which along with the Sewer-Tie-In Program has been a valued source of financial assistance to homeowners in unsewered areas. Adoption of statewide point-of-sale cesspool phase out requirements is expected to increase demand for the program and heightens the need to sustain this form of financial assistance for homeowners.

Elements of a Comprehensive Municipal OWTS Program

Local governments are best suited to oversee proper operation and maintenance of OWTS. DEM has identified the suggested elements of a comprehensive municipal program (Note: None of the elements below are required by state or federal rule or law):

- Approved Onsite Wastewater Management Plan
- Participation in the Community Septic System Loan Program
- Adoption of an Onsite Wastewater Management ordinance
- Mandatory inspections are part of the Onsite Wastewater Management Plan
- Web-based tracking system
- Website for information and education on OWTS issues
- Town staff person whose primary responsibility is management of the municipal onsite wastewater management program
- Cesspool phase out program

Climate Change: The impacts of projected climate change through sea level rise and warmer soil temperatures may decrease the effectiveness of OWTS in the coastal zone because:

- Sea level rise will increase the vulnerability of systems in the coastal zone to storm damages.
- Rising water tables (due to sea level rise) in the coastal zone will decrease the available aerated soil to treat wastewater beneath the system. Wet and saturated conditions beneath the system favor pathogen survival and transport. RI benefits from a long0standing regulation requiring an increased separation to the water table in the coastal zone.
- Warmer soil temperatures statewide will potentially reduce available oxygen for wastewater treatment in the soil.

Design standards for OWTS will need to be periodically evaluated in light of environmental changes cause by climate change.

OWTS Policies

OWTS Policy 1: Protect groundwater, surface water quality, and public health through proper siting, design and construction of onsite wastewater management systems.

OWTS Policy 2: OWTSs should be properly used and maintained.

OWTS Policy 3: Ensure proper OWTS use and maintenance through municipal onsite wastewater management programs.

OWTS Policy 4: Ensure that OWTS protect the public health and the environment.

OWTS Policy 5: Promote the removal of cesspools, especially in riparian areas.

See Part 7, Implementation Matrix for all Recommended Actions.

Stormwater

Pollutants: sediment, pathogens, nutrients, metals, petroleum products, salt, pesticides, heat

Key points:

- Stormwater is a widespread source of water quality degradation in RI.
- Stormwater is a critical component of our water infrastructure that must be effectively managed along with wastewater and drinking water.
- Stormwater from existing impervious surfaces, not just from new development, must be addressed in order to achieve improvements in water quality.
- Maintenance of stormwater management practices is often neglected and must be improved.
- Increased storm intensities can overwhelm storm drain systems and cause increased flooding.
- The major obstacle to abating stormwater pollution is the lack of a reliable source of funding.
- Low impact development (LID) and green infrastructure strategies are a key focus for long-term stormwater management.
- Strategies are needed for reducing impervious cover.

Water Quality Concern: Stormwater runoff is a widespread source of water quality degradation in RI with a majority of our water quality impairments known or suspected to be caused in part by stormwater. Stormwater impacts include: pathogen contamination resulting in beach closures and closure of shellfish growing areas, nutrient enrichment of waterbodies resulting in algal blooms (including toxic cyanobacteria), elevated levels of other pollutants (e.g., metals), stream bank erosion, and aquatic habitat alterations from high flows and deposition of sediment. The degree to which stormwater impacts water quality in any particular watershed is primarily a function of the amount of impervious cover and how stormwater generated from the impervious cover is managed. (See discussion on impervious cover in Part 2, Urbanization and Impervious Cover. This section will focus on stormwater management.)

> Many of the sources of pollution discussed in other sections of this Plan adversely impact water quality due to their conveyance by stormwater into our surface waters and to a lesser degree groundwater. See discussions on combined sewer overflows, road salt and sand application, agriculture, lawn care, pet waste, atmospheric deposition, surface mining, and silviculture.

Proper design, siting and installation of stormwater BMPs as property is developed or redeveloped are not enough to achieve state water quality goals. Two additional challenges associated with stormwater management include:

- *Proper maintenance of BMPs:* Maintenance of the existing stormwater infrastructure is a glaring weakness at the state, local and private sector levels. Stormwater management BMPs for improving water quality must be maintained or the water quality benefits of the BMP will largely be lost; and

- *Improving treatment of stormwater from existing developed lands*: Accelerating the pace at which performance of stormwater management on existing public and private property is improved continues to be a significant challenge. Many of the completed TMDL's identify the need to improve stormwater management from existing properties in the watershed to reduce pollutant loadings to impaired waters. The responsibility for upgrading stormwater infrastructure rests largely with municipal governments and the Rhode Island Department of Transportation. However, stormwater from private property often flows into the public system. In many watersheds it will also be necessary to reduce pollution from stormwater runoff generated from private properties by taking action to properly manage this stormwater on-site.

Minimizing Impacts: Management of stormwater from impervious surfaces and from site construction is a multi-faceted approach at both the state and municipal levels that includes:

- Managing new construction: managing construction activity runoff and post construction runoff with appropriate BMPs;
- Managing the existing stormwater systems: identification of the components of the system and maintaining the system, including repairs and upgrades; and
- Controlling sources of pollution that contribute pollutants to stormwater.

Stormwater management at the State level involves the regulatory programs below:

- State permitting for projects subject to Rules pursuant to: DEM and CRMC Freshwater Wetlands Programs, DEM Water Quality Certification Program, DEM Groundwater Discharge Program, DEM RI Pollutant Discharge Elimination System Program, and CRMC Coastal Management Program. Development permitted by state programs must comply with the following:
    - The RI Stormwater Design and Installation Standards Manual (RIDEM and CRMC 2010) includes specific provisions to ensure stormwater is treated to protect water quality and is managed as specified in R.I. Gen. Law 45-61.2, *Smart Development for a Cleaner Bay Act of 2007*:
        - Maintain pre-development groundwater recharge and infiltration on site to the maximum extent practicable;
        - Demonstrate that post-construction stormwater runoff is controlled, and that post-development peak discharge rates do not exceed pre-development peak discharge rates; and
        - Use low impact-design techniques as the primary method of stormwater control to the maximum extent practicable.
        - While the manual established stronger minimum standards for treating stormwater discharges, it also recognized that new and innovative technologies to achieve treatment are constantly emerging. The manual provides a mechanism to integrate new technologies through a technical assessment protocol. In addition, as other new information develops, DEM and CRMC expect to make periodic updates to the manual as appropriate to ensure water quality protection goals are adequately protective and to facilitate its implementation. Over time the manual will likely need to be updated to reflect changing precipitation patterns.
    - Soil Erosion and Sediment Control Handbook (2015) -- The Handbook will assist property owners, developers, engineers, consultants, contractors, municipal staff and others in planning, designing and implementing effective soil erosion and sediment control plans for the development and redevelopment of properties. Implementation of the practices in this Handbook, as required by the RI Stormwater Design and Installation Standards Manual,

will significantly reduce sedimentation in surface waters associated with construction activities.

- Implementation of the federally required Phase II MS4 (Municipal Separate Storm Sewer System) Program. Pursuant to DEM regulations and general permit, municipalities, DOT, Universities and others must comply with 6 minimum stormwater management measures: public education and outreach, public involvement/participation, illicit discharge detection and elimination, construction site runoff control, post construction runoff control, and pollution prevention/good housekeeping. In addition, where a TMDL identifies stormwater discharges as contributing to water quality impairments, the responsible MS4 permitee is required to amend the local stormwater management plan to address TMDL requirements; e.g. retrofitting stormwater infrastructure.

- DEM Industrial Activity Multi-Sector General Permit that establishes standards for listed activities to minimize impacts from stormwater, such as material handling and storage, equipment maintenance and cleaning, industrial processing or other operations that occur at industrial facilities that are often exposed to stormwater.

Other State Responsibilities: Department of Transportation (DOT)

DOT has significant responsibilities for stormwater management associated with state roads, bridges and parking areas. It manages stormwater infrastructure that includes an estimated 25,000 catch basins and 3,800 outfalls. As a regulated MS4, the DOT has recently embarked on a ten-year strategic program to improve stormwater management consistent with a federal consent decree issued in 2016 resulting from an EPA enforcement action under the Clean Water Act. It is estimated that DOT will expend $6.6-$16.8 million annually for improvements to its stormwater management activities that address past deficiencies including a lack of regular maintenance. Activities include developing and implementing stormwater control plans in sub-watersheds where DOT outfalls contributed to known impaired water quality, expanded sampling including detection of illicit connection to state stormwater drains, completing an inventory of its stormwater system and implementing an effective programs for inspection, cleaning and repair program of infrastructure and street sweeping. To support the program, additional personnel have been assigned to coordinate and implement the program including on-going maintenance activities. This significant commitment by DOT has the potential to beneficial to many waterbodies located across the State by reducing the pollutant and other impacts of stormwater discharges from state roads and related properties.

Local governments must also take an active role in implementing their local land use authorities and administering the MS4 Phase II Program if stormwater is to be effectively managed. Local stormwater management is an essential service that must be integrated into all relevant aspects of local government, including planning, engineering and public works. Both State agencies and communities should work together to develop strategies and incentives to reduce impervious cover in new and existing developments.

In many cases, local planning ordinances need to be amended in order to implement innovative land use controls, including conservation development, green infrastructure, and low impact development (LID). To support municipal efforts, DEM and CRMC prepared the *LID Low Impact Development Site Planning and Design Guidance Manual*[2] which provides information on different LID strategies such as site clearing, roadway and parking design, landscaping, and using compact development. Implementation of LID will also reduce the burden on CSO (See also Wastewater Treatment Facilities Section.) by significantly reducing the flows into these systems.

What Is LID?

LID is quite different from conventional stormwater treatment, which is often referred to as "pipe-to-pond" stormwater management. LID is a comprehensive approach to managing stormwater that is integrated into a project design to minimize the stormwater impacts from development. In the past, the landscape was altered significantly to fit the style of development; whereas LID reverses the process by adapting the development to fit into the landscape.

LID is defined as:

> "a site planning and design strategy intended to maintain or replicate predevelopment hydrology through the use of site planning, source control, and small-scale practices integrated throughout the site to prevent, infiltrate and manage runoff as close to its source as possible." (RI Stormwater Design and Installation Standards Manual)

The LID approach to stormwater management focuses on the preservation and use of natural systems for stormwater management. "Green Infrastructure" is a form of LID that utilizes vegetation in managing stormwater. Green infrastructure also provides other benefits as reducing the urban heat island effect, providing micro-habitats, improving visual appeal and enhancing the quality of life. The primary goal of LID is to reduce runoff and mimic the way water moved through the site before development by using site planning and design strategies to store, infiltrate, evaporate, and detain runoff as close as possible to the point where precipitation reaches the ground. Stormwater is managed in smaller, cost-effective treatment practices located throughout the development site rather than being conveyed to and managed in one or more centralized facilities. Use of these strategies helps to reduce off-site runoff and ensure adequate groundwater recharge.

[2] http://www.dem.ri.gov/programs/bpoladm/suswshed/pdfs/lidplan.pdf

Currently, the effectiveness of local stormwater management varies widely with many municipalities lacking the financial resources, staff or expertise to fully meet the MS4 Phase II requirements. State bond funds have been used to distribute state grants to enhance local capacity to implement stormwater management through equipment purchases, support for illicit detection work, and construction of BMPs. Additional local needs include improved guidance on BMPs, training and technical assistance related to Phase II, and continued financial assistance to build and implement local stormwater programs. RIDEM is working with partners, including RIDOT, URI, and others, to expand technical assistance as resources allow.

The total capital needs for stormwater infrastructure are not as well documented as those for wastewater. The 2012 Clean Water Need Survey includes $58.3 million in stormwater related needs but this figure well under-estimates the actual long-term needs due to the documentation requirements needed to be included in the survey as a qualified need; e.g. engineering cost estimates, etc. Similarly, the 2016 Project Priority List, which includes $12 million for stormwater projects or needs in 8 communities, also significantly under-estimates the total long-term needs. The actual total need for repair and upgrade of stormwater infrastructure for water quality purposes is believed to be hundreds of millions higher. State and local governments should continue efforts to better document estimates of need.

In addition to capital needs, stormwater systems need resources to support operation and routine maintenance. The major obstacle to abating stormwater pollution is the lack of reliable funding to support needed retrofitting and ongoing maintenance of stormwater infrastructure. DEM has been able to utilize certain state bond funds and limited federal funds to provide matching grants to municipalities and other entities, but the funding sources are variable. In order to address local funding shortfalls, DEM has partnered with municipalities interested in exploring the feasibility of establishing sustainable local (or regional) funding sources, such as a stormwater enterprise or utility fund. While stormwater projects are eligible for low interest loans via the Clean Water SRF, there are barriers that have limited its use for such projects including the smaller scale of many stormwater projects and the lack of bonding authority needed for loan collateralization. A stormwater utility fee is based on the demand placed on the municipal stormwater system by each user, not on property's assessed value. It is therefore considered more equitable than other funding methods since users with a large burden on the stormwater system will pay their fair share. As with a water or sewer utility, a stormwater utility fee generates revenue based upon the amount of stormwater generated on a property and conveyed to a public stormwater system. These fees are assessed by measuring the amount of impervious cover within a parcel and are determined by the stormwater management financing needs of the municipality. They can be adjusted over time to continually meet those needs.

Stormwater Utility District Feasibility reports have been completed for three communities and discussions are underway for an Upper Narragansett Bay Regional Stormwater Utility that could include up to six municipalities. A stormwater utility provides a means for:

- Consolidating or coordinating responsibilities that were previously dispersed among several departments and divisions;
- Generating funding that is adequate, stable, equitable and dedicated solely to managing stormwater; and
- Developing stormwater management programs that are comprehensive, cohesive and consistent year-to-year.

Climate change is predicted to produce wetter and more variable precipitation conditions in the decades ahead with more frequent intense storms that have large amounts of precipitation falling over shorter time periods. Stormwater management systems are designed based on the average precipitation rates in the recent past. The capacity and performance of these systems will be an issue to closely evaluate as precipitation patterns in RI change in response to climate change. Over time, the Stormwater Design and Installation Standards Manual will likely need to be updated to reflect changing precipitation patterns.

Stormwater Policies

Stormwater Policy 1: Manage stormwater to protect and restore water quality.

Stormwater Policy 2: Seek to maintain and restore pre-development hydrology through LID techniques and associated BMPs.

Stormwater Policy 3: Ensure management of MS4s to minimize impacts to water resources.

Stormwater Policy 4: Seek to educate public officials and private contractors about stormwater management.

Stormwater Policy 5: Seek to reduce stormwater from existing impervious surfaces on private property.

Stormwater Policy 6: Support the development of dedicated and sustainable funding for stormwater management.

Stormwater Policy 7: Ensure that stormwater management programs address climate change impacts.

See Part 7, Implementation Matrix for all Recommended Actions.

Road Salt and Sand Application

Pollutants: salt, sand

Key point:

- Minimizing impacts to water resources from road salt and sand application while at the same time maintaining public safety presents a difficult challenge.

Water Quality Concern: White stained pavement and layers of sand at the edge of the road are ample evidence of our efforts to maintain the safety of our roadways in winter. But there is a water quality cost for the application of salt and sand. Salt and sand wash into surface waters impacting aquatic life, and salt can enter groundwater and contaminate drinking water wells.

Salt and sand is applied to RI roads by the Department of Transportation (DOT) staff, municipal staff and private contractors generally either as a mixture of 1:1 salt to sand ratio or as just sand. Weather conditions ultimately determine how much is applied. Municipal data is not available, but DOT annual average number of pounds of salt per lane mile in 2005 to 2013 ranged from a high of 791 to a low of 382, averaging 516 pounds per lane mile per year (DOP 2014).

The sand that remains on the roadway after the winter season is either washed into our waters, affecting aquatic life and streambed habitat dramatically, or it becomes a major contributor to stormwater BMP failure by clogging the systems. DOT estimates that only about 5 to 10 % of the sand applied is recovered as street sweepings (DOP 2014). Whereas it is possible to collect much of these and that is applied by means of effective road sweeping and maintaining stormwater BMPs, the salt rapidly dissolves in water. The chloride component of the salt cannot be treated by any stormwater BMP and therefore it easily moves into groundwater or over land into surface waters.

Minimizing Impacts: Steps can be taken to reduce the amount of salt and sand applied to roads without compromising winter travel safety. The following actions are being taken by DOT:

- Anti-Icing (Brine) -- Liquid brine (23.3% salt-water solution) applied before or early in a snowfall prevents the formation of frost and bonding between snow and ice and pavement. This practice has only been in wide use since February of 2012. The pavement appears wet temporarily, but as the water evaporates, a layer of salt bonds to the semi-porous road surface, preventing the snow from bonding to the road. The use of brine is effective in reducing the total amount of salt used during snow storms.
- Pre-wetting -- Pre-wetting adds chemical solutions to the salt and sand mixture, causing the mixture to stick to the road instead of bouncing and blowing off to the shoulder.
- Spreader Technology --Sixty-nine of DOT's fleet of 100 snow plow/spreader trucks are equipped with "closed loop spreader control systems". These automated additions allow the operators to accurately administer and monitor the exact amount of salt applied. DOT has seen a significant reduction in pounds per lane mile of salt applied with the use of closed loop system.
- Road Temperatures –DOT uses real-time information systems capable of monitoring road temperatures. This technology is especially useful in spots such as the Newport Bridge where air temperatures may significantly vary from road surface temperatures.
- Reduced Salt Zones – DOT uses an alternative mixture of sodium chloride and calcium chloride in the Scituate Reservoir watershed at 170 pounds per lane mile.

The technology and practices utilized by DOT is much more advanced than that currently used by municipal governments and by private contractors. For example, no vehicles other than DOT use the advanced spreader technology and only one community is known to apply a brine solution. Private contractors play a significant role in winter maintenance in support of state and local governments on public roads and on private property. Up to 300 private contractor vehicles can be used by DOT depending on the severity of the winter[3].

The sand and salt must be stored in a manner to reduce impacts to water quality, primarily by covering of the salt pile in a structure and containing runoff from the site. DEM Groundwater Quality Rules require covering of all piles (public and private) with at minimum a durable cover in areas where groundwater is classified GA and GAA. As of 2014, all but 5 of the 20 state salt piles are under cover in a permanent structure[4].

Road Salt and Sand Policy: Assure public safety but reduce impacts to water resources from road salt and sand operations.

See Part 7, Implementation Matrix for all Recommended Actions.

[3] http://www.planning.ri.gov/statewideplanning/land/water.phpTechnical Paper 163 Road Salt
[4] Ibid

Discharges to Groundwater (Non-OWTS)

Pollutants: petroleum products, toxic chemicals, metals, and stormwater inputs.

Key points:

- There are many suspected unauthorized groundwater discharges that must be identified and regulated, either through the approval or closure process.

- The emphasis on groundwater discharge of stormwater must always consider the value and sensitivity of the groundwater resource such that stormwater impacts are not simply shifted from surface water to groundwater.

Water Quality Concern: Discharges of non-sanitary wastewater (any wastewater not regulated by the OWTS Program) to groundwater occur throughout the state in both sewered and non-sewered areas. Just about any type of activity may have such a discharge into a floor drain, piped into a subsurface system (dry well, leaching chambers, etc.) or piped to the ground surface. Common discharges include stormwater (see previous Stormwater Policy Section), car washes, commercial and industrial process waters, cooling waters, and rinse waters, injections of chemical and biological materials to remediate contaminated groundwater and floor drain drainage from a wide variety of activities, including vehicular and motorized equipment repair shops. Localized instances of soil and groundwater contamination have occurred because of these unregulated groundwater discharges. The primary contaminants of concern are petroleum products and a variety of chemical wastes which may include volatile organic compounds and inorganics.

It is particularly important in dealing with groundwater resources to prevent such contamination from occurring in the first place. Once in the groundwater, contaminants may persist for decades and can also impact surface waters. The process of completely remediating groundwater is generally very lengthy, very expensive, and often technically infeasible.

Minimizing Impacts: The DEM "Groundwater Discharge Rules" (Rules for the Discharge of Non-Sanitary Wastewater and Other Fluids To or Below the Ground Surface) regulate discharges into the ground and onto the ground surface that will infiltrate to the groundwater. The Rules also incorporate the requirements of the federal Underground Injection Control (UIC) Program for specific discharges below the ground surface, as delegated to the state by EPA pursuant to the Safe Drinking Water Act. The Groundwater Discharge Rules address all non-sanitary discharges to groundwater that are not addressed under the OWTS Program and prohibit the subsurface disposal of hazardous waste. Program activities under these rules include the review of discharge applications and the subsequent issuance of discharge system approvals and registrations, the oversight of voluntary and involuntary closures of groundwater discharges, and the on-going monitoring review of facility discharge operations to ensure compliance with program approval conditions (e.g., review of required analytical data of facility effluent and groundwater quality, system maintenance records and any modification to approved activities). As of August 2015, the Groundwater Discharge Program has:

- Reviewed and approved groundwater discharge system closures at 525 facilities; and
- Reviewed and approved the construction and installation of groundwater discharge systems at 974 facilities. 62 of these facilities are required to regularly submit maintenance records and analytical monitoring data of facility effluent and groundwater quality.

It is estimated that there are likely hundreds of unauthorized groundwater discharges within the State that have not yet been identified or evaluated. Lack of awareness on the part of facility owners contributes to this continuing problem of non-compliance with the Groundwater Discharge Program requirements. Recent program efforts have focused on the identification, review and closure of unauthorized discharges at higher risk facilities such as floor drains at motor vehicle-related facilities.

As described previously under Stormwater Management, infiltration to groundwater is one of the primary principles of stormwater management within the State in order to decrease flow volumes and pollutants to surface water. Stormwater infiltration uses engineered BMPs and the natural groundwater flow system to treat pollutants. Infiltrating increasing volumes of stormwater necessitates proper management of these groundwater discharges to prevent impacts to groundwater used for drinking water and other beneficial uses.

Discharges to Groundwater (Non-OWTS) Policy: Protect groundwater quality and public health and ensure that groundwater discharges are properly designed, sited, constructed and operated.

See Part 7, Implementation Matrix for all Recommended Actions.

Agriculture (See also discussion of Pesticide Application)

Pollutants: nutrients, pathogens, sediment, pesticides, petroleum wastes

Key point:

- The most important step to minimize the impact of agricultural operations on water resources is for a farm to develop and implement a Farm Conservation Plan that addresses water quality issues.

Water Quality Concern: Rhode Island's farms contribute to the state's economic development and provide Rhode Islanders with local food and farm landscapes, as well as tourism opportunities and wildlife habitat. But the nature of farming in RI has changed significantly over the past 20 years. There are fewer large farms (particularly dairy farms) and more of smaller, specialized farms in RI. The smaller farms are producing more locally consumed farm products. Farming will continue in Rhode Island, thus it is important to ensure that these operations are conducted in a manner that avoids water quality impacts.

US Department of Agriculture 2012 Census of Agriculture shows there are 1,243 farms in RI using 69,589 acres (USDA 2014). A farm is defined by USDA as “Any place from which $1,000 of agricultural products were produced and sold, or normally, would have been sold, during the Census year.” These latest numbers show essentially a doubling of the number of farms and acres in farmland from 1990 (580 farms, 33,000 acres) to today. The average size of a farm is 56 acres with the median 24 acres. Farms with 9 acres or less increased from the last census in 2007, and now account for 35% of all farms.

The potential water quality contaminants associated with agricultural operations include nutrients (from fertilizers and animal wastes), pathogens and organic materials (primarily from animal wastes), sediment (from field erosion), pesticides, and petroleum products. Well managed farms can operate with minimal adverse impacts on water resources. However, instances of significant contamination of surface water and groundwater have occurred.

In addition, water withdrawals are a management issue of increasing concern in certain watersheds, particularly in the southern portion of the state. The need for irrigation water can place high demands on local groundwater or surface water supplies which, in turn, can cause a low flow condition in streams potentially resulting in dramatic negative impacts on stream ecology. (See Water Withdrawal topic later in this Section)

Minimizing Impacts: An important means to minimize the impact of agricultural operations is for a farm to develop and implement a Conservation Plan that addresses water quality issues. Plans are usually developed in consultation with DEM and the US Department of Agriculture, Natural Resource Conservation Service (NRCS). A farm Conservation Plan describes the implementation practices needed to solve natural resource concerns and may include multiple components to address particular resource issues, such as nutrient management, erosion control, irrigation management, integrated pest management, wildlife and habitat management, forest management and others. In addition to protecting natural resources important to the farm, many of the practices included in such plans offer additional benefits to the farmer including cost savings. Conservation Plans are not currently required in RI. However, a significant number of farms (almost 900) have developed plans as a result of participation in the RI Farm, Forest Open Space Program, which is a state program to allow eligible properties to be assessed at its current use, rather than its value for development. Conservation Plans are a requirement of this program. Some farms also follow recommended conservation practices voluntarily without the preparation of a written plan.

There are no state regulations that establish standards for specific farm management practices to control or prevent water pollution. However, DEM has created standards and specifications for agricultural best management practices which aim to prevent or minimize pollution of surface waters and groundwater. These standards and specifications are guidelines only. The guidelines are designed so that farmers may understand and identify on-farm sources of water pollution and implement effective strategies to address them.

In those instances, where farmers decide to take actions to prevent contamination or upgrade their existing structural or management practices, DEM Agriculture and the USDA NRCS will work with farmers to identify the appropriate corrective strategies. Funding to implement best management practices may then be available through the NRCS Environmental Quality Incentives Program (EQIP). This program provides financial and technical assistance to farmers to help plan and implement conservation practices that address natural resource concerns. Farmers that apply through EQIP may be eligible for technical and financial assistance on projects built in accordance with the NRCS standards. Since the adoption of the 2008 USDA Farm Bill, 821 EQIP contracts have been awarded in RI. In addition, NRCS has dedicated 5% of the EQIP funds for projects in priority watersheds chosen jointly with DEM under the joint EPA/USDA National Water Quality Initiative to work with farmers to implement approved strategies to improve water quality. NRCS estimates that for each watershed (HUC-12), farmers representing only 2 to 10% of the total farmland acreage in that watershed have participated in the EQIP Program.

Agriculture Policy: Protect groundwater and surface water quality and public health through proper agricultural management.

See Part 7, Implementation Matrix for all Recommended Actions.

Lawn/Turf Management (See also discussion of Pesticide Application)

Pollutants: Nutrients, pesticides

Key Point:

- Education of homeowners on proper turf management continues to be the primary strategy to minimize water quality impacts.

Water Quality Concern: The care and maintenance of residential lawns and other landscaped areas such as golf courses, cemeteries, athletic fields, and parks, can contribute to water quality degradation. Turf is a major feature of all but the highest density urban landscapes, and how it is managed impacts water quality. Excessive amounts and using inappropriate formulations of fertilizer and pesticides, and poor timing of applications can result in impacts to groundwater or stormwater.

Turf is often referred to as the largest "crop" in the United States. Over 22, 070 tons of fertilizer (including lime) was sold in RI from July 2012 to June 2013 (RI Division of Agriculture). This data is broken down by amount sold by bag, bulk and liquid. Bag sales represented 18,516 tons of the total (84%). If one assumes that bags are generally for the consumer market, whereas bulk and liquid shipments are for farmers, and that most of the bagged materials are for lawns, we can see a picture forming of the relative potential impact of turf grass management on our water resources.

Minimizing Impacts: Proper turf management depends on the use of the turf. Athletic fields, golf courses and other heavily used grassed areas are managed much differently than residential lawns. There is no single maintenance approach that is applicable to all turf areas whether due to type of use or the site's soil characteristics. Athletic fields, golf courses, etc. are usually professionally managed and represent a small fraction of the overall turf area compared to home lawns. Most homeowners are not aware of the appropriate best management practices to reduce the impacts to water quality in managing their lawns.

Many states, including five in the New England/New York region have enacted state laws to minimize pollution from the overuse and misuse of fertilizer on turf grass. RI has no state law to address fertilizer use. Local government actions to address fertilizer use have been limited to resolutions, ordinances requiring the use of sustainable vegetation and conditions placed on permit approvals. These state and local laws regarding turf management are difficult to enforce, therefore, strategies for managing fertilizer and pesticide use on turf are focused on education and training. The URI Cooperative Extension Program and other associations have produced public information materials and provided onsite training and education on proper lawn management. The intent has been for RI residents, landscaping companies, turf managers for golf courses and athletic fields, and garden centers to be aware of and to implement the appropriate strategies to reduce water quality impacts from turf care activities.

Lawn watering is the primary use of our water resources in the summer -- the time when water levels in streams and groundwater are at their lowest. This water use stresses some public supplies and may jeopardizing public safety (water for fire suppression) and the resulting low stream flows can have devastating effects on stream ecology (See section on Watershed Hydrology). The most effective way to minimize water quality impacts associated with lawn care is simply to minimize lawn area. To the extent that some landscaping is desired, minimum maintenance/minimum disturbance and xeriscaping strategies (the use of plant materials that require low moisture and/or nutrient requirements) should be pursued.

With regard to both residential and non-residential turf management, problems can also originate from storage and disposal practices for fertilizers and pesticides. Chemicals can leak from hoses and containers, either accidentally or because of carelessness or negligence.

Lawn/Turf Management Policy: Prevent adverse water quality impacts from lawn and other areas of turf management.

See Part 7, Implementation Matrix for all Recommended Actions.

Pesticide Application

Pollutant: pesticides

Key point:

- No permits are necessary for legal pesticide applications (not banned or otherwise restricted by RI State Law) on the farm or in the home, except for application of pesticides directly into the aquatic environment.

Water Quality Concern: Pesticides applied to our lawns, parks and agricultural fields have been detected in RI's groundwater and surface water. The detections are generally at low concentrations below drinking water and water quality standards, but their occasional presence indicates that the potential exists for greater impacts to water quality. Contamination by leaching into groundwater or carried from pesticides into surface waters by stormwater can result from over application, applying the wrong chemical or applying at the wrong time (e.g., just before a storm).

Minimizing Impacts: Federal Law requires all pesticides distributed in the USA to be registered with the EPA. On the state level, the DEM Division of Agriculture is responsible for enforcing state laws and regulations developed to protect people from poisonings and to prevent environmental degradation that might result from improper use of pesticides on farms, in yards, and inside homes. Through this program, commercial pesticide applicators are trained, tested, and licensed to achieve a minimum level of competence in the pesticide application industry.

Pesticides that are applied by a licensed applicator in accordance with the EPA approved label directions are considered protective of environmental quality, and such application is not reviewed by DEM. The only applications reviewed by DEM are herbicides applied directly to surface waters and wetlands to control nuisance and invasive aquatic and emergent species. This use of herbicides has increased over the years as these species have had dramatic impacts on aquatic habitat and use of the State's waters (65 applications reviewed in 2014). (See also section on Aquatic Habitat Management). The best means to minimize the impacts from pesticides is to use the least amount necessary, the proper pesticide for the targeted pest, least toxic effective form of pesticide and to employ alternative physical and biological controls wherever practicable.

Pesticide Application Policies

Pesticide Application Policy 1: Minimize the use of pesticides.

Pesticide Application Policy 2: Minimize impacts from pesticides to water quality.

See Part 7, Implementation Matrix for all Recommended Actions.

Boating and Marinas

Pollutants: Pathogens, nutrients, petroleum waste, chemicals, metals

Key Points:

- RI's No Discharge Area designation must be enforced and adequately supported by well-maintained pumpout facilities.
- RI's Clean Marina Program is an underutilized Program that provides a unique opportunity to minimize marina impacts on water quality.

Water Quality Concern: Boating is a major recreational activity and economic generator in RI. There were 34,772 boats registered in RI in 2014 (over the last 6 years the highest number was 41,584 in 2010). The primary water quality concern from boating is the illegal discharge of sanitary waste (pathogens and nutrients). There are over 140 marinas located in the tidal waters of RI. Although marinas are not one of the leading sources of water pollution, their location at the water's edge means that there is always the potential to release pollutants directly into the water, thus causing a localized impact on water quality. Water quality concerns from marinas include pollutants released from vessel maintenance, handling of petroleum products, sewage (see above regarding pumpouts) and stormwater management. Boats require a great deal of maintenance over the course of a year: engines must be tuned and lubricated; hulls must be washed, sanded and painted; and vessels must be prepped to withstand the cold of winter. Each of these tasks—along with a myriad of other vessel maintenance activities—has the potential to release pollutants onto land and into the water.

Minimizing Impacts: Under the federal Clean Water Act it is illegal to discharge untreated sewage from a vessel within 3 miles of shore. This includes all of Narragansett Bay. In 1998, Rhode Island became the first state in the country to receive the US Environmental Protection Agency's No Discharge Area designation for all of its marine waters. A No Discharge Area is a designated body of water in which the discharge of untreated *and* treated boat sewage is prohibited (this does not include grey water or sink water).

To maintain the No Discharge Area designation for the state's marine waters, DEM must assure that there are pumpout facilities available to RI boaters and that the pumpout facility infrastructure is in sound operating condition. As of 2013, 67 marine sanitation pumpout facilities were operating in RI waters -- 51 dockside pumpout facilities and 16 pumpout boats. From 1994 to 2012, DEM has awarded 110 grants of federal funds to towns and private marinas totaling $1,668,138 for the development and maintenance of pumpout facilities. The grants averaged approximately $15,000 each with approximately 60% of the funds used for new facilities and 40% for facility maintenance. This public-private partnership has successfully reduced a significant source of pathogen contamination to the state's coastal waters. A survey in 2013 documented that 708,717 gallons of wastewater was collected through pumpout facilities – the highest volume recorded since the surveys began in 2000.

In 2007, the RI No Discharge Law (RIGL 46-12-39.1) went into effect; requiring all boats with permanently installed marine toilets to be inspected and certified that they have taken the steps necessary to prevent overboard discharges of sewage when operating or moored in Rhode Island waters. All boats subject to the program must obtain and display a no discharge certificate decal valid for four years issued by a DEM authorized certification agent (typically a harbor master or marina/boatyard staff).

The RI Clean Marina Program was developed by CRMC, DEM, Rhode Island Marine Trades Association, and Save the Bay in 2007 to support and encourage the efforts of marina owners to better manage their facilities to prevent water pollution. This is a voluntary, incentive-based program for existing marinas designed to recognize and promote environmentally responsible marinas, boatyards, and yacht clubs that employ water quality best management strategies to prevent pollution and conserve resources. It is required by CRMC for new or expanding marinas. The CRMC developed the RI Clean Marina Guidebook to aid marina operators in their efforts to obtain a Clean Marina designation. While all marina facilities need to be at a minimum compliant with any federal and state regulatory issues to receive a Clean Marina designation, it is the implementation of BMPs for additional water quality protection that earns a marina the designation. Unfortunately, only 4 marinas have been designated as of January 2014. Marinas that participate in the Clean Marina Program are recognized for their environmental stewardship and once certified as a Clean Marina facility, can expect positive publicity and may attract new, environmentally responsible boaters.

Boating and Marinas Policy: Ensure boating activity and marinas do not adversely impact water resources.

See Part 7, Implementation Matrix for all Recommended Actions.

Hazardous Material and Petroleum Product Spills

Pollutants: petroleum products, toxic chemicals

Key Point:

- Prompt and effective response to hazardous material and petroleum product releases is crucial in order to mitigate potentially greater impacts on water quality.

Hazardous Material or Hazardous Waste?

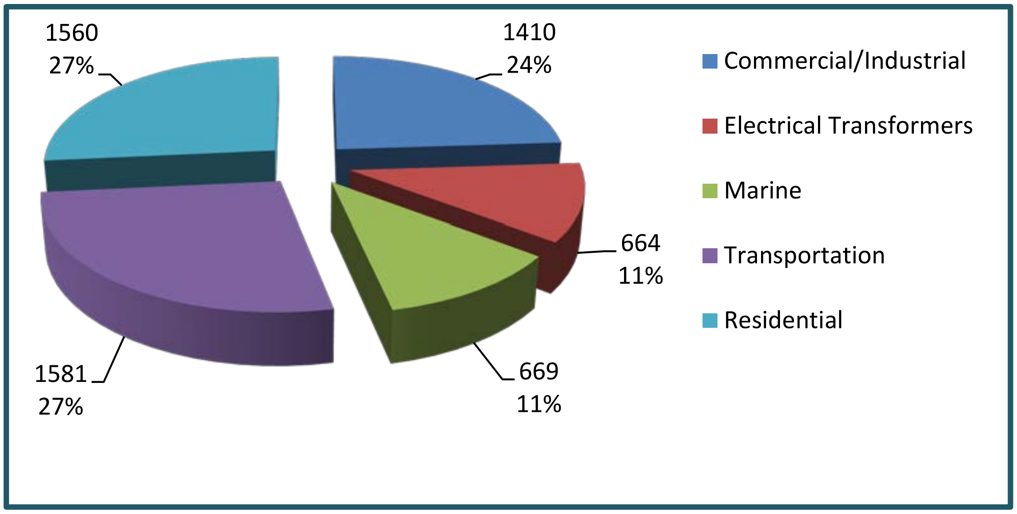
Hazardous materials are chemicals in their virgin form that are defined by certain state and federal lists as "hazardous;" that is of a quantity, concentration, or of certain physical or chemical characteristics that is or significantly contribute to an increase in mortality or an increase in serious illness; or pose a substantial present or potential hazard to human health or the environment. Once the "material" is no longer needed or capable of being used for its intended use, and it is to be disposed of or has been released to the environment, it is a "waste."

Water Quality Concern: It could be a grounded oil barge on our coast leaking oil, a tanker truck accident on Interstate 95, or it could be a small spill or leak from a home heating oil tank – accidents are inevitable. These inadvertent releases of hazardous materials and petroleum products can have significant impacts on groundwater and surface water quality.

The most common spills are spills of petroleum products. Data from the DEM Office of Emergency Response from 2004 - 2013 on the category of oil spills in RI is presented in Figure 15 below. An average of about 650 oil spills per year were reported in this time. It is noteworthy that residential fuel oil spills from delivery and storage are consistently the largest or next to largest category of oil spills by number reported annually. Few homeowners know that homeowner's insurance policies often do not cover damages and cleanup costs due to heating oil spills and leaks.

Large oil spills in RI have fortunately been rare. In recent history there have been two. In January 1996, the oil barge North Cape ran aground along the South Kingstown coast and spilled an estimated 828,000 of heating oil into the Block Island Sound. As a result, 250 square miles of fishing grounds were closed. In June 1989, the oil tanker M/V World Prodigy ran aground on Brenton Reef off Newport spilling an estimated 290,000 gallons of heating oil into coastal waters. Both spills caused damage to fish and wildlife. The response to spills of this scale involves multiple federal and state agencies that coordinate to contain, cleanup, assess damage to natural resources and oversee implementation of restoration actions.

Figure 15, Total Number of Oil Spills by Sector, 2004-2013



Minimizing Impacts: DEM's Office of Emergency Response is the first line of defense in protecting public health and safety and environmental quality in the event of a release through implementation of actions pursuant to the RI Emergency Response Plan. Emergency responders are prepared to limit the risks from oil and chemical spills, failed tanks or pipelines, fires or fumes, overturned trucks, sunken vessels, litter, abandoned drums, and the like. This Office responds to approximately 600-1000 incidents each year.

The industrial and commercial facilities ("Tier 2 facilities") that exceed certain volume thresholds for the storage of hazardous materials are required to prepare emergency response plans that are shared with local and state officials. These plans outline clear areas of responsibilities and actions to be taken in the event of a chemical release caused by accident, fire or natural disaster.

Whereas the storage of hazardous materials is a significant threat to water quality (see the following sections) due in part to the large number of storage tanks, there is only one pipeline in RI that would be considered a potential threat – the petroleum products pipeline from the Exxon Mobil terminal in East Providence to Springfield, MA. This pipeline and any other pipeline are subject to the US Department of Transportation Pipeline and Hazardous Material Safety Administration Regulations, Office of Pipeline Safety Standards and Regulations. No RI regulations address pipeline management. However, RI DEM Emergency Response staff will respond to any leak or spill associated with a pipeline.

Hazardous Materials Management

Effective hazardous materials management requires a multi-phase approach to ensure that water resources, the environment, and public health and safety are protected:

- *Ability to respond to accidents and leaks in a timely and effective manner to limit the environmental impact.*
- *Proper storage and handling to prevent accidents and leaks (see also the Sections on Underground Storage Tanks and Above Ground Storage Tanks).*
- *Proper disposal of waste generated in the use of the hazardous materials (See also previous Section on* Hazardous Material and Petroleum Product Spills).
- *Strategies to clean up the environmental impacts from any accidental or illegal releases and addresses climate change (see also Contaminated Site Clean-up).*

Hazardous Material and Petroleum Product Spills Policy: Protect water resources and public health and safety from spills of hazardous materials and petroleum products.

Part 7, Implementation Matrix for all Recommended Actions.

Underground Storage Tanks for Hazardous Materials

Pollutants: petroleum products, toxic chemicals, metals

Key Point:

- Although spills and leaks from underground storage tanks (USTs) cannot be completely prevented, the number, size and impact of these events on RI's water resources can be decreased by ensuring proper management of these facilities.

Water Quality Concerns: Underground storage tanks (USTs) are used throughout Rhode Island to store petroleum products such as motor fuels and heating oils and to a lesser degree other types of chemicals. UST facilities have potential to cause significant pollution of groundwater should a leak or spill occur.

Leaking underground storage tank systems (tanks, piping and dispensers) were for many years considered the major threat to groundwater quality in RI. Leaking USTs have caused significant impacts, including the contamination of numerous private wells, temporary and permanent disruption in the use of public wells, explosions and fires at construction sites, explosion hazards within buildings, and the leaching of petroleum into surface waters. This threat has decreased dramatically since the first DEM UST Program regulations were enacted in 1984. Since the DEM Program was established, 15,184 of the 17,737 regulated tanks in RI have been removed (as of January 2013).

Since 1984, 1,946 leaking underground storage tank (LUST) cases have been investigated. As of May 19, 2014, DEM had 220 active LUST cases. Leaks/spills may result from equipment failure or operator error at the tank, in the piping, or at the dispenser. The number of annual LUST cases has been dropping over the years as the number of tank systems come into compliance with the Rules. The number of new LUST sites per year peaked in the mid-1990s with an average of 156 new sites each year in the five-year period from 1994 to 1998. In comparison, the average number of new sites in the five-year period from 2009 to 2013 is 19 sites.

Minimizing Impacts: The remaining 2,553 active USTs, must comply with the comprehensive DEM "Rules and Regulations for Underground Storage Facilities Used for Petroleum Products and Hazardous Materials" (UST Rules). The UST Rules incorporate federal minimum requirements with additional state standards for facility registration, leakage tests, facility inspections, training of onsite operators, response to leaks, and procedures for cleaning up leaking tank sites. The next major required upgrade for UST facilities (except heating oil systems) is a state requirement that all single walled tank systems be removed over a seven year period from 2017 to 2024 based on system age.

DEM regulates all USTs except home heating oil tanks less than 1,100 gallons in capacity that are located at residences and on farms. Although most heating oil tanks less than 1100 gallons are likely above ground (outside or in a basement), an unknown, but suspected large number of heating oil tanks are buried. These tanks will eventually leak. RI state statute 46-12.1 enables municipalities to adopt ordinances providing for the regulation and control of underground storage tanks and establishing procedures for the registration, testing and removal of such underground tanks. DEM has encouraged municipalities to use this authority to prohibit USTs in sensitive areas and focus their efforts on encouraging removal of home heating oil tanks.

The RI Underground Storage Tank Financial Responsibility Fund provides clean-up funds for eligible applicants (See also the discussion in the following Sub-section on Above-ground Storage Tanks for Hazardous Materials.). The first payments from the fund were made in 1997, and a total of $55 million has been distributed through July 2011.

Underground Storage Tanks for Hazardous Materials Policy: Prevent impacts to water resources from underground storage tank leaks and spills.

See Part 7, Implementation Matrix for all Recommended Actions.

Above-ground Storage Tanks for Hazardous Materials

Pollutants: petroleum products, toxic chemicals, metals

Key Points:
- Above-ground storage tanks are not regulated as effectively as underground storage tanks.
- Above-ground storage tanks for non-petroleum based products (not waste) are not subject to environmental regulations.

Water Quality Concerns; Above-ground storage tanks (ASTs) are used throughout Rhode Island to store petroleum products such as motor fuels and heating oils and to a lesser degree other types of chemicals. They range in size from small residential ASTs for heating oil, of which there are thought to be thousands, to bulk oil storage facilities. As of January 2014, DEM has identified approximately 300 bulk oil storage facilities, many of which have more than one tank subject to the regulations. Releases from the operation of AST facilities have been associated with extensive soil and groundwater contamination, as well as surface water impacts.

Minimizing Impacts: The RI "Oil Pollution Control Regulations" establish standards to prevent release of material from those facilities with a combined above ground storage capacity of greater than 500 gallons of oil, gasoline or any other substance refined from petroleum. These regulations include provisions for secondary containment, facility inspections, tank closure, and groundwater monitoring and spill response.

Unlike the UST Program, which is driven by federal environmental protection standards and generously supported by federal funding, the AST Program is supported solely by state resources. As a result, DEM's ability to manage this program effectively has been compromised by the lack of resources. The regulated AST facilities must comply with the provisions of the regulations, including monthly inspections.

When looking at the universe of hazardous materials storage, there is a gap in the regulatory net in regards to above ground storage of products (not waste) that are not subject to the "Oil Pollution Control Regulations" -- these are the non-petroleum based chemicals. Measures have to be in place to meet fire and safety standards for above ground storage of non-petroleum based hazardous materials, but there are no additional requirements stipulating procedures for environmental protection, such as secondary containment, facility inspections for tank integrity, etc. that are required for petroleum products. In comparison, the UST program regulates the underground storage of petroleum products and hazardous materials.

Above-ground Storage Tanks for Hazardous Materials Policy: Prevent impacts to water resources from above ground storage tank leaks and spills.

See Part 7, Implementation Matrix for all Recommended Actions.

Waste Management – Solid Waste and Hazardous Waste

(The clean-up of historic sites that have caused contamination is addressed in the following section on Contaminated Site Clean-Up.)

Pollutants: toxic chemicals, petroleum products, metals, nutrients, solid waste

Key Points:

- Effective oversight of all aspects of waste management will ensure minimal impacts to water resources.
- Pollution prevention strategies to minimize the volume of solid and hazardous waste generated is an essential component of waste management to minimize potential future impacts on water quality.

Water Quality Concerns: For decades, solid waste was disposed of in community-run disposal sites that were not properly managed to prevent environmental impacts. These disposal sites contain a vast array of contaminants that have the potential to pollute groundwater and surface water. These sites were each closed under standard practices in use at the time of closure. The conditions of closure and the environmental monitoring required at each of these sites vary considerably.

At present, the Tiverton Landfill, which accepts only solid waste from Tiverton residents, is the only community facility in operation. All other solid waste in RI is disposed of at the RI Resource Recovery Corporation Central Landfill in Johnston. Hazardous waste can cause a water quality problem at any point in the generation, transport, treatment, storage and disposal stages due to spills, accidents or improper management. Water quality issues from hazardous waste (See also Policies and Actions on Contaminated Site Clean-up) have historically resulted from the illegal disposal of these materials.

Minimizing Impacts: The DEM "Solid Waste Regulations" ensure that solid waste management facilities are designed and operated to protect surface water and groundwater quality at such facilities as landfills, transfer stations, incinerators, waste tire storage, petroleum contaminated soil processing, construction and demolition debris, and waste composting (including yard and leaf). As of July 2015, 46 such facilities were active in RI.

DEM "Rules and Regulations for Hazardous Waste Management" are in place to manage hazardous waste at all steps in the process. (Note: there are no hazardous waste disposal facilities currently in RI.) As part of the DEM pollution prevention efforts, the Office of Customer and Technical Assistance has produced manuals and other materials regarding hazardous waste compliance (as well as other issues) for auto body shops, used oil recycling, and auto salvage facilities.

Household hazardous waste, such as pesticides, oven cleaner, pool chemicals, nail polish remover, oil-based paints, and many others presents a different set of management challenges. Improper disposal of these materials into an OWTS or into the sewer (or just dumped on the land surface) can contaminate our waters. The RI Resource Recovery Corporation has managed the Eco-Depot for many years as a free service for Rhode Island residents who wish to dispose of their household hazardous waste safely and properly. Collection dates are set for Saturdays at the Central Landfill and at community locations across the State (45 dates were set for 2015, 15 at the Central Landfill and 30 at off-site locations). See also the goals and policies for waste reduction and recycling in the State Guide Plan Element: *Solid Waste 2035, RI Comprehensive Solid Waste Management Plan* adopted in 2015[5].

Waste Management – Solid Waste and Hazardous Waste **Policy:** Minimize impacts to water resources from solid waste and hazardous waste.

See Part 7, Implementation Matrix for all Recommended Actions.

Contaminated Site Clean-Up (excluding USTs)

(Note: clean-up of leaking USTs is also addressed in a separate section)

Pollutants: Toxic chemicals, petroleum products, metals

Key Point:

- Contaminated site cleanup is often an expensive and long-term process that is nonetheless essential to assure water quality goals in a watershed are met.

Water Quality Concern: Discovery of active and former commercial and industrial sites that have contamination of soil, groundwater and river sediments from hazardous materials and petroleum products are unfortunately a fairly common occurrence in RI. Most of the contamination that has been discovered is a result of activities that predated the comprehensive environmental regulations that have been in place since the 1980s.

Many of the contaminated sites lie in areas where problems could, or do threaten surface water, groundwater, and other sensitive environmental resources that the state is trying to protect and/or restore. Restoration of these sites and former municipal waste sites (described in previous Section on Waste Management – Solid Waste and Hazardous Waste) is essential to assure long-term water quality goals in a

[5] http://www.planning.ri.gov/documents/LU/2015/SolidWaste2038_Approved_05142015_Final.pdf

watershed are met. Of the 1786 state and federal sites described below, 60% of these sites are within 500 feet of a stream, pond or wetland (RIGIS data).Water quality issues at these sites are typically:

- Contaminated groundwater that can impact drinking water wells and flow to and impact down gradient surface waters.
- Contaminated sediment from historical discharges of waste into these waters. Although discharges of toxic pollutants to our waters have been reduced and eliminated, persistent high concentrations of contaminants in bottom sediments of rivers, ponds, and bays continue to degrade aquatic habitat in localized areas, particularly in the urban core.

Minimizing Impacts: DEM oversees the investigation and remediation of sites contaminated with hazardous wastes and petroleum products. In accordance with State and Federal Laws, the programs ensure that investigations and remedial activities are conducted in a consistent manner that adequately protects human health and the environment.

- Sites that are <u>not</u> subject to the federal Superfund Program described below are managed by the state Remediation Program. The DEM "Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases" define the process and requirements.
    - Analysis of RIGIS data for state designated sites of soil and water contamination reveals:
        - Total number of sites = 327
        - 66% of these sites are within 500 feet of surface water bodies and wetlands.

- DEM also assists in the cleanup of federally designated "superfund sites", the evaluation of sites on EPA's list of potential superfund sites, and the clean-up of former Department of Defense sites. These sites do not include the sites addressed by the state site remediation program discussed above. There are 9 sites designated as Superfund sites (also referred to as National Priority List sites).
        - Analysis of RIGIS data for federally designated sites of soil and water contamination reveals there are a 1459 total number of sites, and 58% of these sites are within 500 feet of surface water bodies and wetlands.

Cleaning up contaminated property ('brownfields") for reuse and redevelopment is a critical component to the future community revitalization and economic growth of the State's urban areas. According to EPA it has been estimated that for every acre of redeveloped Brownfield property, 4.5 acres of greenspace are spared. Until recently, funding to finance the assessment and cleanup of Brownfields had been limited to grant and loan funding provided by the EPA Brownfields program. This funding has been provided to state and local government agencies and non-profit organizations through a competitive program since 1994. As of 2015, EPA has awarded over $4 million to RI municipalities and DEM for site assessments. EPA has also awarded over $9 million in cleanup grants across the state. In addition, over $6 million in cleanup and assessment funding has been provided through various Brownfields Cleanup Revolving Loan Funds, providing grants and loans with below market fixed interest rates and flexible repayment terms to qualified brownfield owners/developers to finance eligible site cleanup costs. In 2014 RI voters approved a $5 million bond for Brownfields cleanup and redevelopment projects which allowed DEM to establish a state Brownfields Program in 2015.

Contaminated Site Clean-Up (excluding USTs) Policy: Restore water quality and protect human health by remediation of contaminated sites and encouraging redevelopment and reuse of contaminated sites.

See Part 7, Implementation Matrix for all Recommended Actions.

Dredging and Dredge Material Management

Pollutants: sediment, metals, toxic chemicals

Key Points:

- Dredged material must be properly managed at both the location of its removal and its final use or disposal site to minimize impacts on water quality.
- RI strongly encourages the beneficial use of dredged material.

Water Quality Concern: In a state with significant boating and shipping sectors, dredging of our waterways is vital to maintain navigational access to harbors and marinas. Sediment from natural sedimentation patterns and that which is carried off the landscape by stormwater is deposited in our waterways and builds up to levels that impede ship and boat traffic. Due to RI's long industrial history, sediments from urbanized rivers and coastal waters targeted for removal may contain a variety of pollutants, such as metals and hydrocarbons.

Dredging can impact water quality at both the point of material removal and the subsequent location of its in-water disposal, if this option is chosen. The potential impacts to the aquatic environment include:

- Suspended sediment from dredging and disposal that can impact marine life, such as submerged aquatic vegetation and fish larvae
- Loss of marine life from the location of dredging and disposal
- Loss of bottom habitat in the area being dredged and at the place of disposal, and
- Creation of pockets of low dissolved oxygen in areas over-dredged.

The upland disposal of dredged material also has potential impacts, primarily the infiltration to groundwater of contaminants from the sediment, including chlorides.

Minimizing Impacts: CRMC and DEM administer the "Rules and Regulations for Dredging and the Management of Dredged Material" to ensure that dredging in the marine environment and management of the associated dredged material is conducted in a manner which is protective of surface water and groundwater quality. In addition, dredging is prohibited during critical times of the year for fish spawning and migration.

The material to be dredged must be analyzed in order to ensure that the use or disposal of the dredged material will not impact water quality. RI strongly encourages the beneficial use of dredged material for brownfields redevelopment, beach nourishment, landscaping, habitat restoration and/or creation, construction projects, landfill cover and other useful purposes.

Dredging projects in the northern half of the state mainly dispose of the dredged material in the Confined Aquatic Disposal (CAD) cells located in the upper Providence River. These sediments are not suitable for open-water disposal and the cells are required to be capped. The CAD cells have limited capacity, therefore new cells will have to be created. Dredging projects in the southern half of the State will typically dispose of sediments as beach nourishment. Some marinas will reuse material on-site. Larger dredge projects where the sediment does not meet beach nourishment criteria will opt to dispose of the material at an EPA designated offshore regional disposal site in Rhode Island Sound. Dredging also occurs in the coastal ponds. Coastal storms erode beaches and transport sediment into the ponds, requiring dredging to increase flushing to the ponds, restore sand to the beaches and open access to the ponds. On the Narrow River, dredge material are being used in experimental coastal wetland restoration projects. Beneficial reuse of dredged material is a priority disposal option under R.I. Gen. Law 46-6-1(3)

Dredging and Dredge Material Management Policies

Dredging and Dredge Material Management Policy 1: Reduce water quality impacts of dredging at both the location of material removal and the location of its use, reuse, or disposal in water or on land.

Dredging and Dredge Material Management Policy 2: Protect fish spawning and migration patterns from impacts of dredging.

See Part 7, Implementation Matrix for all Recommended Actions.

Pet Waste

Pollutants: pathogens, nutrients

Issue Highlight:

- Pet owners must act responsibly to control pet waste.

Water Quality Concern: Pet waste can be a significant contributor of bacteria and other pathogens to surface waters. The primary issue is dog waste, although other backyard pets (horses, goats, etc.) can cause localized problems. Dog waste in urban and suburban areas that is left on the sidewalk, or on grass near the street, can be washed into stormwater drainage systems and cause downstream water quality impairments. It has been estimated that for a small bay watershed (up to 20 square miles), 2 to 3 days of droppings from a population of 100 dogs contribute enough bacteria, nitrogen, and phosphorus to temporarily close a bay to swimming and shell fishing (USEPA website Water: CZA, Pollution Prevention Management Measures). Dog waste can harbor a host of different bacteria, parasites and viruses that can cause human illness and disease. One gram of dog waste contains 23 million fecal coliform bacteria, almost twice as much as human waste (RIDEM 2010). In Rhode Island, there are approximately 200,000 dogs and it is generally estimated that dogs produce one-half pound of feces per dog per day (RIDEM 2011), which means 100,000 pounds of dog waste is generated per day in RI.

Minimizing Impacts: All of our waters, particularly those identified as impaired due to bacteria (Section xx), can benefit from better control of pet waste. Management of pet waste is clearly the pet owner's responsibility, but only about 60% of dog owners pick up after their pets (NRDC 3-4-14). Pet waste can be flushed, buried, or sealed in bags and put in the trash.

Pet Waste Policy: Protect water quality from pet waste.

See Part 7, Implementation Matrix for all Recommended Actions.

Waterfowl

Pollutants: pathogens and nutrients

Key point:

- A sustainable statewide strategy is necessary for waterfowl management to mitigate impacts to water quality.

Water Quality Concern: Despite the appeal of feeding the ducks, most people don't realize that ducks and geese can significantly contribute to water pollution. Feeding of waterfowl, along with the large lawns and open land near waterbodies that allow waterfowl to land and congregate, can result in dramatic and unnaturally high concentrations of waterfowl in some locations. Whether by direct deposition into waterbodies or via transport by stormwater, the bacteria and nutrients in their waste can end up in our waterbodies. Recent concern has focused on the large numbers of resident Canada geese. As reported by the Southern RI Conservation District (SRICD 2013), a single Canada goose can eat up to four pounds of grass and produce up to 2 pounds of fecal waste a day. Although most people find a few geese acceptable, problems develop as local flocks grow and their droppings become excessive.

Canada goose populations in Rhode Island can be broken into two broad groups: migratory and resident. Migratory Canada goose populations are not considered to be a problem in Rhode Island since they do not nest locally and experience significant hunting pressure across much of their migratory routes. However, resident Canada goose populations have increased greatly over the last 50 years in southern New England.

Minimizing Impacts: Efforts to control waterfowl to minimize water quality degradation that have been attempted in RI include:

- Education on the negative impacts of feeding waterfowl;
- Stopping the public from feeding waterfowl (signs, ordinances);
- Modifying habitat. Waterfowl, especially grazers like geese, prefer easy access to water. Maintaining an uncut vegetated buffer along the shore will make the habitat less desirable to geese; and
- Controlling goose populations with hunting and nest disruption.

Waterfowl Policy: Minimize water quality impacts from waterfowl populations in RI, particularly Canada geese.

See Part 7, Implementation Matrix for all Recommended Actions.

Land Application of Wastewater Treatment Facility Solids

Pollutants: nutrient, pathogens, metals, pharmaceuticals and personal care products *(or emerging contaminants)*

Key point:

- Only Class A Biosolids (treated sludge) are land applied in RI as fertilizer or soil amendments.

Water Quality Concern: The solids that are removed in the wastewater treatment facility (WWTF) operations (sludge) (See also previous Section on waste water treatment facilities.) contain numerous types of contaminants including pathogens, nutrients, metals, and pharmaceuticals and other emerging contaminants. Land application of these solids is one potential option for disposal for this material that can reintroduce these contaminants onto the landscape.

Minimizing Impacts: All aspects of sewage sludge management – generation, treatment, transport, disposal, land application are regulated in accordance with DEM's "Rules and Regulations for Sewage Sludge Management." Most of the sludge generated at RI's wastewater treatment facilities is disposed of by incineration (~85%). Although the DEM Rules have standards for land disposal of sludge (burial) and land application of minimally treated sludge, neither of these methods of sludge management have recently been utilized in RI, and they are not likely to be used given siting restrictions and economic considerations.

DEM allows for the beneficial use of biosolids (treated sludge) to provide nutrients and soil conditioning properties for growing crops, silviculture, and establishing vegetative cover for reclamation sites. Currently in RI only Class A Biosolids are applied to land as fertilizer or as a soil amendment. Class A Biosolids are those biosolids that have been treated (e.g., by composting) to kill off pathogens and which have been tested to meet specified metals limits. This renders the product safe for application to food crops and vegetation for animal grazing without any requirement for DEM permits. In addition to biosolids generated in state (primarily at the Bristol wastewater treatment facility), significant quantities of Class A biosolids are brought into the state from the Massachusetts Water Resource Authority's Boston wastewater treatment facility and in bags of Milorganite generated by the Milwaukee Metropolitan Sewage District. Class B and Class C Biosolids have higher concentrations of contaminants and significant restrictions on their use:

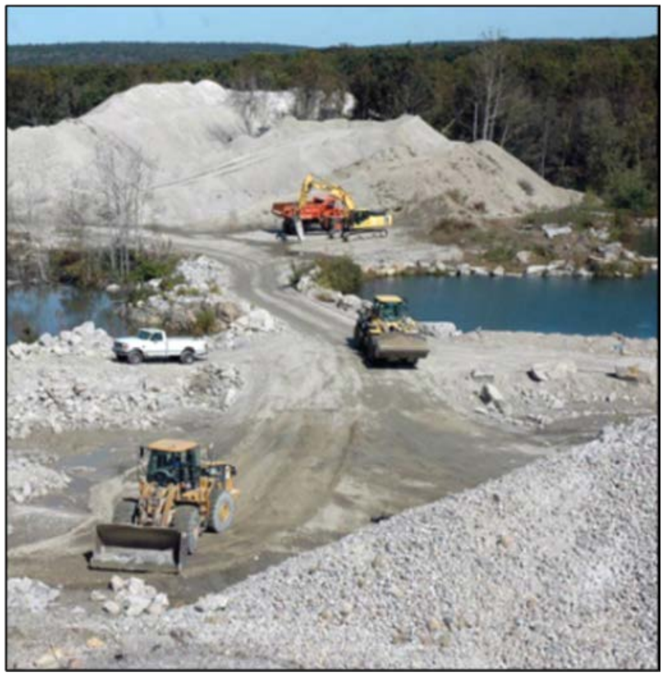
- Class B Biosolids Land Application – operate under the requirements for land application of sludge,
- Class C Biosolids Disposal – land application prohibited, used as landfill cover or disposed in solid waste facilities.

The threat to water quality from the land application of biosolids is similar to that posed by any other application of fertilizer or manure where inappropriate application could cause water quality impairments from nutrients, except that biosolids are likely to have low-level concentrations of emerging contaminants that are not treated by standard procedures.

Land Application of WWTF Solids Policy: Prevent water quality impacts from land application of wastewater treatment facility solids.

See Part 7, Implementation Matrix for all Recommended Actions.

Surface Mining



Pollutants: sediments, chemical releases

Key point:

- Protecting water quality from material excavation operations requires diligent site oversight both during removal operations and post- removal through the period necessary to successfully reclaim and stabilize the site.

Water Quality Concern: Surface mining activities in Rhode Island are generally limited to sand and gravel operations and stone quarrying/rock crushing operations, of which there are approximately 15 to 20 facilities operating in RI regularly. The primary water quality concern from these operations is deposition of sediments in nearby surface waters and wetlands from improperly managed sites and poorly reclaimed former sites. Sedimentation is exacerbated by a failure to establish adequate buffers prior to commencing operations, or by not limiting the areas of disturbance. Any washing or other type of processing conducted onsite adds to the water quality concerns associated with mining operations.

Abandoned or improperly restored excavation areas pose additional problems. Sand and gravel operations are too often planned and carried out with little regard for post-production reclamation needs, such as regrading, restoring topsoil, and re-vegetating. Exposed sites that are not properly restored may continue to erode for many years. Abandoned excavation areas have also tended to become a convenient location for illegal dumping and disposal of wastes. The process of removing material decreases the depth to the water table from the surface and in some cases exposes the water table, thus increasing the vulnerability of the groundwater resource to spills or leaks from machinery operating in the excavation area. Once the excavation is completed, any future use of the site will present a greater risk to groundwater due to the decreased separation from an activity and the water table.

Minimizing Impacts: If there is a discharge to waters of the state from the site, sand and gravel mining and dimension and crushed stone activities must adhere to the conditions of the DEM Multi-Sector General Permit for Stormwater Discharge Associated with Industrial Activity. In cases where the excavation is below grade or entirely bermed, there may not be a discharge. If there is a discharge, the DEM multi-sector permit requires a stormwater management plan for the operations that identify BMPs to control stormwater, including site stabilization at the conclusion of activities. Many municipalities have earth removal ordinances that address these facilities and protect water quality by specifying operational and reclamation standards. Sand and gravel excavation also occurs on a temporary basis as a site is prepared for other future uses. As discussed in the Stormwater Section, activity that disturbs greater than one acre is subject to the RIPDES Construction General Permit.

Surface Mining Policy: Prevent water quality impacts from pollutants associated with resource extraction operations.

See Part 7, Implementation Matrix for all Recommended Actions.

Silviculture

Pollutants: sediment

Key Point:

- The utilization of BMPs and the generally small scale of activities limit the overall impacts of timber harvesting on water quality in RI.

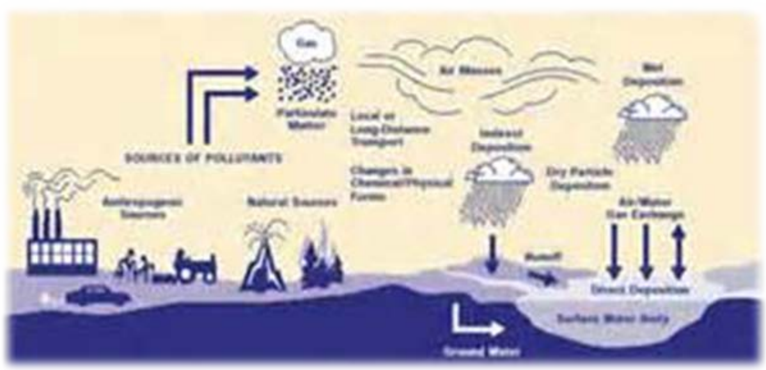
Water Quality Concern: While harvesting forest products can contribute to water quality degradation due to increases in soil erosion and sedimentation, the utilization of BMPs and the generally small scale of such activities limit the overall impacts to water quality in RI. With the exception of clearing for development (subject to stormwater permitting), the timber harvesting operations that take place in RI generally involve selective cutting in localized areas.

Minimizing Impacts: Commercial wood-cutting operations are regulated by DEM Division of Forest Environment, which requires that any harvester be registered with DEM, file a Notification of Intent to Cut, implement required BMPs to prevent impacts to water quality, and comply with the Freshwater Wetlands Program Rules. The Rhode Island Forest Resources Management Plan (March 2005), State Guide Plan Element 161, points out the benefits of forest land to water quality and the need to ensure that BMPs are adhered to in order to prevent impacts to water quality. The most recent strategies for silviculture are in the state forest actions plan "*RI Forest Resource Assessment and Strategies, A Plan to tomorrow's Forests*" that was updated in 2010 by DEM.

Silviculture Policy: Protect water quality during forest harvesting operations.

See Part 7, Implementation Matrix for all Recommended Actions.

Atmospheric Deposition



Pollutants: mercury, nutrients, acidity

Key Point:

- Reducing impacts of atmospheric deposition on RI's waters requires a regional management approach to controlling sources contributing pollutants to the atmosphere.

Water Quality Concern: The atmosphere is a significant pathway for some pollutants that enter our waters. These pollutants -- primarily mercury, nitrogen and phosphorus -- are deposited directly into our waterbodies and onto the landscape. Pollutants can be deposited in both wet (precipitation) and dry (natural fallout) conditions. Pollutants deposited on the land are carried into RI's waters by stormwater, which needs to be properly managed to reduce this avenue for impacting water quality (See also Stormwater Policies and Actions).

Fish consumption advisories are in place for freshwaters across the state due to elevated levels of mercury. The vast majority of this mercury in our waters (98%) is a result of atmospheric deposition and 75% of the mercury in the atmosphere is from anthropogenic sources primarily generated by coal-fired power plants, municipal waste combustors, sewage sludge incinerators, and residential heating (NEIWPCC 2007). Mercury is a potent neurotoxin that poses risks to human health. Exposure to this toxic metal occurs when humans consume fish that contain mercury's most toxic form, methylmercury.

Minimizing Impacts: Meeting water quality standards for mercury will require reductions from mercury sources within the Northeast region, U.S. states outside of the region, and global sources. The Northeast states have all moved to reduce emissions from mercury and releases through limits on incinerators and coal-fired utilities. With the reductions being achieved locally, the New England states are now interested in collaborating on region-wide fish tissue sampling to evaluate progress toward reducing fish tissue concentrations of mercury. Based on calculations in the Northeast Regional Mercury TMDL, atmospheric deposition of mercury from anthropogenic sources needs to be reduced by 98% in order to meet desired fish tissue concentrations (NEIWPCC 2007).

Nitrogen is another significant pollutant deposited from the atmosphere (See previous discussion of nutrients in Part 2). Combustion (motor vehicles, power plants) provides the high temperatures necessary to convert stable nitrogen gas into the reactive nitrogen oxides. These nitrogen oxides are then converted to nitric acid vapor and particulate nitrates that are removed by precipitation from the air. A large amount of nitrogen is lost to the atmosphere as ammonia from fertilizer applications and livestock primarily in the Midwest that can be carried to the northeast. The USGS New England water quality modeling of total nitrogen in New England streams concluded that for the entire study area, 50% of the nitrogen loads came from atmospheric deposition (USGS 2004). Nutrient modeling in 2011 for Green Hill Pond and Eastern Ninigret Pond predicted that approximately 8% and 10%, respectively, of the total nitrogen load was from atmospheric deposition directly onto the water surface (South Kingstown 2011). Atmospheric deposition of phosphorus has been identified in the TMDLs for ponds exhibiting signs of eutrophication, albeit as generally a minor source, compared to waterfowl. The Mashapaug Pond (Cranston) TMDL (RIDEM 2007) concluded that 11% of the total phosphorus load was from atmospheric deposition.

Atmospheric Deposition Policy: Reduce mercury, nitrogen, phosphorus, and other pollutants from atmospheric deposition.

See Part 7, Implementation Matrix for all Recommended Actions.

Marine and Riverine Debris

Pollutants: solid waste (litter, trash, etc.)

Key point:

- Debris is an often overlooked water quality issue best addressed through increased public awareness.

Water Quality Concern: Styrofoam cups, plastic drinking water bottles, fishing line, cigarette butts, and other types of debris floating in our rivers and coastal waters and washed up on our beaches is not just a visual litter or waste issue. It is a water quality issue. Bulky debris can take the form of rotting pilings, damaged docks, abandoned boats, tires and other items that may pollute and physically damage aquatic habitat. Trash and debris in our waters can:

- Injure swimmers and beach goers;
- Kill and injure wildlife: many species accidentally ingest trash, mistaking it for food. Abandoned fishing nets and gear, discarded fishing line and other forms of debris can entangle marine wildlife – sea turtles, sea birds, and fish.
- Threaten tourism and recreation, and the dollars they add to local economies by limiting people's enjoyment of beach and water-related activities.
- Complicate shipping and transportation by causing navigational hazards; and generate steep bills for retrieval and removal.

An estimated 90% of waterway debris comes from land-based sources (NOAA 1999) -- blown into the Bay or ocean or most commonly washed off our streets and into our waters via storm drains. Debris also comes from recreational and commercial boaters. Annual coastal cleanups have been conducted in RI every year since 1986. In 2014, 16,368 pounds of debris were collected along 59 miles of shoreline at 80 locations in RI by 2,101 volunteers. The top ten items collected in descending order by number collected: cigarette butts, food wrappers, plastic bottle caps, plastic bottles, yards of fishing line, straws and stirrers, beverage cans, plastic bags, glass bottles, and metal bottle caps (Save the Bay, 2014 International Coastal Cleanup, Rhode Island Report).

In 2005, in response to concerns about debris, the not-for-profit organization Clean the Bay was formed. Its mission is to clean debris from Narragansett Bay and RI's coastal shorelines. It has coordinated dozens of cleanups in cooperation with governmental partners, private supporters and volunteers. DEM has partnered with Clean The Bay on Project Clean Sweep: an initiative, funded by a grant from the National Oceanographic and Atmospheric Association (NOAA), that aims to remove over 500 tons of washed up boats, docks, pilings, telephone poles, and other large and small marine debris that has drifted ashore in Narragansett Bay over time.

Minimizing Impacts: Recent efforts in Rhode Island that address the issues above include:

- Proposed state legislation for: 1) extended producer responsibility for packaging, which would include measures to increase collection, recycling and reuse of discarded post-consumer packaging, and 2) statewide bans on use of plastic bags by retailers.
- Municipal bans on the use of plastic checkout bags by retailers in Barrington.
- Rhode Island's state beaches are smoke-free as of 2013. The RI DEM and Department of Health initiated this mandatory no smoking requirement at all Rhode Island state beaches to keep beaches clean and to protect people and wildlife from the risks and ramifications of smoking at the beach; note that cigarette butts are the number one item collected in annual beach cleanups.
- Initiatives by DEM, National Park Service and various partners to encourage the collection and recycling of snarled fishing line.
- Grant funded efforts to remove large pieces of debris from derelict boats and docks.

Marine and Riverine Debris Policy: Reduce impacts from human generated debris in RI waters.
See Part 7, Implementation Matrix for all Recommended Actions.

Aquaculture

Pollutants: Nutrients, organic wastes, (potential for pharmaceuticals, e.g., antibiotics)

Key point:

- Whereas shellfish operations can improve water quality, finfish operations have the potential to degrade water quality.

Water Concern: Quality: Aquaculture is a growing industry in RI with 55 active farms growing shellfish over 206 acres at the end of 2014 (CRMC 2014). This is an increase from 22 farms in 2004 and 6 farms in 1996. Oysters remain the number one aquaculture product with approximately 7.5 million oysters sold annually for consumption, far exceeding the number of hard shell clams and blue mussels also being grown. Water quality can be potentially improved by the filter feeding actions of these shellfish operations, and in fact oyster beds have been proposed as a means to restore water quality in other jurisdictions. In RI, many of the nutrient- enriched waters that might benefit from the action of filter feeders are also contaminated with elevated pathogens and therefore aquaculture operations are generally prohibited. The Narragansett Bay Estuary Program, using EPA Southeast New England Program funding, has supported a research project to evaluate the potential for growing of rib mussels for water quality purposes.

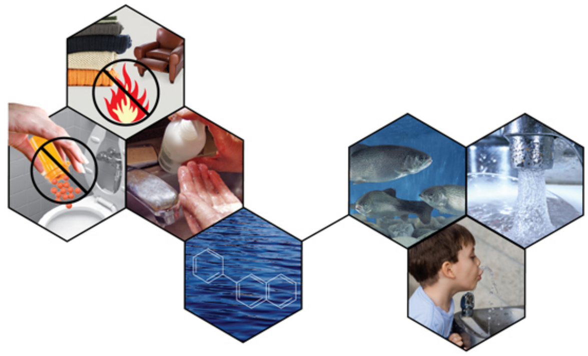
Finfish aquaculture operations are essentially limited to the three state freshwater fish hatcheries – Lafayette, Carolina and Perryville – for the stocking of ponds and rivers for fisherman. These facilities have caused downstream water quality impacts due to the release of excessive levels of phosphorus. Discharges from these facilities are permitted by the RIPDES Program, and each facility is working to ensure compliance with their effluent limitations. Use of any medications or other drugs in the raising of the fish is to be reported to the RIPDES Program, but no such use has been reported to date. Smaller facilities raising finfish – such as research facilities, small farm ponds – fall below the RIPDES program regulatory threshold.

Minimizing Impacts: Currently there are no operations in open waters to grow finfish in pens for commercial purposes. Should these operations be proposed, they will be required to obtain a permit from the RIPDES Program. Nutrients, organic wastes and antibiotics from this type of operation have generated water quality concerns in other states.

Aquaculture Policy: Prevent impacts to water quality from aquaculture operations.
See Part 7, Implementation Matrix for all Recommended Actions.

Contaminants of Emerging Concern

Pollutants: multiple chemicals



Key Points:

- Analytical detection methods have enabled the detection of these chemicals in our waters at very low concentrations (e.g., parts per trillion ranges or less).
- At this time, many unknowns remain regarding the potential for adverse effects on public health and the environment from these contaminants.

Water Quality Concern: Contaminants of emerging concern are compounds that are not commonly monitored and their health and environmental impacts have not been completely determined due to their "emerging" nature. These contaminants include flame retardants in fabric, chemicals for non-stick surfaces, plastic additives, and pharmaceutical and personal care products (PPCP). PPCPs have been the most widely analyzed category of emerging contaminants. PPCPs comprise a diverse and vast group of chemicals including, but not limited to, prescription and over-the-counter human drugs, veterinary drugs, diagnostic agents, nutritional supplements and vitamins, and other consumer products such as anti-bacterial soaps, fragrances, cosmetics, and sun-screen agents.

PPCPs and other emerging contaminants enter RI's waters primarily by means of wastewater treatment facility effluent, combined sewer overflows and onsite wastewater treatment systems. However, they may also originate from animal feeding areas, land application of biosolids and manure, and aquaculture. PPCPs are being detected in groundwater and surface water of the Northeast at very low concentrations. New and improved analytical detection methods have enabled the detection of these chemicals in the parts per trillion ranges or less.

Currently there are no US EPA/state ambient water quality criteria, water quality standards, or drinking water standards for most of the PPCPs and other emerging contaminants. These compounds are not routinely monitored for as part of federal or state monitoring programs, therefore much of the monitoring to date has depended on specific research projects. The presence of these chemicals in waterbodies has been linked to impacts on aquatic species, including changes in fish sex ratios, development of female fish characteristics in male fish, changes in nesting behavior by fish, and adverse effects on invertebrates. At this time, many unknowns remain regarding the potential for adverse effects on public health and the environment. Rhode Island will look to EPA for guidance concerning PPCPs.

Nanoparticles are another class of emerging contaminants. Nanoparticles are another class of emerging contaminants that due to their growing use in a wide range of products from computer chips to sunscreen will require close evaluation of their impacts on water quality. Nanoparticles, which exist naturally and which we breathe all the time, have at least one dimension smaller than 1 micron and potentially as small as atomic and molecular length scales (~0.2 nm). Nanotechnology is incredibly promising because particles at this size scale may have dramatically different properties than their "normal" sized counterparts. While nanoparticles can be quite benign, it is being discovered that some can be toxic. However, scientists are only now just beginning to study the effects of nanoparticle fate and transport in the environment.

Minimizing Impacts: Recent efforts to control pharmaceuticals in our environment have focused on proper disposal of unused drugs by encouraging the public not to flush these drugs into our sewer systems or into onsite wastewater treatment systems and by promoting use of drug disposal designated locations (e.g., police stations). However, most of the drugs that enter the environment do so as a result of human excretion of the unmetabolized drug and their breakdown products. Expecting wastewater treatment systems to treat our waters to remove these chemicals and materials (and those yet to be determined) is unrealistic. The long-term solution is to consider the environmental and public health consequences of drugs and other chemicals/materials (and their degradation by-products) when the formulations are being developed (a process referred to as "green chemistry").

Contaminants of Emerging Concern Policy: Prevent impacts to water quality from contaminants of emerging concern.

See Part 7, Implementation Matrix for all Recommended Actions.

Aquatic Habitat

As noted in the initial discussion of "water quality," this WQMP is concerned with the protection and restoration of aquatic habitats from not just pollution sources but also from other types of stressors that result in physical changes to the aquatic habitat, such as wetland alterations, invasive species, barriers to stream flow, and water withdrawal. This section will discuss these stressors and identify actions needed to protect, enhance and restore habitat conditions in support of aquatic life and healthy, and sustainable aquatic ecosystems.

Aquatic Habitat Policy: Prevent further degradation of aquatic habitats and support collaborative efforts to restore habitat conditions on a prioritized basis.

See Part 7, Implementation Matrix for all Recommended Actions.

Wetland Alterations (Freshwater and Coastal)

Stressor: Physical alteration

Key Points:

- Avoidance and minimization of alterations to wetlands is the primary focus of DEM and CRMC regulatory programs.
- Protection of the land adjacent to wetlands as naturally vegetated buffers is important. Restoration of wetland and riparian buffers provides multiple resource protection benefits.
- Adaptation strategies to minimize the loss of salt marsh due to sea level rise should be pursued.

Water Quality and Aquatic Habitat Concern: Wetlands are generally those areas that are flooded or that have water at or near the surface of the ground for part of the growing season. Wetlands function as a component of the larger hydrologic system through which water moves within a watershed. Both freshwater and coastal wetlands perform valuable functions in a watershed, including:

- Flood control and storm damage prevention -- Wetlands store precipitation, intercept stormwater that is running over the land, and receive and store overflow water from adjacent rivers, streams, lakes, and ponds. The collected and stored water is held in the wetland for a period of time, and then it is slowly released downstream. Coastal wetlands dampen storm surge and protect inland property.

- Pollutant removal -- Wetlands can trap and hold sediments and pollutants absorbed onto those sediments, they can transform nutrient pollutants by way of plant uptake and denitrification by microbes, and they can trap or treat heavy metals and other chemicals.

- High productivity --Freshwater wetlands and salt marshes are among the most productive natural systems regionally and worldwide. They produce more plant and animal biomass than upland forests and grasslands. In the coastal zone, high productivity supports the food chains of the coastal ponds and estuaries and subsequently the fish and shellfish industries.

- Fish and shellfish -- Wetlands are required habitat for many freshwater, anadromous and saltwater fish and shellfish. Freshwater fish depend on wetlands for clean water, food, spawning and nursery areas, and for plant cover. Several anadromous fish spawn in the freshwater portions of rivers, including blue back herring and American shad. Salt marshes, flats, and tidal creeks are habitat for numerous commercially harvested species, including menhaden, bluefish, striped bass, and clams.

- Wildlife habitat and biodiversity -- Freshwater and coastal wetlands provide habitat for wetland wildlife species, including birds, mammals, reptiles, amphibians, and invertebrates. Swamps and other wetlands may be especially important in urban areas where other upland areas have been developed and the wetland is the only remaining habitat.

- Open space and recreation -- Wetlands are popular and attractive places for many recreational activities, including swimming, fishing, canoeing, hiking, hunting, bird-watching, and photography. These recreational activities also contribute to Rhode Island's economy by generating money spent on travel, lodging, licenses, and equipment. According to a recent American Sport fishing report residents and tourists in RI spend about $38 million in total on freshwater fishing, while generating about $5.6 million in federal, state and local tax revenues.

- Climate Change Mitigation: Wetlands can function as natural carbon sequestration systems that can contribute to climate change mitigation. Wetlands already contain a significant percentage of the carbon that is sequestered in natural systems. Peatlands contain 30% of all global soil carbon. Coastal wetlands contain up to 70% of carbon sequestered in marine environments. While discerning the net effect on greenhouse gases is complex, the role of wetlands in carbon sequestration is worthy of continued attention and provides an additional rationale for strong protection of wetland resources[6].

Minimizing Impacts: Historically there has been a significant loss of wetlands resources in the State due to filling and other alterations. However, since the 1970s, Rhode Island State Law, policies and regulations have recognized the importance of protecting wetlands. DEM and CRMC administer permitting programs that regulate activities that may alter wetlands and require that any alterations be avoided and minimized. The agencies have jurisdiction over vegetated wetlands and surface waterbodies as well as certain lands that surround them. In 2015, State Law was amended with respect to providing additional protection of freshwater wetlands by DEM and CRMC. This followed the 2014 *Final Report of the Legislative Task Force* on wetland setbacks produced by the Division of Planning that examined the adequacy of freshwater water lands protection in RI[7]. This report recommended both strengthening of wetland protection through

[6] "Wetlands and Climate Change: Consideration for Wetland Program Managers", Association of State Wetland Managers, July 2015.
[7] http://www.planning.ri.gov/documents/LU/legtask/2015/LTF_Final_Report_2014.pdf

increased setbacks and streamlining of the regulatory process. Rules to implement the changes in State Law were under development as of adoption of this Plan.

Effective management of wetland resources requires a strategy that includes both protection and restoration activities. With respect to freshwater wetlands, areas of particular state interest include enhancing or restoring the functions and values of riparian wetlands and buffers and identifying and protecting wetlands of high ecological value. Rhode Island is working towards a statewide wetland restoration strategy that will facilitate voluntary restoration activities.

In the coastal zone, Rhode Island is focusing attention on the vulnerability of salt marshes to climate change, especially impacts from sea level rise. Coastal wetlands provide critical nursery habitat for fisheries, play a role in absorbing nutrients to protect water quality and provide other benefits. A collaborative effort is underway to simulate the coastal wetland migration under different sea level rise scenarios. This information will support development of adaption strategies that may improve the resiliency of salt marshes in light of climate change. Wetland habitats are also valued within the Rhode Island State Wildlife Action Plan (RIDEM Twenty freshwater wetland (plaustrine) habitats and 20 estuarine wetland habitats are identified as key habitats to protect species of greatest conservation need. (See Appendix G for more details.)

Wetland Alterations (Freshwater and Coastal) Policies

Wetlands (Freshwater and Coastal) Policy 1: Protect wetland functions and values by avoiding and minimizing alterations and wetland loss.

Wetlands (Freshwater and Coastal) Policy 2: Facilitate restoration of the quality and quantity of wetlands and adjacent buffers.

See Part 7, Implementation Matrix for all Recommended Actions.

Aquatic Invasive Species (AIS)

Stressor: Physical alteration of aquatic habitat due to excessive plant growth and loss of bio- diversity caused by invasive aquatic plant and animal species.

Key Points:

- An effective management approach to aquatic invasive species includes measures to prevent the introduction of new species, to rapidly respond to new infestations and to undertake the long-term management techniques to control existing infestations.
- Rhode Island lacks an organized lake management program needed to effectively prevent establishment and spread of aquatic invasive plant species in freshwaters.

Water Quality and Aquatic Habitat Concern: An aquatic nuisance species or "invasive species" is defined as a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters (National Aquatic Nuisance Prevention and Control Act of 1990). Invasive species are considered to be second only to direct habitat destruction as a cause of declining biodiversity in the United States. Impacts from AIS generally include:

- Reduced diversity of native plants and animals
- Impairment of recreational uses such as swimming, boating, and fishing
- Degradation of water quality
- Degradation of wildlife habitat
- Increased threats to public health and safety
- Diminished property values
- Declines in finfish and shellfish populations
- Loss of coastal infrastructure due to habits of fouling and boring organisms
- Local and complete extinction of rare and endangered species
- Economic impacts on aquaculture and other water dependent industries
- Increased expenditures on prevention, eradication or control

Aquatic invasive plants are a widespread problem has emerged as a significant management issue for the state and local stewards of lakes. DEM has documented the presence of one or more aquatic invasive species in 89 of 148 lakes which constitute 57 % of lakes surveyed in RI. As noted in Part 2, 54 lakes have sufficient growth of AIS to be categorized as having degraded (impaired) habitat conditions. A total of 13 different species have been detected, with variable milfoil and fanwort being the plants most commonly found. Aquatic invasive plants create dense vegetative growth in lakes that interferes with the desirable uses of lakes and has been documented by researchers in New England and elsewhere to reduce lakeside property values as the infestation progresses. The occurrence of aquatic invasive plants in Rhode Island lakes is similar to that documented in neighboring Connecticut and Massachusetts (RIDEM 2012b).

Freshwater and coastal wetlands are vulnerable to invasives as well. DEM documented invasives in 48% of the freshwater wetlands it monitored between 2007 and 2012. Phragmites and purple loosestrife are spreading rapidly in wetlands and along waterways, clogging these waterways and out-competing native species. Phragmites, which is also common in coastal wetland, creates dense stands of vegetation that reduce habitat values. Experience has shown it is difficult to eradicate.

Marine aquatic invaders that have become established in Rhode Island include the European green crab, Asian shore crab, lace bryozoan, codium, the red macroalgae, and various species of sea squirts and shellfish pathogens. A 1999 Cornell University study estimates a $44 million per year economic loss to New England and the Canadian Maritime Provinces due to predation on commercially valuable shellfish by the European green crab.

Minimizing Impacts: The RI Aquatic Invasive Species Management Plan (CRMC et al 2007) was the first comprehensive effort to assess the impacts and threats of aquatic invasive species in Rhode Island. This Plan establishes a framework to coordinate state government activities with those of federal agencies, nongovernmental organizations and academic institutions with focus on coordination, monitoring, research and public education and outreach to prevent the introduction and spread of aquatic invasive species in both Rhode Island's freshwater and marine environments. Given the advancement in characterization of AIS concerns in RI since its adoption, it will be appropriate to update the plan when resources allow.

In response to growing public interest and a legislative mandate, Rhode Island developed the Freshwater Lakes and Ponds Report (2012b) that summarized information on the threats to lake quality including AIS. This Plan recommends actions to prevent, control and mitigate the impacts of aquatic invasive species. This plan notes the need for establishment of a lake management program and an expanded level of technical and financial assistance targeted at protecting and improving conditions in lakes and ponds. While a lake management program has not yet been established, DEM was able to initiate a competitive grant program with a portion of the proceeds of a 2012 bond issue. The program has made nine grant awards to support AIS control actions in 8 lakes. Eradication of well-established aquatic invasive species infestations is not usually feasible, therefore a commitment to long-term management is needed. The most commonly employed techniques to combat aquatic invasive plants, including chemical treatment with herbicides, are usually expensive to implement. Lake management planning should include an emphasis on actions needed to control pollution sources, in particular phosphorus that can promote plant growth in freshwater systems. DEM is continuing to survey for AIS in freshwater systems and has provided expanded information, data and guidance through its website.

Aquatic Invasive Species Policy: Prevent the introduction, establishment and spread of aquatic invasive species (AIS).

See Part 7, Implementation Matrix for all Recommended Actions.

Barriers to Stream Connectivity

Stressor: Physical alterations in riverine ecosystems that limit access to aquatic habitat.

Key Point:

- Many barriers erected in streams no longer serve a useful purpose and pose an impediment to the full functioning of riverine ecosystems.
- Many stream crossings need upgrading to allow for full functioning riverine ecosystems.

Water Quality and Aquatic Habitat Concern: Development in RI has resulted in the alteration of rivers and streams throughout the state. Dams of varying size were constructed on all larger rivers and many of the smaller streams in RI. Not as dramatic as a dam, but equally disruptive for some riverine species, are substandard stream crossings that are characterized by constricted or inadequate flow, perched culverts, blocked crossings or crossings in disrepair. These barriers to stream connectivity prevent the free movement of aquatic life up and down a river system. The result is fragmented aquatic habitat, potential impacts on water quality and an increased potential for flooding.

Minimizing Impacts: There is growing recognition that restoration of stream connectivity is important to enhance the functioning of RI's riverine ecosystems. The DEM Division of Fish and Wildlife implements a program to restore access to anadromous fish habitat through either the construction of fish passages or removal of barriers. Major fish passage projects, including dam removals, are planned or have been completed in the Pawcatuck, Blackstone, Ten Mile, Pawtuxet and Woonasquatucket Rivers. With implementation of certain projects continuing, the DEM is partnering with the Narragansett Bay Estuary Program to update the strategy on a statewide basis.

Addressing barriers other than dams has also been the focus of recent work. The RI Resource Conservation and Development Council and the Natural Resources Conservation Service working with multiple partners, have implemented the Stream Continuity Project between 2006 and 2013. Of the 4,374 identified stream crossings in RI, over 1200 were assessed in different watersheds, and 69 of these were found to have severe or significant barriers (RIRC&D 2013). Information from these assessments will be integrated into watershed plans.

Barriers to Stream Connectivity Policy: Restore riverine ecosystem functioning through the elimination of barriers to stream connectivity.

See Part 7, Implementation Matrix for all Recommended Actions.

Water Withdrawals

Stressor: Reduced stream flows

Issue Highlight:

- Statewide water demand doubles during the low flow period when there is less water available; increase due in large part to agriculture and lawn watering.

Water Quality and Aquatic Habitat Concern: Withdrawals of water from certain streams or adjacent aquifers can severely impact the quantity and quality of stream water available during low flow periods. Impacts to the aquatic habitat occur due to loss of riverbed area covered by water, receding wetlands, loss of vernal pools and inadequate baseflow and in-stream water depth for a healthy, reproducing natural fish population. Additionally, lower flows increase pollutant concentrations downstream of dischargers and where discharge limits are based on certain flow assumptions, the limits may no longer prove protective.

Minimizing Impacts: A goal of State Guide Plan Element 721, W*ater 2030* is "*To Protect and preserve the health and ecological functions of the State".* Implementing this goal in conjunction with the SGP Element *Land Use 2025*, will help ensure that Rhode has the available water with good quality that it needs for today and tomorrow. As noted in *Water 2030*, Rhode Island does not have a separate permitting system to regulate water withdrawals. Conditions may be placed on new projects involving withdrawals subject to the state freshwater wetlands regulations or the water quality regulations. The Water Resources Board (WRB) is designated as the authority to devise an allocation of water resources among users to ensure that long range considerations of water supply prevail over short term considerations by prioritizing water withdrawals.

DEM has developed a watershed-based approach for reviewing water withdrawal requests and the Water Resources Board has incorporated this approach into their assessments of water availability. The Stream Flow Depletion Methodology presumes a withdrawal done consistent with the methodology will maintain stream flows that are protective of aquatic ecosystems during varying hydroperiods including the low flow period. This approach identifies those watersheds or portions of watersheds where adequate stream flows will support additional withdrawals as well as those which have constraints to further withdrawals. Analysis of current conditions indicates that the Chipuxet River, Hunt River, and Annaquatucket River watersheds are the primary water supply basins where peak demand routinely exceeds the available supply necessary to avoid adverse impacts to water quality.

Water Withdrawal Policy: Consider hydrologic capacity and aquatic resources in managing water use and withdrawals.

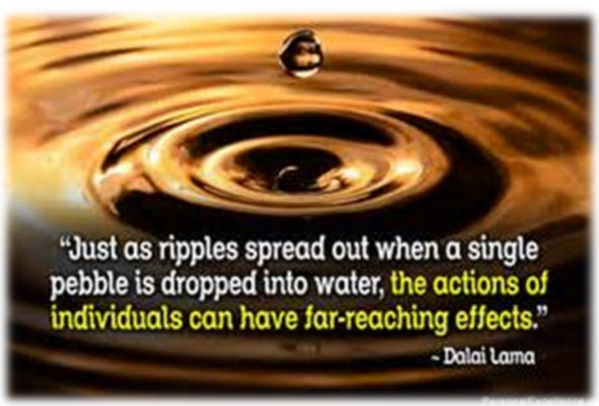
See Part 7, Implementation Matrix for all Recommended Actions.

Encouraging Individual Actions

Each of RI citizens can make a difference to improve water quality by being aware of our water resources and taking steps (often simple) to protect and restore these resources, including participating in decision making regarding these resources. (See Appendix xx for information on individual actions for water quality protection and restoration.) Individual actions in our own backyards may not have a much of an effect by themselves, but the overall cumulative impact (positive or negative) on water quality in the watershed by individuals can be dramatic! The challenge has always been how best to inform the public and how to interest the public enough to take actions to make a difference. Federal, state and local water quality professionals need to improve their communication skills to get this message out effectively. These professionals can benefit from social science research that gives insight into how best to increase public understanding and awareness. There have been many efforts to increase public understanding of our water resources over the past few decades by many state and federal offices. Unfortunately, most (but not all) of these have been in response to a particular initiative and have been short-lived. There is a real need to establish sustainable coordinated efforts.

Individual Actions Policy: Increase public understanding of our water resources and actions that can be taken to protect and restore these waters.

See Part 7, Implementation Matrix for all Recommended Actions.



Part 7 Implementation

Achieving healthy aquatic ecosystems and other water quality goals will require sustained and expanded efforts to prevent and abate pollution and habitat degradation. Through the implementation of Clean Water Act and other programs, substantial progress has been made controlling the discharge of pollutants associated with sanitary and industrial wastewater. Managing the more diffuse sources of pollution associated with human land uses, including the generation of stormwater runoff, continues to present significant challenges. More work is also needed to mitigate the historic alterations made to many aquatic habitats. As indicated in the following Matrix, a wide range of actions will be needed to advance progress toward water quality goals. Adaptive management will be required especially in light of changing climate. Applying watershed approaches is recognized as the most effective approach to long—term management of water resources and provides an opportunity to integrate planning and align actions in a manner that recognizes and addresses the cumulative impacts on the beneficial uses of our waters. Collaboration among all levels of government and other stakeholders on water protection and restoration will be important to the future success of our collective efforts.

This Plan finds that state agencies generally have adequate legal authority to regulate the sources of pollution that degrade Rhode Island water resources. With federal and state law as its foundation, the water quality framework in place has identified the major stressors on our water resources as pathogens and nutrients and flagged emerging issues that warrant management attention. Existing water pollution control programs need to be adequately enforced to prevent new problems. Rhode Island also benefits from well-established laws and programs for protecting wetland resources and coastal habitats from physical alteration. However, other stressors including invasive species, fragmentation, hydro-modification and a changing climate continue to threaten or degrade these habitats.

Among state level water quality and habitat protection programs, areas identified as severely constrained or threatened by a lack of capacity included the following: monitoring, lake management including aquatic invasive species, aquatic habitat restoration and climate change. While DEM and CRMC carry-out some activities, these programmatic areas represent areas where program development is a primary need. In the case of monitoring, the capacity needs include both staffing and funding to sustain long-term core monitoring programs that are deemed essential to effective water resource management. Monitoring priorities include several public health concerns including the need for expanded surveillance of cyanobacteria blooms that may produce toxicity, fish tissue contamination and freshwater bathing beach conditions.

Also noted throughout this Plan are other important opportunities for the State to work closely with municipal governments to strengthen implementation of Rhode Island's management of water quality and aquatic habitats. These include improving coordination and integration of infrastructure planning for water supply, public and on-site wastewater disposal, and stormwater and floodplain management. In addition, fostering close alignment of comprehensive land use plans with infrastructure planning will serve to facilitate sustainable economic growth. Full adoption of low impact development approaches to the design of new and re-development is needed. The State should expand technical assistance and training to meet the needs of municipalities charged with local implementation of many of the actions included in this Plan.

Part 7 Implementation

New strategies or approaches are needed to overcome the staffing limitations that exist in municipalities which constitute a significant barrier to the implementation of local actions.

The long-term financial needs pertaining to wastewater and stormwater infrastructure are a major concern and reflective of a situation that exists at a national scale. Current financing programs are not currently projected to keep pace with needs. This Plan highlights the need for continued assessment of needs and consideration of innovative financing approaches as part of the needed on-going effort toward addressing the problem.

Implementation Matrix

The Implementation Matrix which follows contains the goals, policies, and actions for all of the overarching general topics and the various water quality topics described previously in the Plan. Actions were developed as follows:

- Vision
  - Goal(s)
    - Policies
      - Actions for each policy
        - Lead agency (Lead) & Supporting agencies (Support)
          - Timeframes
            - As Necessary (AN)
            - Ongoing (O)
            - Short Term (1-2 years)
            - Medium term (3-5 years)
            - Long term (more than 5 years)

It is intended that this Element provides the prevailing goals and polices for water quality management and planning in the State. In cases of conflicting or outdated polices and recommendations, this Element has precedence. The below are the Acronyms and Abbreviations used in the Implementation Matrix which follows.

All	All parties in this listing
ACAD	Academia
ACOE	Army Corps of Engineers
ConsD	Conservation Districts
CRMC	Coastal Resources Management Council
RIIB	Rhode Island Infrastructure Bank *(Formerly Clean Water Finance Agency)*
DEM	Department of Environmental Management
DOH	Department of Health
DOP	Division of Planning - Statewide Planning Program
DOT	Department of Transportation
EMA	Emergency Management Agency
EMC	Environmental Monitoring Collaborative
EPA	US Environmental Protection Agency
GA	RI General Assembly
M	Municipalities
MS4s	Municipal Separate Storm Sewer Systems (includes DOT and Universities)
MTA	Marine Trades Association
NBC	Narragansett Bay Commission
NGO	Non-Governmental Organizations
NBEP	Narragansett Bay Estuary Program
NRCS	USDA Natural Resources Conservation Service
RIFCO	Rhode Island Forest Conservator Organization
RIRRC	Rhode Island Resource Recovery Corporation
RC	Rivers Council
SNEFCI	Southern new England Forest Consortium Incorporation
STL	Save The Lakes
Priv	Private Sector
State	State Agencies – multiple relevant agencies
URI	University of RI Cooperative Extension
USGS	US Geological Survey
WRB	Water Resources Board
WS	Water Suppliers

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Part 4 Water Quality Monitoring and Assessment Actions[1]			
State Monitoring Policies: **Monitoring Policy 1: State water resource management should include monitoring as an essential component.** **Monitoring Policy 2: State supported monitoring programs should continue to produce data that is useful to state management.** **Monitoring Policy 3: Monitoring data should be accessible to users for decision-making at all levels.** **Monitoring Policy 4: Provide benefits to monitoring efforts through coordination.** **Monitoring Policy 5: Align monitoring programs with regional data collection strategies relating to climate change, aquatic ecosystems and water quality.**			
Actions A. Complete development of comprehensive environmental monitoring strategy, prioritize gaps and continue to strengthen coordination of monitoring activities through the RIEMC.	EMC	DEM, CRMC	ST
B. Complete update of the RI Water Monitoring Strategy and Freshwater Wetlands Monitoring Strategy. Incorporate groundwater monitoring.	DEM	EMC,USGS	ST
C. Complete update of monitoring strategy for saltmarshes incorporating parameters to assess impacts of climate change.	CRMC, NBNERR	STB, EMC	ST
D. Continue to monitor high priority target habitats consistent with 2015 RI State Wildlife Action Plan. Reduce data gaps to refine mapping and identification of Conservation Opportunity Areas.	DEM	CRMC	O
E. Secure additional resources to support implementation of essential state monitoring programs. Prevent disruption in important on-going data collection efforts; e.g. streamflow.	EMC	DEM, CRMC	O
F. Prioritize gaps in existing data collection efforts. Through collaboration and new investment, initiate monitoring to reduce priority gaps including but not limited to surveillance of conditions that present public health threats (cyanobacteria, fish tissue contamination).	EMC	ALL	ST
G. Establish sentinel networks to collect data on a long-term basis to detect and characterize environmental change associated with changing climate, including participation in regional networks.	EMC	ALL	MT

[1] See Part 4 for more details.

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
H. Collaborate with and support volunteer monitoring programs that contribute data useful to state management planning and decision-making.	EMC	WS, DOP, DEM, DOH	O
I. Improve capacity among state agencies, URI and other partners to exchange data electronically and provide public access to monitoring data.	DEM, EMC		
Water Quality Assessment Policy: Ensure that water quality standards and criteria protect the quality of RI waters and aquatic habitats.			
Actions A. Review and update state water quality standards and criteria to reflect new scientific understanding.	DEM		MT
B. Incorporate new approaches into the framework of water quality standards to strengthen protection of high quality waters.	DEM		MT
C. Develop numeric nutrient water quality criteria as a refinement to existing narrative criteria.	DEM		MT
D. Develop and apply biocriteria or metrics, such as indices of biological integrity, as refinements to state water quality standards and criteria.	DEM		MT
E. Expand state capacity to synthesize and interpret data through the development and use of refined environmental indicators and metrics.	DEM/CRMC	EMC	ST
F. Upgrade data systems to support federally mandated reporting of water quality data and assessment results.	DEM	DOA	MT
Aquatic Habitat Assessment Policy: Prevent further degradation of aquatic habitats and support collaborative efforts to restore habitat conditions on a prioritized basis.			
Actions A. Expand state capacity to synthesize and interpret data through the development and use of refined environmental indicators and metrics consistent with the SWAP.	DEM		MT
B. Continue collaboration in regional collaborative projects or programs related to habitat assessments that help inform management in RI.	DEM		O
Planning Policies **Planning Policy 1: Support, promote and facilitate sustainable land use practices and planning that protects quality from new development and improves water quality upon redevelopment.** **Planning Policy 2: Watershed-based plans will provide a sound basis for implementation of water quality management actions at the state and local level.** **Planning Policy 3: Ensure planning for water quality protection and restoration is effectively coordinated to maximize efforts.**			

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Planning Policy 4: Build state and local capacity to address key gaps in planning that currently limit effective lake management and riparian buffer protection and restoration.			
Actions A. Continue to implement existing TMDLs and develop new TMDLs where necessary.	DEM	M	O
B. Encourage Municipalities adopt LID ordinances. (see also stormwater)	DEM/URI	DOP/M	O
C. Use alternative approaches to development that reduce potential impacts to water quality.	State	DOP	O
D. Include overlay protection zones within zoning ordinances for sensitive resources (e.g., aquifer recharge areas, wellhead protection areas, drinking water reservoir watersheds, etc.).	M	DOP	MT
E. Include maps of all tributary streams, wetlands and other sensitive areas within community comprehensive plans.	M	DOP DEM	MT
F. Study use of the urban services boundary as a tool in prioritizing water quality protection and restoration activities.	DEM CRMC	DOP	O
G. Plan for acquisition of land or development rights for water quality protection and conservation of aquatic habitats.	DEM, WS,M	WRB	O
H. Integrate completed watershed plans into local comprehensive plans.	M,RC	DOP DEM	MT
I. Review and comment on comprehensive plan updates regarding water quality protection policies.	DEM CRMC	DOP	O
J. Update water quality sections of water supply system management plans.	WS	WRB	AN
K. Develop watershed plans for each of the 27 watershed planning areas and update on a regular basis.	DEM	DOP,RC	LT
L. Hold periodic workshops on progress in meeting watershed protection strategies.	DEM	RC	MT
M. Increase public understanding of water quality and watershed management issues.	All	State	O
N. Foster public involvement in river and watershed planning, decision-making, and management.	DEM	RC	O
O. Establish a lake management program at the state level.	DEM	GA	ST
P. Develop guidance on the preparation of lake management plans, support development and implementation of these plans.	DEM		ST
Q. Encourage formation of additional lake associations to support local lake management.	DEM		O
R. Support the existing and encourage designation of new watershed organizations by the River Council.	RC	DEM DOP	O
S. Review and update the Rivers Council Rivers Classification system and enabling legislation.	DEM	RC,DOP	MT
T. Update Rivers Council classifications for consistency with DEM and CRMC Programs.	DEM	RC	MT

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
	CRMC		
Part 6 Pollution Source and Aquatic Habitat Management[2]			
Overarching Management Policies			
Climate Change Policy: Ensure management of water quality and aquatic habitats is adapted to minimize adverse impacts associated with a changing climate change. **Pollution Prevention Policy: Prevent water pollution whenever possible.** **Compliance and Enforcement Policy: Ensure compliance with federal, state and local regulatory programs for water quality protection and restoration.** **Data Management Policy: Ensure that integrated, well supported data management systems are available for water resource protection and restoration program management.**			
Actions A. Encourage industries and specific businesses to adopt pollution prevention strategies.	DEM	Acad Priv	O
B. Expand the Environmental Results Program to other industry sectors.	DEM	Priv	MT
C. Provide resources for enforcement of federal, state and local laws and regulations for water quality protection.	All	All	O
D. Enforce laws and regulations with penalties that will deter future non-compliance.	DEM,CRMC	EPA, M	O
E. Use State data management systems to improve agency effectiveness and public access to the data.	DEM,CRMC	State	MT
F. Replace and upgrade key data systems that have become outmoded including permit databases for wetlands, OWTS	DEM,CRMC	State	MT
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policies			
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 1: Ensure that the planning, designs, and construction of wastewater systems will protect public health and water quality and that the facility planning process, considers climate change and guides the expansion and use of public wastewater systems.			

[2] See Part 6 for more details.

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Actions			
A. Mandate all wastewater systems maintain and periodically update facility plans.	DEM	NWPC	O
B. Develop incentives for wastewater system owners to develop, update and implement facility plans.	DEM	RIIB	ST
C. Strengthen State oversight of facility planning and ensure consistency with *Land Use 2025*.	DEM	DOP	O
D. Evaluate opportunities for regional approaches to wastewater management.	DEM	M,CRMC	LT
E. Reduce information gaps on location and ownership of public sewer lines.	DEM	NWPCA	ST
F. Complete vulnerability assessments of wastewater systems relative to potential impacts from climate change.	DEM	NWPCA	ST
G. Devise and implement adaptation strategies that will improve wastewater system resiliency to climate change.	DEM	NWPCA	MT
H. Strengthen State authority regarding community–based solutions to persistent on-site wastewater management problems.	DEM,CRMC	M	LT
I. Develop community-wide wastewater plans that integrate facility planning and on-site wastewater management planning.	M	DEM	MT
J. Strengthen state oversight for consistency between comprehensive plans, local wastewater management plans and facility treatment plans.	DEM,CRMC	DOP,M	ST
K. Adopt municipal and state regulations to require properties with ready access to public sewer systems will be connected.	DEM	M,GA	ST
L. Identify and prioritize areas statewide where sewers are needed consistent with *LU 2025* and as determined by water quality data or public health risks.	DEM,DOH	CRMC, DOP, M	LT
N. Adopt regulations to ensure privately constructed WWTFs are properly operated and maintained.	DEM	Priv	ST
O. Continue state oversight of construction and maintenance of wastewater system infrastructure.	DEM	M	O
P. Update standards to allow for innovative technologies in the design of wastewater systems.	DEM	URI, Priv	O
Q. Inspect wastewater infrastructure projects to ensure they are constructed as designed.	DEM	Priv	AN
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 2: Ensure discharge permits to surface waters will protect water quality.			
A. Maintain the State discharge permitting program (RIPDES) as delegated by the EPA pursuant to the federal Clean Water Act.	DEM	EPA	O
B. Implement water quality monitoring programs to support the development and re-issuance of RIPDES permits.	DEM	EMC	O
C. Develop, refine and apply improved scientific tools and data systems to support permitting decision-making.	DEM,CRMC	EMC	AN

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
D. Issue and periodically update water quality based permits for wastewater discharges with discharge limits that support water quality standards.	DEM	PRIV	AN
E. Issue and periodically update permits for cooling water discharges that do not degrade aquatic ecosystems.	DEM	PRIV	O
F. Study technological innovations in wastewater management and advanced treatment technologies.	DEM	PRIV,	LT
G. Improve data management systems for timely and efficient reporting among federal, state and local entities.	DEM,CRMC	M,EPA	MT
H. Adapt data systems for electronic submittal of permit applications and associated reports in coordination with EPA requirements.	DEM	EPA	MT
I. Develop rules to address pollutants of emerging concern discharged from wastewater facilities in their effluent or solids (sludge).	DEM	EPA	ST
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 3: Encourage and support efforts to achieve effective control of upstream wastewater discharges in MA which affect downstream water quality in RI.			
Actions A. Collect, synthesize and share scientific information that characterizes the upstream contribution from MA to water pollution problems in RI waters.	NBEP	DEM CRMC EPA	O
B. Participate in EPA decision-making to ensure downstream impacts on RI waters from MA wastewater sources are properly considered in EPA permit decisions.	NBEP	DEM	AN
C. Encourage timely implementation of WWTF upgrades in MA portion of the Narragansett Bay watershed.			
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 4: Ensure that toxics and other substances are not introduced into wastewater systems in quantities that may cause disruption of desired treatment processes.			
Actions A. Implement effective pretreatment programs at the state and local/system level.	DEM	M	O
B. Improve coordination among municipal pretreatment programs and private operators of WWTFs.	DEM	M,PRIV	ST
C. Expand programs that collect grease from restaurants and other sources for beneficial re-use.	PRIV	DEM	ST
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 5: Continue to ensure wastewater systems are operated and maintained to provide effective wastewater treatment.			
Actions A. Require operation and maintenance plans for all WWTFs to be followed and inspect WWTFs.	DEM	NWPCA. EPA	O
B. Maintain wastewater operator certification program.	DEM	NWPCA EPA	O

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
C. Expand wastewater certification requirements for privately owned and industrially operated wastewater treatment systems.	DEM	PRIV	ST
D. Provide training of WWTF operators including the use of more advanced and complex treatment technologies.	DEM	NWPCA EPA	O
E. Provide training and professional development opportunities to attract and develop effective managers for wastewater systems.	DEM	NWPCA EPA	MT
F. Establish asset management programs within all major public wastewater systems.	DEM	NWPCA EPA	ST
G. Require prompt reporting and response actions in the event of sewer system overflows.	DEM		O
H. Provide technical assistance to wastewater dischargers to foster improved performance, in particular small businesses.	DEM	EPA	MT
I. Enforce rules on proper sludge management generated via wastewater treatment.	DEM		AN
J. Create and update a statewide sludge management plan for sludge generated at WWTFs.	DEM	EPA	ST
K. Revise policies to broaden the use of sustainable practices in wastewater operations.	DEM	NWPCA EPA	AN
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 6: Continue to improve coordination of wastewater management planning for OWTSs and sewered areas.			
Actions A. Adopt a comprehensive wastewater management plan addressing facilities planning and onsite wastewater management planning.	M	DEM	L
B. Require that facilities planning for municipal/public sewer systems assesses areas for OWTS suitability.	M	DEM,CRMC	O
C. Approve sewer extensions which are consistent with *Land Use 2025* Future Land Use Map and necessary to protect public health.	M	DEM DOP	O
D. Require connection to sewer systems where access exists.	M	DEM	S
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 7: Continue to reduce nutrient pollutant loadings from wastewater treatment facilities.			
Actions A. Reduce pollutant loadings of nitrogen from WWTFs affecting upper Narragansett Bay.	DEM	NBC NWPCA	MT
B. Complete upgrades for phosphorus controls at targeted WWTFs.	DEM	NBC NWPCA	ST
C. Develop decision-making tools to support future decisions on nutrient reductions from WWTFs discharging to the Narragansett Bay Watershed and its tributaries.	NBEP	DEM CRMC	LT

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 8: Continue to minimize untreated discharges from Combined Sewer Overflows (CSO).			
Actions A. Implement CSO abatement strategies for Providence metropolitan region and City of Newport.	NBC, Newport	DEM	O
B. Evaluate the effectiveness of Phase 2 of the NBC CSO Abatement Program and refine plans for Phase 3 of the Program.	NBC	DEM	MT
C. Encourage CSO abatement in MA portion of Narragansett Bay watershed (Fall River).	EPA	DEM CRMC	ST
D. Minimize the generation of combined sewer overflows.	NBC, Newport	DEM	MT
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 9: Continue to reduce discharges that result from sewer system overflows.			
Actions A. Replace or repair conveyance systems and pump stations to prevent sewer systems overflows within all public wastewater systems.	WWTF	DEM	AN
B. Identify and eliminate sources of excessive amounts of water entering into sewer systems.	WWTF	DEM	AN
C. Provide state technical assistance to aid in the investigation of sewer system overflows.	DEM	EPA	AN
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 10: Ensure necessary financial resources are available for wastewater systems.			
Actions A. Continue to provide financing via the Clean Water SRF Program.	EPA,DEM	GA	O
B. Identify, document and prioritize capital wastewater systems statewide needs.	DEM	WWTF	MT
C. Survey long-term infrastructure financing needs and identify options for supplementing existing funding mechanisms including increasing capacity of the State Revolving Fund (SRF).	DEM	WWTF GA	ST
D. Use enterprise funds as an appropriate means of managing WWTF financial resources.	WWTF	DEM,GA	O
E. Incorporate energy efficiencies and use of sustainable energy sources in wastewater operations.	WWTF	DEM NWPCA	MT
F. Charge sewer assessments and use fees that are fair and equitable.	WWTF	DEM NWPCA	AN
G. Ensure privately operated WWTFs have sufficient financial resources to repair and upgrade such systems as needed.	PRIV	DEM	O

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Onsite Wastewater Treatment Systems (OWTS)			
OWTS Policy 1: Protect groundwater, surface water quality, and public health through proper siting, design and construction of onsite wastewater management systems.			
Actions A. Implement current OWTS Rules and continually assess the effectiveness of these Rules.	DEM	URI	O
B. Provide training opportunities for OWTS design and installation professionals.	DEM	URI	O
C. Provide oversight of DEM licensed professionals including field inspections.	DEM	URI	O
D. Strengthen disciplinary process for DEM licensed professionals.	DEM	URI	MT
E. Support development of alternative technologies that provide advanced treatment to address site limitations.	DEM	URI	O
OWTS Policy 2: OWTSs should be properly used and maintained.			
Actions A. Evaluate performance of alternative treatment OWTSs and required maintenance and revise state rules if necessary.	DEM	CRMC URI	O
B. Establish a technical working group to develop standards and processes for operation and maintenance of alternative treatment OWTS.	DEM	CRMC URI	ST
C. Establish operating permits for large OWTS with required renewals to ensure permit compliance.	DEM	URI	MT
D. Evaluate the need for additional treatment standards for discharges with high-strength wastewater, e.g., restaurants.	DEM	URI	ST
E. Provide public education on the proper use of OWTSs.	DEM, URI	CRMC	O
F. Promptly repair or replace failed OWTSs.	Owners	DEM	O
OWTS Policy 3: Ensure proper OWTS use and maintenance through municipal onsite wastewater management programs.			
Actions A. Develop, implement, and update municipal onsite wastewater management programs.	M	DEM,UR I	O
B. Provide funding for the CSSLP to provide financial assistance to homeowners for repair and replacement of OWTS.	RIIB	DEM,GA	O
C. Improve state and local data management systems to facilitate data sharing.	DEM, M	EPA	LT
OWTS Policy 4: Ensure that OWTS protect the public health and the environment.			
Actions A. Implement denitrification requirements in the Salt Pond and Narrow River critical resource areas.	DEM, CRMC	M	O
B. Expand denitrification requirement to other poorly flushed coastal embayments with nitrogen caused water quality impairments due in part to OWTS.	DEM, CRMC	URI	AN

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
C. Evaluate technologies/strategies for reducing phosphorus from OWTSs in areas with phosphorus caused water quality impairments due in part to OWTSs.	DEM	URI	MT
D. Study how to assess and respond to the cumulative impacts of OWTS.	DEM, CRMC	URI	LT
E. Study the need for more intensive OWTS management in 1) densely developed areas that are dependent on private drinking water wells and 2) wellhead protection areas where nitrogen in the public well exceeds one-half the drinking water standard.	DEM	CRMC URI DOH	AN
F. Evaluate the performance of OWTS on treating emerging contaminants of concern.	DEM	URI DOH	AN
G. Continue to evaluate the effects of climate change on OWTS performance and amend Rules.	DEM, CRMC	URI	AN
OWTS Policy 5: Promote the removal of cesspools especially in riparian areas.			
Actions A. Complete 2007 Cesspool Phase-out Act requirements.	DEM	M,PRIV	ST
B. Eliminate continued use of large capacity cesspools as required by state and federal rules.	DEM	EPA	LT
C. Implement the 2015 legislation for cesspool replacement at time of property sale or transfer.	DEM	PRIV	ST-O
Stormwater			
Stormwater Policy 1: Manage stormwater to protect water quality.			
Actions A. Implement, and update as necessary, RI Stormwater Design and Installation Standards Manual and Erosion and Sediment Control Handbook.	DEM CRMC	M NRCS	O
B. Continue management of the DEM Multi-Sector General Permit for Stormwater Discharge Associated with Industrial Activity.	DEM		O
C. Improve compliance with the construction site requirements issued by the stormwater permitting programs.	DEM CRMC		MT
D. Evaluate the performance of approved stormwater BMPs.	DEM, CRMC		O
E. Support the development of new technologies/BMPs for stormwater management.	DEM CRMC	M	O
F. Investigate strategies for reducing pollutants in stormwater	DEM	CRMC,M	O
G. Develop strategies to protect high quality waters from further degradation due to stormwater (e.g., by requiring increased emphasis on LID, limiting effective impervious cover).	DEM CRMC	M	MT

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
H. Consider requiring post development peak discharge rates to be less than pre-development peak discharge rates, particularly in areas prone to flooding.	DEM, CRMC	M	MT
I. Evaluate the utility and practicality of establishing goals for reducing and limiting effective impervious cover by watershed.	DEM CRMC	M,RC	MT
J. Track the amount of impervious cover by watershed that is being treated for stormwater management.	DEM CRMC	RC	LT
Stormwater Policy 2: Seek to maintain and restore pre-development hydrology through LID design techniques and associated BMPs.			
Actions A. Identify strategies to help implement LID in state and municipal programs.	DEM CRMC	M	MT
B. Incorporate LID in local development review ordinances, with emphasis on “green” (vegetative) infrastructure.	M	DOP	O
C. Improve communication with municipalities at time of project review.	DEM CRMC	M	ST
Stormwater Policy 3: Ensure management of MS4s to minimize impacts to water resources.			
Actions A. Implement DEM MS4 General Permit Program -- evaluate compliance and effectiveness.	DEM	MS4s	O
B. Prioritize stormwater drainage systems for retrofitting (coordinate with TMDLs).	MS4s	DEM	O
C. Strengthen and enforce requirements for retrofitting as part of TMDL implementation.	DEM	MS4s	O
D. Improve maintenance of stormwater management systems to increase longevity and maximize performance.	MS4s		ST
E. Collaborate on managing connected state and local stormwater systems.	DOT	M	MT
Stormwater Policy 4: Seek to educate public officials and private contractors about stormwater management.			
Actions A. Conduct training programs for public officials and private contractors on various aspects of stormwater management.	DEM MS4s	URI RC	O
B. Consider certification programs for different elements of stormwater management.	DEM CRMC	M	MT

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Stormwater Policy 5: Seek to reduce stormwater from significant areas of existing impervious surfaces on both public and private property.			
Actions A. Improve maintenance of stormwater systems on private property.	Priv	DEM	MT
B. Develop tools to incentivize stormwater management retrofit on private property.	DEM CRMC	GA, PRIV	O
C. Examine options for requiring management of stormwater from existing private development.	DEM CRMC	MS4s	MT
Stormwater Policy 6: Support the development of dedicated and sustainable funding for stormwater management.			
Actions A. Provide technical and financial assistance to municipalities to establish funding mechanisms for stormwater management.	DEM	GA	ST
B. Investigate the potential for establishing stormwater credit markets and trading.	DEM	EPA	LT
C. Establish regional stormwater management approaches where possible	MS4s	DEM	O
D. Evaluate opportunities to integrate management of wastewater and stormwater systems.	MS4s	DEM	ST
Stormwater Policy 7: Ensure that stormwater management programs address climate change impacts.			
Actions A. Evaluate the impact of climate change on existing stormwater management systems.	DEM CRMC	MS4s	LT
B. Incorporate new data on climate change into stormwater management design standards, including projections for increased storm intensities	DEM CRMC	EPA	LT
Road Salt and Sand Application			
Road Salt and Sand Policy: Assure public safety but reduce impacts to water resources from road salt and sand operations.			
Actions A. Upgrade DOT and municipal equipment and adopt new and innovative techniques for more effective control of snow and ice on roadways.	DOT, M		O
B. Evaluate economically feasible alternatives to sodium chloride that are effective and environmentally safe.	DOT	DEM,M	O
C. Evaluate strategies for possible training and certification mechanisms for all road salt/sand applicators.	DOT	M	LT

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
D. Establish minimal equipment standards used by all road salt/sand applicators.	DOT	M	LT
E. Designate reduced salt zones near drinking water sources, and in watersheds of chloride impaired waters.	DOT M	DEM DOH	AN
F. Maintain all salt and sand storage areas and cover salt piles (public and private).	DOT M, Priv	DEM	O
G. Dispose of snow in accordance with the DEM snow disposal policy.	DOT M, Priv	DEM	O
H. Improve efficiency and frequency of street sweeping to remove sand applied to roads and parking areas.	DOT, M, Priv	DEM	S
Groundwater Discharges (Non-OWTS)			
Groundwater Discharges (Non-OWTS) Policy: Protect groundwater quality and public health and ensure that groundwater discharges are properly designed, sited, constructed and monitored.			
Actions A. Implement the Groundwater Discharge Rules for permitting groundwater discharges, monitoring of major discharges and closure of groundwater discharges.	DEM		O
B. Maintain state primacy for the Underground Injection Control Program (UIC).	DEM	EPA	O
C. Identify facilities with unauthorized discharges that are subject to the Rules and require permitting or closure.	DEM	M	O
Agriculture			
Agriculture Policy: Protect groundwater and surface water quality and public health through proper agricultural management.			
Actions A. Require farmers participating in the Purchase of Farmland Development Rights Program to prepare Conservation Plans. Encourage other farmers to prepare voluntary Conservation Plans.	DEM	NRCS	MT
B. Regularly inspect farms with required Conservation Plans (e.g., farms enrolled in Farm, Forest, Open Space Program) for compliance.	DEM		ST,O
C. Encourage farmers to participate in NRCS cost-sharing programs.	NRCS	DEM	ST

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
D. Collaborate on implementing the National Water Quality Initiative.	NRCS DEM		O
E. Encourage farmers to establish and maintain effective riparian buffers.	DEM	NRCS	O
F. Selectively monitor groundwater and surface water quality near agricultural operations.	DEM		MT
I. Consider the need for regulations to address specific agricultural threats to water quality.	DEM	NRCS URI	MT
Lawn/Turf Management			
Lawn/Turf Management Policy: Prevent adverse water quality impacts from lawn and other areas of turf management.			
Actions A. Develop and implement homeowner outreach programs especially about “zero P” products.	URI	DEM NGO	O
B. Develop and implement green certification programs for business sectors engaged in lawn care and turf management.	DEM		ST
C. Consider establishing training and certification requirements for lawn care professionals.	DEM, P		LT
D. Consider regulations for reduced areas of disturbance for turf and encouraging xeriscaping and alternative landscaping strategies.	M	DEM URI	O
E. Develop strategies to promote BMPs for lawn watering.	WS	M, O	O
Pesticide Application			
Pesticide Application Policy 1: Minimize the use of pesticides. **Pesticide Application Policy 2: Minimize impacts from pesticides to water quality.**			
Actions A. Implement DEM Rules and Regulations Relating to Pesticides.	DEM		O
B. Encourage farmers to include an integrated pest management component into their Farm Conservation Plan.	DEM	NRCS	O
C. Promote proper homeowner use of limited pesticides and encourage alternatives.	DEM	NGO URI	O
D. Incorporate the latest research on impacts of new and previously approved pesticides into state decision-making on pesticide use in RI.	DEM	Acad	O

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Boating and Marinas			
Boating and Marinas Policy: Ensure boating activity and marinas do not adversely impact water resources.			
Actions			
A. Provide and maintain an adequate number of pumpout facilities.	DEM		O
B. Oversee compliance with the No Discharge Area designation.	DEM		O
C. Partner with RI Marine Trades Association to educate, inform and encourage additional participation in the Clean Marina Program.	CRMC	MTA	O
Hazardous Material and Petroleum Product Spills			
Hazardous Material and Petroleum Product Policy: Protect water resources and public health and safety from spills of hazardous materials and petroleum products.			
Actions			
A. Support capacity of the state and local governments to respond to spills of hazardous materials and petroleum products in a safe, timely and effective manner.	DEM EMA	GA	O
B. Implement and update as necessary the RI Emergency Response Plan.	EMA	DEM	AN
C. Ensure facilities have updated emergency plans, test their plans appropriately and inspect such facilities for hazardous material and oil spill preparedness.	EMA	DEM	O
Underground Storage Tanks for Hazardous Materials			
Underground Storage Tanks for Hazardous Materials Policy: Prevent impacts to water resources from underground storage tank leaks and spills.			
Actions			
A. Implement "*Rules and Regulations for Underground Storage Facilities Used for Petroleum Products and Hazardous Materials*."	DEM		O
B. Maintain adequate financial support for the UST Financial Responsibility Fund.	DEM		O
C. Educate homeowners on the threat to water quality from underground home heating oil tanks and the potential financial consequences.	DEM	URI,M	O

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
D. Consider ordinances prohibiting heating oil USTs, particularly in areas dependent on private wells and in wellhead protection areas.	M	DEM	MT
E. Develop strategies for removing and replacing existing underground home heating oil USTs.	Priv	DEM,M	LT
Above-ground Storage Tanks for Hazardous Materials			
Above-ground Storage Tanks for Hazardous Materials Policy: Prevent impacts to water resources from above ground storage tank leaks and spills.			
Actions			
A. Update and revise the "Oil Pollution Control Regulations" to improve regulation of AST facilities.	DEM		MT
B. Establish procedures to prevent or minimize impacts to water resources from the above ground storage of <u>non-petroleum</u> based hazardous materials.	DEM	EMA	LT
C. Educate homeowners on the threat to water quality from above ground home heating oil tanks and the potential financial consequences.	DEM	M	MT
D. Municipalities consider adopting stringent standards for siting and operation of above ground storage facilities.	M	DEM	LT
Waste Management (Active) – Solid Waste and Hazardous Waste			
Waste Management (Active) – Solid Waste and Hazardous Waste Policy: Minimize impacts to water resources from solid waste and hazardous waste.			
Actions			
A. Implement *Solid Waste 2038*, RI Comprehensive Solid Waste Management Plan (May 2015).	RIRRC	DEM	O
B. Continue to enforce DEM *Solid Waste and Hazardous Waste Rules*.	DEM	RIRRC	O
C. Ensure complete and proper closure of former solid waste disposal sites.	M, DEM		AN
D. Ensure that waste management facility siting guidelines consider potential impacts to groundwater and surface water resources.	DEM	RIRRC DOP	ST
E. Decrease the volume of waste generated so as to limit the needs for siting of future solid waste management facilities.	All	All	O
F. Work with selected industries to reduce and properly manage hazardous waste.	DEM	Priv	O
G. Promote increased understanding of household hazardous materials and continue to annually provide opportunities for household hazardous waste disposal.	RIRRC	DEM	O

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Contaminated Site Clean-Up			
Contaminated Site Clean-Up Policy: Restore water quality and protect human health by remediation and encouraging redevelopment of contaminated sites.			
Actions A. Implement state site remediation program and the federal Superfund program to clean-up sites that are impacting water quality.	DEM	EPA	O
B. Support financing for continued brownfields clean-up efforts.	DEM	EPA	O
C. Ensure that contaminated sites are promptly identified and reported to minimize further environmental degradation and potential public health effects.	DEM	M	O
D. Evaluate innovative technologies and strategies to address soil and water contamination.	DEM	EPA	O
E. Evaluate models and methods for risk assessment to ensure proper levels of clean-up are attained.	DEM	EPA	O
Dredging and Dredge Material Management			
Dredging and Dredge Material Management Policy 1: Reduce water quality impacts of dredging at both the location of material removal and the location of its use or disposal in water or on land. **Dredging and Dredge Material Management Policy 2: Protect fish spawning and migration patterns from impacts of dredging.**			
Actions A. Continue to implement the "*Rules and Regulations for Dredging and the Management of Dredged Material*".	CRMC DEM	ACOE	O
B. Establish new Confined Aquatic Disposal Cells for disposal of dredged material.	CRMC DEM		
C. Develop a general dredge permit for small projects and restoration projects.	CRMC, DEM		MT
D. Study using clean dredge material for salt marsh restoration to assist with climate change adaptation.	CRMC	DEM	O

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Pet Waste			
Pet Waste Policy: Protect water quality from pet waste.			
Actions A. Consider municipal ordinances requiring owners to pick up after their pets on all property.	M	DEM	O
B. Educate the public about the impact of pet waste on water quality.	DEM, M	RC	O
C. Adopt strategies for controlling pet waste at State and local public facilities.	DEM, M	RC	O
D. Adopt municipal ordinances with BMPs for backyard livestock owners to properly control animal wastes.	DEM	M	ST
Waterfowl			
Waterfowl Policy: Minimize water quality impacts from waterfowl populations in RI.			
Actions A. Devise a sustainable statewide strategy for waterfowl management, particularly Canada geese.	DEM NRCS	Cons D	MT
B. Discourage the feeding of ducks and other waterfowl, particularly in waters identified as impacted by waterfowl in TMDLs. Consider local ordinances to prohibit feeding.	RC,M	DEM	ST
C. Increase public understanding of proper waterfront landscaping to deter geese.	DEM	M	O
D. Train volunteers to assist in controlling goose populations, particularly in waters identified as impacted by waterfowl in TMDLs.	Cons D DEM	NGO	O
E. Establish a state carrying capacity for Canada Geese.	DEM	NRCS	LT
F. Encourage hunting of Canada Geese.	DEM	NGO	ST
Land Application of Wastewater Treatment Facility Solids			
Land Application of Wastewater Treatment Facility Solids Policy: Prevent water quality impacts from land application of wastewater treatment facility solids.			
Actions A. Ensure land application of sludge is in compliance with the “Rules and Regulations for Sewage Sludge Management.”	DEM	NWPCA	O

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Surface Mining			
Surface Mining Policy: Prevent water quality impacts from pollutants associated with resource extraction operations.			
Actions A. Enforce conditions of the DEM Multi-Sector General Permit for Stormwater Discharges for surface mining operations.	DEM		O
B. Consider local earth removal ordinances with requirements for water resources protection and site reclamation.	M	DEM, DOP	MT
Silviculture			
Silviculture Policy: Protect water quality during forest harvesting operations.			
Actions A. Implement the *Rhode Island Forest Resources Management Plan*, State Guide Plan Element 161, strategies for protecting water quality during forest harvesting operations.	DEM	DOP, RIFCO, SNEFCI, RIFT	O
Atmospheric Deposition			
Atmospheric Deposition Policy: Reduce mercury, nitrogen, phosphorus and other pollutants in waters from atmospheric deposition.			
Actions A. Participate in regional initiatives to reduce air pollution contributing mercury, nitrogen, phosphorus and acidity.	DEM	EPA	O
B. Manage stormwater to capture and remove pollutants from atmospheric deposition before discharge to surface waters.	DEM, M	CRMC	O
Marine and Riverine Debris			
Marine and Riverine Debris Policy: Reduce impacts of human generated debris in RI waters.			

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Actions A. Increase public understanding of the need to reduce marine and riverine debris.	NGO	DEM M NBEP	O - ST
B. Ensure debris is properly contained (on land and on boats) to minimize release to the environment.	M	DEM	O
C. Develop source reduction strategies for items most often found in the state's waters.	DEM, M	NGO	MT
D. Support increased efforts by government and non-governmental organizations to prevent and remove marine and riverine debris; and increase participation in coastal and river clean-ups.	NGO, DEM, M	NBEP	O
Aquaculture			
Aquaculture Policy: Prevent impacts to water quality from aquaculture operations.			
Actions A. Manage state fish hatcheries for compliance with discharge limits (RIPDES).	DEM		O
B. Develop a strategy for managing finfish aquaculture in open waters to mitigate potential water quality impacts.	CRMC	DEM Priv	MT
C. Use shellfish beds for water quality restoration.	CRMC	DEM Priv	ST
Contaminants of Emerging Concern			
Contaminants of Emerging Concern Policy: Prevent impacts to water quality from contaminants of emerging concern.			
Actions A. Educate the public and the health care community on proper disposal of un-used drugs.	DOH	DEM	O
B. Research the impacts on RI Waters of pharmaceuticals and personal care products and other emerging contaminants of concern.	Acad	DOH DEM	O
C. Increase monitoring of drinking water supplies.	DOH	WS,EMC	LT
D. Develop strategies to reduce threats/impacts to water resources from emerging contaminants, including advocating for a "green chemistry" approach to product formulation.	Acad	DOH,DE M	LT

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Aquatic Habitat			
Aquatic Habitat Policy: Prevent further degradation of aquatic habitats and support collaborative efforts to restore habitat conditions on a prioritized basis.			
Wetlands (Freshwater and Coastal) Policy 1: Protect wetland functions and values by avoiding and minimizing alterations and wetland loss.			
Actions A. Implement the Freshwater and Coastal wetland regulatory programs and periodically review and update rules with new scientific understanding.	DEM CRMC		O
B. Provide technical assistance to applicants for project designs that avoid and minimize impacts on wetlands.	DEM CRMC	Priv	O
C. Map vernal pools and share information with municipalities and other interested stakeholders.	DEM	CRMC,M	LT
D. Develop and implement strategies to mitigate alteration of salt marshes due to climate change, in particular and sea level rise.	CRMC	DEM NGO NBEP	ST
Wetlands (Freshwater and Coastal) Policy 2: Facilitate restoration of the quality and quantity of wetlands and adjacent buffers.			
Actions A. Complete development of statewide freshwater wetlands restoration strategy.	DEM		MT
B. Complete development of statewide salt marsh restoration strategy.	CRMC		MT
C. Improve tracking of wetland and aquatic habitat restoration projects.	DEM CRMC	NBEP	MT
D. Provide financial assistance for priority wetland restoration projects; e.g., projects that deliver multiple benefits for habitat, water quality and other functions and values.	DEM CRMC	EPA NBEP	ST-O
Aquatic Invasive Species			
Aquatic Invasive Species Policy: Prevent the introduction, establishment and spread of aquatic invasive species (AIS).			

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Actions A. Educate water users about AIS and measures that should be taken to prevent their spread.	CRMC,DEM	NGO	ST
B. Continue surveillance for AIS and refine rapid response protocols for control.	CRMC, DEM	NGO	O
C. Provide financial and technical assistance to local entities carrying out lake management.	DEM	NGO	ST-O
D. Implement 2007 AIS Plan and 2012 Lakes Report	DEM	NGO	ST-O
E. Develop and implement regulations governing the possession, transport and sale of aquatic invasive species.	DEM	CRMC STL	ST
Barriers to Stream Connectivity			
Barriers to Stream Connectivity Policy: Restore riverine ecosystem functioning through the removal of barriers to stream connectivity.			
Actions A. Update the statewide strategy for anadromous fish restoration.	DEM	CRMC, RC	MT
B. Provide financial assistance to projects that enhance stream connectivity.	DEM	NRCS	ST-O
C. Identify stream crossings which are substandard and present barriers to movement of aquatic life.	DEM	RC,NRCS	ST-O
Water Withdrawals			
Water Withdrawal Policy: Consider hydrologic capacity and aquatic resources in managing water use and withdrawals.			
Actions A. Implement *RI Water 2030*, State Guide Plan Element 721, strategies for water withdrawals.	WRB WS	DEM	O
B. Identify cost effective approaches for supplementing and augmenting public water supply consistent with *RI Water 2030* and *Land Use 2025*.	DOH WS	WRB, DOP	ST
D. Incorporate the Streamflow Depletion Methodology into all agency water withdrawal decisions.	DEM	WRB DOH	MT
E. Evaluate water withdrawal impacts in the context of climate change.	DEM	WRB, WS	ST-O

IMPLEMENTATON MATRIX - POLICIES and ACTIONS	LEAD	SUPPORT	TIME-LINE
Encouraging Individual Actions			
Encouraging Individual Actions Overarching Policy: Increase public understanding of our water resources and actions that can be taken to protect and restore these waters.			
Actions A. Form a working group to collaborate on communicating public education with a unified message to the public.	Acad, URI DEM CRMC	DOH	MT
B. Develop an outreach/communication strategy which uses social media.	Acad, URI DEM, CRMC		LT
C. Train agency water resource staff communicate water science and policy to the public.	ALL	ALL	LT

Appendix A

Rivers Council Classifications 2004

Rhode Island law, Section 46-28-7(d), specifies that the classification plan of the Rivers Council contain a minimum of three classes: pristine rivers, recreational rivers, and working rivers. The Council has expanded on the minimum requirement and developed five freshwater classes:

- pristine
- water supplies
- open space
- recreational; and
- working.

For estuaries, the Council has adopted CRMCs six water use categories:

- Type One: Conservation Areas
- Type Two: Low-Intensity Use
- Type Three: High Intensity Boating
- Type Four: Multipurpose Waters
- Type Five: Commercial and Recreational Harbors
- Type Six: Industrial Waterfronts and Commercial Navigation Channels.

Discussed within the various classifications are the terms contact and non-contact recreational uses. Contact uses means there is prolonged contact with the waterbody. Examples of contact recreational uses are swimming, wading, and water-based fishing. Non-contact uses involve minimal contact with the water and include canoeing, boating, and land-based recreational activities. The Council followed a policy of recommending contact versus non-contact recreational uses based upon not only knowledge of bacterial levels within the water but also on known or potential toxic pollutant threats from current land-based activities. Where a river or river segment is classified as suitable for swimming and other contact recreational activities, it can be surmised that the river or river segment is also suitable for canoeing or other non-contact recreational activities. The only caveat to this logic would be if there were enough flow or water in the river segment to physically allow these activities to occur. The Council has attempted to note such low flow areas within the individual classifications.

Freshwater Classifications

Pristine Waters This category includes rivers or sections of rivers that are free of impoundments and are generally inaccessible except by trail, with watersheds or shorelines essentially undisturbed and primitive, and water relatively unpolluted. It also includes Significant Wildlife Habitat and Natural Area Rivers, which are rivers, lakes, streams, tributaries, and their associated wetlands that support communities of flora or fauna significant or unusual to Rhode Island. This includes unique critical habitat with rare or endangered species notwithstanding lower than high water quality conditions. Pristine waterbodies may include Special Resource Protection Waters (SRPWs).

Water Supplies These are public drinking water sources, which include:

- Rivers, impoundments, and lakes used for water supply purposes; and/or
- Tributaries to water supplies; and/or
- Areas officially designated as potential public drinking water supplies.

These waters may include watersheds that directly feed or replenish existing and/or potential public drinking water supplies.

Open Space Waters This category includes waterbodies that have high scenic value, have relatively undeveloped banks, provide good fish and wildlife habitat, support or could support recreational use, and are typically situated in low-density rural areas (although they may traverse historic village centers). They may function as open space corridors, natural areas, or greenways. These waters are generally suitable for both contact recreation such as swimming and fishing, and non-contact recreation such as canoeing.

Recreational Waters This category includes waterbodies, rivers, or river segments that are readily accessible, that may have some development along their shorelines, and may have undergone some impoundment or diversion in the past. These shall include sections of rivers along mill villages, but shall not include sections where development may be characterized as urban. These waters are typically situated in suburban areas and are generally suitable for canoeing and other non-contact recreational activities. They may function as open space corridors or greenways.

Working Waters These waterbodies, rivers, or river segments are readily accessible, have development along their shorelines, have undergone impoundment or diversion, and adjoin development that may be classified as urban.

Coastal – Estuarine Water Classifications

The Coastal Resources Management Council (CRMC) was created by R.I.G.L. 46-23 in 1971. Part of CRMC's mission has been the description and classification of tidal waters and coastal ponds falling under their jurisdictional authority. Accordingly, for those areas already classified by the CRMC, the Rivers Council will adopt the existing CRMC classifications. In some instances, there is a close correlation between the CRMC definitions used for coastal waters and the definitions the Rivers Council has adopted for fresh waters. However, there are other cases where no correlation exists. CRMC includes waters outside of the purview of the Rivers Council. The following definitions are quoted from *The State of Rhode Island Coastal Resources Management Program, as amended* (a.k.a the "Red Book").

Type 1 Conservation Areas Included in this category are (1) water areas that are within or adjacent to the boundaries of designated wildlife refuges and conservation areas, (2) water areas that have retained natural habitat or maintain scenic values of unique or unusual significance, and (3) water areas that are particularly unsuitable for structures due to their exposure to severe wave action, flooding, and erosion.

Type 2 Low-Intensity Use This category includes waters in areas with high scenic value that support low-intensity recreational and residential uses. These waters include seasonal mooring areas where good water quality and fish and wildlife habitat are maintained.

Type 3 High-Intensity Boating This category includes intensely utilized water areas where recreational boating activities dominate and where the adjacent shorelines are developed as marinas, boatyards, and associated water-enhanced and water-dependent businesses.

Type 4 Multipurpose Waters This category includes (1) large expanses of open water in Narragansett Bay and the Sounds which support a variety of commercial and recreational activities while maintaining good value as a fish and wildlife habitat; and (2) open waters adjacent to shorelines that could support water-dependent commercial, industrial, and/or high-intensity recreational activities.

Type 5 Commercial and Recreational Harbors These waters are adjacent to waterfront areas that support a variety of tourist, recreational, and commercial activities.

Type 6 Industrial Waterfronts and Commercial Navigation These water areas are extensively altered in order to accommodate commercial and industrial water dependent and water-enhanced activities.

Appendix B
Glossary

Atmospheric Deposition: The process by which chemical substances, such as pollutants, are transferred from the atmosphere to the earth's surface.

BOD: Biochemical oxygen demand

Brownfields: means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. (EPA)

CRMC: Coastal Resources Management Council

CSO: Combined Sewer Overflow

CWA: Clean Water Act

EPA: United States Environmental Protection Agency

Hazardous Waste: Any waste or combination of wastes of a solid, liquid, contained gaseous, or semi-solid form that, because of its quantity, concentration, or physical or chemical characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment.

Effluent: an outflowing of water or gas from a natural body of water, or from a manmade structure.

Estuary: that part of the mouth or lower course of a river in which the river's current meets the sea's tide.

Eutrophication: an ecosystem's response to the addition of artificial or natural nutrients, mainly phosphates, through detergents, fertilizers, or sewage, to an aquatic system. One example is the "bloom" or great increase of phytoplankton in a water body as a response to increased levels of nutrients. Negative environmental effects include hypoxia, the depletion of oxygen in the water, which may cause death to aquatic animals.

Hydric Soil: soil which is permanently or seasonally saturated by water, resulting in anaerobic conditions, as found in wetlands.

Hypoxic: reduced oxygen content of air or a body of water detrimental to aerobic organisms.

Intertidal: of or relating to the littoral region that is above the low-water mark and below the high-water mark.

MCL: Maximum contaminant levels

NOAA: National Oceanic and Atmospheric Administration

NRCS: Department of Agriculture, Natural Resources Conservation Service

OWTS: Onsite wastewater treatment system

Pollution: Human-made or human-induced alteration of the physical, chemical, biological or radiological characteristics and/or integrity of water (DEM WQ Rules)

Pollutant: any material which will likely alter the physical, chemical, biological or radiological characteristics and/or integrity of water. (DEM WQ Rules)

Protect: Actions aimed at maintaining the quality of a water resource and preventing future water quality degradation.

Restore: Actions aimed at improving the water quality conditions in a water resource that has already been degraded or impaired in some aspect.

RIEMC: Rhode Island Environmental Monitoring Collaborative

Siliviculture: The growing and cultivation of trees

Source water: untreated water from streams, lakes, and interconnected underground aquifers that recharge public and private wells and replenish water supply reservoirs.

Sole Source Aquifer: An aquifer that supplies at least 50 percent of the drinking water for its service area and there are no reasonably available alternative drinking water sources should the aquifer become contaminated.

Stratified Drift: *Drift* is the term used for all sediments of glacial origin, no matter how, where, or in what form they were deposited. There are two distinct types of glacial drift: till and *stratified drift*. Till is the material that is deposited directly by the glacier. Stratified drift is the sediment laid down by glacial melt water. The main difference between till and *stratified drift* is that ice cannot sort the sediment it carries, hence till is composed of unsorted particle sizes. *Stratified drift* is sorted according to the size and weight of its fragments

Tidal: of, pertaining to, characterized by, or subject to tides.

TMDL: total maximum daily load

Urbanization: a population shift from rural to urban areas.

USF&W: United States Fish and Wildlife Service

USGS: United States Geological Survey

Wetland[1]: an area defined by R.I. Gen. Law, Title 2, Agriculture and Forestry, Chapter 2, Agricultural Functions of Department of Environmental Management, Part 2-1-13, Fresh Water Wetlands, Section 2-1-20, Definitions. "*Includes, but is not limited to, those areas that are inundated or saturated by surface or groundwater at a frequency and duration to support, and that under normal circumstances do support a prevalence of vegetation adapted for life in saturated soil conditions. Freshwater wetlands includes, but is not limited to: marshes, swamps, bogs, emergent, and sub-mergent plant communities, and for the purposes of this chapter, rivers, streams, ponds, and vernal pools*."

[1] State Law defining freshwater wetlands was amended in 2015 affecting the definition of perimeter and riverbank wetlands and introducing the designation of buffers adjacent to freshwater wetlands. DEM and CRMC were in the process of developing revised regulations to address the changes at the time of adoption of this Plan.

Vernal Pool - As defined by the U.S. Army Corps of Engineers State of Rhode Island General Permit is a confined basin depression with water for two or more continuous months in the spring and/or summer, for which evidence of one or more of the following indicator vernal pool species: wood frogs (Rana sylvatica), mole salamanders (Ambystoma spp.), and fairy shrimp (Eubranchipus spp.) has been documented or for which evidence of two or more of the following facultative organisms: caddisfly (Trichoptera) larvae casings, fingernail clams (Sphaeriidae), or amphibious snails (Basammatophora) and evidence that the pool does not contain an established reproducing fish population has been documented.

Appendix C
References[1]

Adler, R. "*Returning to the Goals of the Clean Water Act*", Natural Resources Defense Council.

Bromberg, K. and M. Bertness, *Reconstructing New England Salt Marsh Losses Using Historical Maps*, Estuaries Vol. 28, No. 6, 2005, P. 823-932.

Center for Watershed Protection:
- *Impacts of Impervious cover on Aquatic Systems*, Watershed Protection Research Monograph No. 1, Ellicott City, Maryland, 2003.
- *Stormwater Manager's Resource*,: http://www.cwp.org/

Chinman, R. and S. Nixon, *Depth-Area Volume Relationships in Narragansett Bay*, University of Rhode Island, Kingston, RI, Technical Report 87, 1985.

Coastal Resources Management Council, Wakefield, RI:
- Rhode Island Aquatic Invasive Species Management Plan, 2007.
- The State of Rhode Island Coastal Resources Management Program, as amended.
- *Aquaculture in Rhode Island; 2014 Annual Sales Report*, 2014.
- *The Rhode Island Sea level Affect Marshes Project (SLAMM) Summary Report*, 2015.

Dahl, T.E., *Wetland Issues in the United States 1780's to 1980's*, U.S. Department of the Interior Fish & Wildlife Service, Washington DC, 1990.

Dillingham, Timothy et al, *The Pawcatuck River Estuary and Little Narragansett Bay: An Interstate Management Plan,* July 1992.

King, J. et al., *Narragansett Bay & Rhode Island Coastal Ponds-Concentrations of Trace Metals in Sediment 1988-1999*, University of RI, Graduate School of Oceanography, 1999.

Narragansett Bay Estuary Program, Providence, RI:
- *Narragansett Bay Water Quality Statistical Trends 2000*, RI DEM- Narragansett Bay Estuary Program and Narragansett Research Reserve, 2000.
- *Narragansett Bay Estuary Program CCMP Update 2012*, 2012.

New England - New York Interagency Committee (NENYIAC). *The Resources of the New England - New York Region*, Part Two, Chapter XVII, Narragansett Bay Drainage, 1955.

NEIWPCC, Northeast Regional Mercury Total Maximum Daily Load, New England Interstate Water Pollution Control Commission, States of Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island and Vermont, 2007.

Ocean Conservancy, *Turning the Tide on Trash; 2014 Report*, 2014.

[1] All URL as of October 13, 2016 an includes some references from NPS Management Plan 2014 for text other than pollution sources.

Peach, Michelle, PowerPoint presentation, Rhode Island Freshwater Wetlands Monitoring and Assessment Plan (WMAP), Rhode Island Natural History Survey, Kingston, RI, April 2013.

Raposa, K. et al , "A Strategy for Developing A Salt Marsh Monitoring and Assessment Program for The State of Rhode Island", NBNERR, Save The Bay, CRMC, in draft – March 2016.

RI Department of Administration, Division of Planning, Providence, RI:

- *Road Salt Application in Rhode Island*, March 2014, Technical Paper #163, 2014.
- State Guide Plan Elements:
    - *Forrest Resources Management Plan*, 2005.
    - *Land Use 2025*, State Land Use Policies and Plan, 2006.
    - *Solid Waste 2038*, RI Comprehensive Solid Waste Management Plan, 2015.

RI Department of Environmental Management, Providence, RI:

- *The Greenwich Bay Fish Kill August 2003: Causes, Impacts and Responses,* 2003.
    - http://www.dem.ri.gov/pubs/fishkill.pdf
- Plan for Managing Nutrient Loadings to Rhode Island Waters, State of Rhode Island and Providence Plantations, Providence, RI, 2005.
- RI Water Monitoring Strategy, 2005.
- RI Freshwater Monitoring Strategy, 2006.
- Total Maximum Daily Load for Dissolved Oxygen and Phosphorus, Mashapaug Pond, Rhode Island, 2007.
- Total Maximum Daily Load Analysis for the Pawcatuck River and Little Narragansett Bay Waters Bacteria Impairments, 2010.
- *Rhode Island Forest Resources Assessment and Strategies, A Plan for Tomorrow's Forests*, 2010.
- Rhode Island Statewide Total Maximum Daily Load for Bacteria Impaired Waters, 2011.
- Integrated Water Quality Monitoring and Assessment Report, 2012.
- Rhode Island Freshwater Lakes and Ponds: Aquatic Invasive Plants and Water Quality Concerns, A Report to the Governor and Rhode Island General Assembly, 2012.
- Libby, Alan, *Inland Fishes of Rhode Island*, Rhode Island Division of Fish and Wildlife, West Kingston, RI, 2013.
- Southern RI Conservation District Grant Application to DEM for Waterfowl Control Measures, 2013.
- 2014 Integrated Water Quality Monitoring and Assessment List.
- 2014 RI Nonpoint Source Management Program Plan.
- Rhode Island State Wildlife Action Plan, 2015.
- *2015 Annual Report to the Governor on the Activities of the Dam Safety Program*.
- RI Wetland Program Core Elements Plan, 2015.

RI Department of Environmental Management and RI Coastal Resources Management Council:

- RI Stormwater Design and Installation Standards Manual, 2010.
- RI Low Impact Development Site Planning and Design Guidance Manual, 2011.

RI Department of Health, *Report on Pollution of Waters of the State*, Division of Sanitary Engineering, Providence, RI, 1946.

Rhode Island Geographic Information System Geospatial 2015 Data Catalog, http://www.rigis.org/data

RI Resource Conservation and Development Council, *Road Crossings as Potential Barriers to Fish and Wildlife Movement: The RI River and Stream Continuity Project*, 2013

Rhode Island Science and Technology Advisory Council, "Accelerating Innovation Through Collaboration in the Ocean State: Science and Technology Infrastructure Plan for Rhode Island", September 2009.

Wastewater Facilities Plan Amendment Report, Draft; April 2011, Town of South Kingstown, RI, 2011.

Turning to the Sea: America's Ocean Future, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Public and Constituent Affairs, 1999.

"*Wetlands and Climate Change: Consideration for Wetland Program Managers*", Association of State Wetland Managers, July 2015.

US Department of Agriculture, National Agricultural Statistics Service 2012 Census of Agriculture, Preliminary Report, 2014

US Environmental Protection Agency (EPA):
- EPA) Website, Water: CZA, Pollution Prevention Management Measures.
- Hellyer, Greg, Memorandum, Wetland Losses in Rhode Island 1780's-1990's, 1995.
- "Watershed Approach Framework", Office of Water Resources (4501F), EPA 840-S-96-001, June 1996.
- *Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence* (Final Report) Washington DC, EPA/600/R-14/475f, 2015.

United States Geological Survey:
- Coles, James F. et al, "The Effects of Urbanization on the Biological, Physical and Chemical Characteristics of Coastal New England Streams", Professional Paper 1695, 2004.
- *Estimation of Total Nitrogen and Phosphorus in New England Streams Using Spatially Referenced Regression Models*, Scientific Investigations Report 2004-512, 2004.

Appendix D
Climate Change & Water Quality Management

This Appendix is composed of excerpts from the text and the Implementation Table of the State Guide Plan Element, *Water Quality 2035,* concerning the topic of climate change. Not all topics in the Element are relevant to the discussion of climate change. It was decided to list just the related topics here for educational purposes and easy referencing by readers. The text, policies and actions that appear within this Appendix are identical as they appeared previously within the main Element.

Excerpt: Part 1 Introduction & Vision

Pg 1 - Key Points:

- Water quality management needs to take into account the effects of **climate change,** including increasing temperatures, more extreme weather events and sea level rise, on our water resources.

Pg. 1-2 Drinking Water -- Clean water safe for human consumption:

Both surface waters and groundwater are relied on as sources of Rhode Island's potable water supplies. Preventing degradation of drinking water supply sources helps sustain the reliable delivery of water safe to drink. Much of the water we consume requires some type of treatment before use. Whether applying to public or private supplies, the extent of treatment depends on the condition of the source water. Degraded source water costs more to treat to meet public health standards. Keeping source waters clean helps avoid added treatment costs and ensures public health. The Department of Health ensures that drinking water quality remains safe for consumption and published *Safe Water RI, Ensuring Safe Water for Rhode Island's Future*[1]. This report summarizes the impacts of **climate change** on drinking water utilities in the State. Other the management of drinking water utilities in the State is found in State Guide Plan RI *Water 2030*[2].

Pg. 1-5 Vision and Goals

This is the State's Plan to protect and restore the quality of Rhode Island's water resources. It encompasses freshwater and saltwater surface waters, groundwaters, and wetlands -- from inland lakes and streams to Narragansett Bay and coastal saltmarshes. The Plan sets forth a management framework with goals, policies and actions aimed at ensuring that Rhode Island's water resources supports healthy aquatic ecosystems and meet the needs of future generations. The Plan is long-range, intended to guide policy and action for the next twenty years while recognizing the need for adaptive management, especially in light of a changing **climate**.

Pg. 1-6 Management Principles

- Water quality management is based on sound science and regularly integrates new information, including improved scientific knowledge, technological innovations and understanding of **climate change** principles.

[1] http://www.health.ri.gov/publications/reports/2013EnsuringSafeWaterForRhodeIslandsFuture.pdf
[2] http://www.planning.ri.gov/
[3] http://www.planning.ri.gov/

Excerpt: Part 2 Rhode Island's Water Resources & Trends

Pg. 2-1 Key Points:

- **Climate change** is recognized as a threat to all aquatic habitats with salt and brackish marshes, coldwater streams, freshwater marshes, vernal pools among the most vulnerable.

Pg.2-9

Salt marshes are among the most ecologically valuable habitats associated with our coastal water resources and already are facing challenges from climate change.

Pg.2-24 Overview of Threats

The condition of Rhode Island's water resources is adversely impacted by stressors which cause water pollution and degradation of aquatic habitat. Stressors are associated with human activities, **climate change** and spread of invasive species. The stressors affecting water quality result largely from human activities relate to how we use our land and waters and include activities which negatively impact our waters by causing changes to their chemical, physical or biological characteristics. In addition to direct discharges of pollutants, stormwater plays a major role in washing pathogens, nutrients and sediment from the landscape into surface waters

Pg. 2-40 Aquatic Habitat Conditions

This plan benefits from the 2015 DEM RI State Wildlife Action Plan (SWAP) which discusses in detail the condition and threats to aquatic habitats and various wildlife species. The SWAP identifies Rhode Island's species of greatest conservation need (SGCN), key habitats and the threats to both in accordance with federal guidance from the United State Fish and Wildlife Service. With input from a large number of scientists and experts, the planning process produced a list of 84 key habitats considered important to the species of greatest conservation need. It is notable that 49 (or 58%) are aquatic or shoreline habitats and included thirty freshwater habitats and nineteen estuarine and marine. See Appendix G, SWAP Habitat Assessments. Each of these habitat types was assessed for its importance to biodiversity, current condition, degree of threat and vulnerability to **climate change**.

Pg.2-41 The RISWAP also identifies specific threats to the key habitats. The Plan recognizes water quality as integral to healthy aquatic habitats and notes that changes in water quality and quantity pose serious threats to all northeastern aquatic systems. In addition to pollution from various sources, other types of stressors adversely affecting habitat condition in RI were identified. These are described in a manner consistent with the IUCN categories of threats that are commonly used by states in the region. Certain threats stand out as of higher concern to certain habitat types. Among 36 key freshwater and estuarine habitats, the most common threats identified can be grouped as follows in rank order were:

- Changes to the natural system- including **climate change** and hydromodifications (dams) (33)

Pg. 2-42 Impacts of Climate Change on Aquatic Habitats

Climate change is recognized as a threat to all aquatic habitats. Changes in temperature, precipitation patterns, hydrology and the frequency of intense storms may impact the physical and chemical characteristics and biota of aquatic habitats. The 2015 SWAP identified the following aquatic habitats as most vulnerable.

Degree of Vulnerability	Habitat Type
Highly Vulnerable	Brackish Marshes,
	Tidal Flats
Vulnerable	Salt Marshes
	Cold water Streams
	Emergent Marshes
	Vernal Pools
	Shrub swamps/wet meadows
	Red Maple (Hardwood) Swamps
	Atlantic White Cedar Swamps
	Floodplain Forests
	Cold water Ponds

It is generally agreed that coastal habitats, including salt marshes, are among the most vulnerable due to accelerating sea level rise. Recent completed SLAMM modeling is projecting significant changes in the extent of salt marsh. As sea level rises, the model predicts initially there might be a gain in salt marsh due to migration inland that would come at the expense of displacing brackish marsh, tidal flats and freshwater wetlands. However, it also predicts the likelihood of marsh migration lessons as sea level continues to rise leading to net projected losses in acreage of salt marsh with 3 feet or more of rise. Existing salt marshes, tidal creeks, sea grass beds and coastal ponds are also vulnerable to damage from more frequent and intense storms.

Freshwater wetlands will be affected by **climate change** due to change in hydrology. Predicted changes in precipitation patterns may change spring seasonal flows and floods and produce drier summers that change groundwater levels and soil moisture. The hydroperiod of vernal pools may shorten affecting the breeding success of species dependent on this habitat such as amphibians. Changing conditions may result in shifts in the plant community as previously wetter areas dry out. For example, marshes and swamps may contract inward toward areas where water is deeper or more reliable. Larger wetlands may become fragmented. Floodplain forests may suffer damage from more frequent intense storms.

Coldwater streams are considered very susceptible to projected **climate changes**. Increases in air temperature will lead to a decline in suitability of coldwater streams as habitat for important species such as Brook Trout. Rising temperatures has ramifications for many important aquatic organisms that make up the dynamic food web within streams and adjoining terrestrial ecosystems.

Pg. 3-4 Executive Climate Change Coordinating Council – (EC4) – R.I. Gen. Law §42-6.2 establishes the EC4. The Council is charged with incorporating consideration of **climate change** into the powers and duties of all state agencies. It is responsible for setting specific greenhouse gas reduction targets, and planning for mitigation and adaptation to **climate change**. The Council, chaired by DEM, works with an advisory board and a science and technical advisory board.

Northeast Regional Association of Coastal and Ocean Observing Systems (NERACOOS) - NERACOOS is a non-profit organization formed in association with the federally authorized International Ocean Observing System (IOOS) – a federal partnership initiative managed by NOAA. Its focus is on developing a sustained regional observing (monitoring) system for the northeast US. Its activities include the design of a sentinel network to track **climate** variability in coastal and ocean waters.

Excerpts: Part 4 Water Quality Monitoring and Assessment

Pg.4-1 Key Points

- **Climate change** reinforces the need for monitoring hydrology and in habitats that are most vulnerable to its impacts.

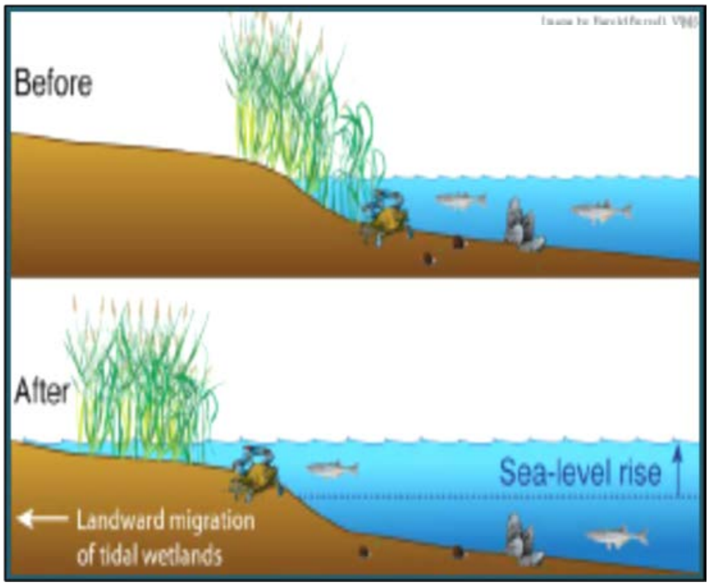
Surface Water Monitoring

Pg. 4-3 Despite limitations in capacity within state agencies, over the last decade progress has been made in reducing data gaps. A network of fixed sites in Narragansett Bay expanded from 5 to 13 locations between 2001 and 2008 although gaps remain in Mt. Hope Bay and the Sakonnet River. DEM's adoption of a rotating basin strategy for river and stream sampling targets a portion of the state's watersheds for monitoring from May to October each year on a five-year cycle. It has resulted in the creation of over 200 sampling stations statewide allowing water quality conditions in a majority of RI stream miles to be characterized (assessed). A collaborative effort is underway to collect fish tissue data from publicly accessible lakes. However, despite the progress, as noted in Part 2, Rhode Island's Water Resources & Trends, significant gaps in available water quality data remain. Priority gaps for public health include: the surveillance of potentially harmful algal blooms, fish tissue contamination data, risk-based monitoring of freshwater beaches, and monitoring of emerging contaminants of concern. Gaps in data also prevent or limit the assessment of water quality conditions in 26% of lakes acres, 35% of river miles and portions of RI's coastal waters including the Sakonnet River and certain embayments. Gaps also exist with respect to fully characterizing changes in aquatic ecosystems including biological responses, related to **climate change** and nutrient reduction. In addition, a lack of stable funding is a concern for several existing core state monitoring programs including the Narraganset Bay Fixed Site Network, the stream gage network, programs that monitor water quality in rivers and streams, and saltwater beach monitoring. These programs have historically been largely reliant on federal funding sources.

Pg. 4-11 State Monitoring Policies:

Monitoring Policy 5: Align monitoring programs with regional data collection strategies relating to **climate change**, aquatic ecosystems and water quality.

Pg. 4-12 Climate Change



As noted in Part 2, **climate change** can have a variety of impacts on water quality and aquatic ecosystems. This reinforces the need for long-term monitoring in waters and habitats that are most vulnerable to its impacts. Currently, state agency managers are particularly concerned with impacts to coastal ecosystems in estuaries, marine waters, and saltmarshes, due to sea level rise, other physical changes, and species composition. Managers will need to adapt current monitoring programs, including those collecting meteorological and hydrologic data, in order to be able to distinguish and understand changes in our water resources that are resulting from the influence of **climate change**. The data is needed to understand ecological impacts as well as support decision on adaptation of water pollution control infrastructure, including wastewater and stormwater systems. Rhode Island monitoring programs will benefit from alignment with regional initiatives concerning **climate change**. Significant analysis and planning has led to recommended regional plans for sentinel monitoring networks for wadeable streams (EPA) and coastal estuaries (NERACOOS). Additional resources will be required to implement these networks in RI.

Excerpts: Part 5 Planning

(Pg.5-11)

One means of promoting healthy watersheds is through the restoration of riparian buffer areas located along rivers, streams and ponds. Riparian buffer plans are typically prepared for a watershed or sub-watershed in order to identify and prioritize opportunities to restore land areas immediately adjacent to a waterbody to a naturally vegetated condition. While appropriate for all watersheds, few such plans have been completed in RI and as such it constitutes a second gap in planning capacity affecting watershed management. As part of DEM's prior sustainable watershed initiatives, buffer restoration plans were completed for the Greenwich Bay and Buckeye Brook watersheds (2005) and Woonasquatucket River watershed (2001, 2003). The plans help to identify sites and may also involve assessment of both the feasibility and potential benefits of buffer restoration for a given site. In the Woonasquatucket watershed, one plan documented a total of 239 potential buffer restoration sites over ninety percent privately owned. The need to work with many landowners to achieve buffer restoration along either a river or pond is recognized as a challenge. Never the less, with growing recognition of **climate change** impacts on riverine systems and floodplains, it is appropriate to focus more attention on riparian buffers as one means to promote resiliency. This type of planning work should aligned with related flood prevention and mitigation activities occurring on the local and state level. Building capacity to advance planning in this area is a current need.

Excerpts: Part 6 Pollution Sources and Aquatic Habitat Management

Pg. 6-1 Key Points

- There are four water cross-cutting resource management topics: **climate change,** pollution prevention, compliance and enforcement, and data management.

Pg. 6-1 Overarching Management Issues

There are four water cross-cutting resource management topics that extend beyond the specific pollution source/programmatic discussions later in this section. They are **climate change**, pollution prevention, compliance and enforcement, and data management.

1. **Climate Change**: As discussed in Part 2, all aquatic ecosystems are likely to be affected over time by changing climate. Evidence of change has already been documented in salt marshes which are being impacted by sea level rise. Other changes to water quality or aquatic habitats are less certain as one tries to project out to 2035. What is known is that it is realistic to anticipate a variety of potential impacts to aquatic ecosystems, water quality and the functioning of the water pollution infrastructure we rely on to help keep our waters clean. Droughts, changing patterns of precipitation and snowmelt, and increased water loss to evaporation as a result of warmer air temperature may result in hydrologic changes that could result in the loss of wetlands, changes in stream flows and water quality. Increased frequency of intense storms may overwhelm existing stormdrains. Temperature change will drive other changes in natural environment processes that in turn affect the quality and quantity of our water resources and the hydrological communities that inhabit them. In some places in the State, sea level rise and salt water intrusion will present management challenges. Specific issues of concern related to **climate change** are included in the descriptions of the pollution sources and habitat stressors that follow. Water resource managers and communities need to continue to access emerging **climate change** information, evaluate potential impacts of **climate change** on water quality programs, and identify and implement needed adaptation responses as **climate change** impacts are happening now.

Pg. 6-2 Overarching Policies

Climate Change Policy: Ensure management of water quality and aquatic habitats is adapted to minimize adverse impacts associated with a changing **climate change.**

Pollution Sources & Policies

Pg. 6-3 Wastewater Discharges to Surface Waters and Collection Systems (Sewers)

Water Quality Concerns:

As part of their operations, the major WWTFs operate 13 septage receiving facilities which accept over 40 million gallons of septage waste annually from OWTS delivered by licensed haulers. WWTFs also generate sludge, 27,000 dry tons per year, which is most often disposed of off-site, with the majority going to RI's Central Landfill in Johnston. While progress has clearly been made in reducing water pollution associated with wastewater infrastructure, not all water quality concerns have been addressed. Current areas of significant focus are controlling nutrient pollution, abating the discharge of combined sewer overflows (CSO), ensuring proper operation and maintenance, exploring solutions to long-term financing needs addressing the vulnerability of WWTF to **climate change.**

Pg. 6-6 Climate Change: By their design and function, a wastewater treatment facility is typically located downgradient from the majority of its service districts. This places them in low-lying areas adjacent to the waters to which they discharge. As a result, wastewater infrastructure is vulnerable to **climate change** impacts associated with both sea level rise and changing precipitation. For example, the impact of the Spring of 2010, flooding from the Pawtuxet River overtopped the Warwick Wastewater Treatment Facility causing it to shut down. Assessments of each system as part of a statewide vulnerability assessment study being coordinated by DEM. The study is incorporating model predictions of coastal inundation due to sea level rise, storm surge as well as riverine flooding. The results will lead to prioritization of adaption measures that minimize impacts on the functioning of public wastewater infrastructure.

Pg. 6-7 Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policies:

Policy 1: Ensure that the planning, design, and construction of wastewater systems will protect public health and water quality and that the facility planning process considers climate change and guides the expansion and use of public wastewater systems.

Onsite Wastewater Treatment Systems (OWTSs)

Pg. 6-10 ***Climate Change:*** The impacts of projected climate change through sea level rise and warmer soil temperatures may decrease the effectiveness of OWTS in the coastal zone because:

- Sea level rise will increase the vulnerability of systems in the coastal zone to storm damages.
- Rising water tables (due to sea level rise) in the coastal zone will decrease the available aerated soil to treat wastewater beneath the system. Wet and saturated conditions beneath the system favor pathogen survival and transport. RI benefits from a long0standing regulation requiring an increased separation to the water table in the coastal zone.
- Warmer soil temperatures statewide will potentially reduce available oxygen for wastewater treatment in the soil.

Design standards for OWTS will need to be periodically evaluated in light of environmental changes cause by climate change.

Stormwater

Pg. 6-15 **Climate change** is predicted to produce wetter and more variable precipitation conditions in the decades ahead with more frequent intense storms that have large amounts of precipitation falling over shorter time periods. Stormwater management systems are designed based on the average precipitation rates in the recent past. The capacity and performance of these systems will be an issue to closely evaluate as precipitation patterns in RI change in response to **climate change**. Over time, the Stormwater Design and Installation Standards Manual will likely need to be updated to reflect changing precipitation patterns.

Pg. 6-16 Stormwater Policies

Stormwater Policy 7: Ensure that stormwater management programs address climate change.

Wetlands (Freshwater and Coastal)

- **Climate Change** Mitigation: Wetlands can function as natural carbon sequestration systems that can contribute to climate change mitigation. Wetlands already contain a significant percentage of the carbon that is sequestered in natural systems. Peatlands contain 30% of all global soil carbon.

Coastal wetlands contain up to 70% of carbon sequestered in marine environments. While discerning the net effect on greenhouse gases is complex, the role of wetlands in carbon sequestration is worthy of continued attention and provides an additional rationale for strong protection of wetland resources[4].

Pg. 6-43 In the coastal zone, Rhode Island is focusing attention on the vulnerability of salt marshes to climate change, especially impacts from sea level rise. Coastal wetlands provide critical nursery habitat for fisheries, play a role in absorbing nutrients to protect water quality and provide other benefits. A collaborative effort is underway to simulate the coastal wetland migration under different sea level rise scenarios. This information will support development of adaption strategies that may improve the resiliency of salt marshes in light of **climate change**. Wetland habitats are also valued within the Rhode Island State Wildlife Action Plan (RIDEM Twenty freshwater wetland (plaustrine) habitats and 20 estuarine wetland habitats are identified as key habitats to protect species of greatest conservation need. (See Appendix G for more details.)

Wetlands (Freshwater and Coastal) Policies

Wetlands (Freshwater and Coastal) Policy 1: Avoid and minimize alterations and losses of wetlands to protect the functions and values they provide.

Wetlands (Freshwater and Coastal) Policy 2: Facilitate restoration of the quality and quantity of wetlands.

Pg. 6-26 Hazardous Material and Petroleum Product Spills

Hazardous Materials Management

Effective hazardous materials management requires a multi-phase approach to ensure that water resources, the environment, and public health and safety are protected:

- *Ability to respond to accidents and leaks in a timely and effective manner to limit the environmental impact.*
- *Proper storage and handling to prevent accidents and leaks (see also the Sections on Underground Storage Tanks and Above Ground Storage Tanks).*
- *Proper disposal of waste generated in the use of the hazardous materials (See also previous Section on* Hazardous Material and Petroleum Product Spills).
- *Strategies to clean up the environmental impacts from any accidental or illegal releases and addresses* ***climate change*** *(see also Contaminated Site Clean-up).*

Excerpts: Part 7, Implementation Matrix - Climate Change Actions

Pg. 7-1 This Plan finds that state agencies generally have adequate legal authority to regulate the sources of pollution that degrade Rhode Island water resources. With federal and state law as its foundation, the water quality framework in place has identified the major stressors on our water resources as pathogens and nutrients and flagged emerging issues that warrant management attention. Existing

[4] "Wetlands and Climate Change: Consideration for Wetland Program Managers", Association of State Wetland Managers, July 2015.

water pollution control programs need to be adequately enforced to prevent new problems. Rhode Island also benefits from well-established laws and programs for protecting wetland resources and coastal habitats from physical alteration. However, other stressors including invasive species, fragmentation, hydro-modification and a **changing climate** continue to threaten or degrade these habitats.

Among state level water quality and habitat protection programs, areas identified as severely constrained or threatened by a lack of capacity included the following: monitoring, lake management including aquatic invasive species, aquatic habitat restoration and **climate change**. While DEM and CRMC carry-out some activities, these programmatic areas represent areas where program development is a primary need. In the case of monitoring, the capacity needs include both staffing and funding to sustain long-term core monitoring programs that are deemed essential to effective water resource management. Monitoring priorities include several public health concerns including the need for expanded surveillance of cyanobacteria blooms that may produce toxicity, fish tissue contamination and freshwater bathing beach conditions.

The following are excerpts of the policies and actions from the Implementation Matrix in Part 7 related to **climate change** for various water quality topics as discussed within this Element. See Part 7 for more detailed information on the Implementation Table and other topics.

EXCERPTS FROM PART 6, IMPLEMENTATON MATRIX[5] POLICIES and ACTIONS FOR **CLIMATE CHANGE**	LEAD	SUPPORT	TIME-LINE
Part 4 Water Quality Monitoring and Assessment Actions[6]			
State Monitoring Policies:			
Monitoring Policy 5: Align monitoring programs with regional data collection strategies relating to climate change, aquatic ecosystems and water quality.			
Actions C. Complete update of monitoring strategy for saltmarshes incorporating parameters to assess impacts of climate change.	CRMC, NBNERR	STB, EMC	ST
Part 6 Pollution Source and Aquatic Habitat Management Actions[7]			
Overarching Management Policies **Climate Change Policy: Ensure management of water quality and aquatic habitats is adapted to minimize adverse impacts associated with a changing climate change.**			
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policies			
Wastewater Discharges to Surface Waters and Collection Systems (Sewers) Policy 1: Ensure that the planning, designs, and construction of wastewater systems will protect public health and water quality and that the facility planning process, considers climate change, and guides the expansion and use of public wastewater systems.			
Actions F. Complete vulnerability assessments of wastewater systems relative to potential impacts from climate change.	DEM	NWPCA	ST
G. Devise and implement adaptation strategies that will improve wastewater system resiliency to climate change.	DEM	NWPCA	MT
Onsite Wastewater Treatment Systems (OWTS)			
OWTS Policy 4: Ensure that OWTS are protective of public health and the environment.			
Actions G. Continue to evaluate the effects of climate change on OWTS performance and amend Rules.	DEM, CRMC	URI	O
Stormwater			
Stormwater Policy 7: Ensure that stormwater management programs address climate change impacts.			

[5] See Part 6 for more details.
[6] See Part 4 for more details.
[7] See Part 6 for more details.

EXCERPTS FROM PART 6, IMPLEMENTATON MATRIX[5] POLICIES and ACTIONS FOR **CLIMATE CHANGE**	LEAD	SUPPORT	TIME-LINE
Actions A. Evaluate the impact of climate change on existing stormwater management systems.	DEM CRMC	MS4s	LT
B. Incorporate new data on climate change into stormwater management design standards, including projections for increased storm intensities.	DEM CRMC	EPA	LT
Pg. 7-19 Dredging and Dredge Material Management			
Dredging and Dredge Material Management Policy: Reduce water quality impacts of dredging at both the location of material removal and the location of its use or disposal in water or on land.			
Actions D. Study using clean dredge material for salt marsh restoration to assist with climate change adaptation.	CRMC	DEM	O
Aquatic Habitat			
Pg. 7-23 Wetlands (Freshwater and Coastal) Policy 1: Protect wetland functions and values by avoiding and minimizing alterations and wetland loss.			
Actions D. Develop and implement strategies to mitigate alteration of salt marshes due to climate change, in particular **sea level rise**.	CRMC	DEM NGO NBEP	ST
Wetlands (Freshwater and Coastal) Policy 2: Facilitate restoration of the quality and quantity of wetlands and adjacent buffers.			
Actions A. Complete development of statewide freshwater wetlands restoration strategy.	DEM		MT
B. Complete development of statewide salt marsh restoration strategy.	CRMC		MT
C. Improve tracking of wetland and aquatic habitat restoration projects.	DEM CRMC		MT
D. Provide financial assistance for priority wetland restoration projects; e.g., projects that deliver multiple benefits for habitat, water quality and other functions and values.	DEM CRMC EPA NBEP		ST-O

EXCERPTS FROM PART 6, IMPLEMENTATON MATRIX[5] POLICIES and ACTIONS FOR **CLIMATE CHANGE**	LEAD	SUPPORT	TIME-LINE
Water Withdrawals			
Water Withdrawal Policy: Consider hydrologic capacity and aquatic resources in managing water use and withdrawals.			
Actions E. Evaluate water withdrawal impacts in the context of climate change.	DEM	WRB WS	ST-O

Appendix E
Outreach

Stakeholder Input and Guidance

The issue of water quality management is an enormous topic. The development of this Plan required a great deal of input from a range of individuals and organizations, from technical experts, to policy professionals, to municipal leaders, to concerned citizens. Each of these groups has a different role in water quality management. The preparation involved a concerted 3-year effort shared between the Division of Planning (DOP), the Department of environmental Management (DEM), and the Coastal Resources management Council (CRMC) to contact, to discuss, and incorporate the views and concerns of various stakeholders into the Update. Extensive input gathered was from individuals and organizations with specialized water quality knowledge including but not limited to other state government agencies, municipal officials, water resource management professionals, local environmental experts, statewide environmental experts, major employers, etc.

A variety of participation strategies were used to engage experts and non-experts. There is a number of environmental justice issues covered within this Plan. The process and staff considered protecting and restoring water resources statewide. Different stakeholders were consulted to discuss and weigh a variety of tradeoffs and technologies in order to set goals and policy priorities that would be reflective of these issues among others. This Appendix is a summary of the major efforts undertaken with some of the key educational pieces used included for information.

Technical Guidance

Water Quality Working Group - A list of the Working Group is in the front of the Plan under the Acknowledgements (page vi). This group was made up of representatives/staff of the Rhode Island Resource Recovery Corporation (RIRRC), the Department of Administration, Division of Planning (DOP) and the Department of Environmental Management Office of Waste Management (DEM). The DOP staff managed the Plan update and adoption processes per a Memorandum of Understanding among the 3 agencies. This Group communicated regularly and met whenever necessary.

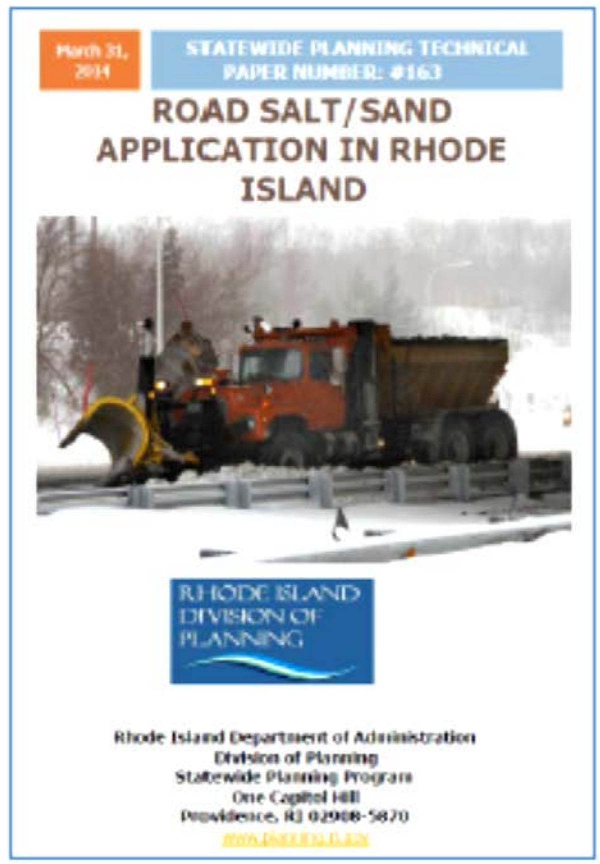
Water Quality Management Plan Advisory Committee – A listing of the Committee is in the front of the Plan (page vi). This multi-disciplinary group was established by the DOP, DEM and CRMC to provide direction and guidance during the preparation of the preliminary draft. The Committee was assembled by the DOP and designed to ensure full and balanced representation of the interests and groups concerned with water quality management issues. It was guided by staff support from the DOP and DEM with technical assistance from CRMC. The Committee provided information and recommendations to assist in preparing a preliminary draft WQMP.

Staff Presentations to Identified Stakeholders – These were additional stakeholders that the Working Group staff met with to provide input on the Plan, given their technical knowledge and/or expertise. Some regular existing meetings were used to also discuss the Update. DOP staff helped coordinate and facilitate meetings. Organizations contacted included:

- RI Rivers Council (May 2014, and March 2016)
- Environmental Monitoring Collaborative
- Narragansett Water Pollution Control Association Executive Board
    - 2016 Clean Water Legislative Luncheon
- Narragansett Bay Estuary Program Management Committee
- RI American Planning Association

- RI Resource Conservation and Development Council
- RI Society of Environmental Professionals
- RI Water Works Association Executive Board
- State Conservation Commission
- Watershed Counts

Other tools used – DOP website – Land Use Section - water resources page, DOP monthly newsletter, Google List Serve, Economics Issue Brief and Technical Report 163.



Appendix F
List of DEM Certified Wastewater Treatment Plants

Wastewater Treatment Facilities/Locations and Officials in Charge
July 2015[1]

Municipal Treatment Plants

WASTEWATER TREATMENT FACILITY/SUPT.	POPULATION CENSUS 2010	ESTIMATED POPULATION SERVED BY SEWERS	DESIGN FLOW (MGD)	AVERAGE DAILY FLOW (MGD)	MAJOR TREATMENT SYSTEMS	RECEIVING WATERS
Town of Bristol **Jose DaSilva, Superintendent** Bristol WWTF 2 Plant Street Bristol, RI 02809 TEL: 253-8877 FAX: 253-2910	22,954	20,700	3.8	2.8	RBC's Chlorination Dechlorination	Bristol Harbor
Town of Burrillville **John E. Martin, III** Burrillville WWTF PO Box 71 Harrisville, RI 02830 TEL: 568-9463 FAX: 568-9464	15,955	9,700	1.5	0.7	Activated sludge Chlorination Phosphorous reduction Dechlorination	Clear River
City of Cranston **(Veolia Water)** **Earl Salisbury** Water Pollution Control Facility 140 Pettaconsett Ave. Cranston, RI 02920 TEL: 467-7210 FAX: 781-5260	80,387	73,200	20.2	13.2	Activated sludge BNR Chlorination Dechlorination Sludge Incineration	Pawtuxet River
Town of East Greenwich **Mike Pacillo** East Greenwich Town Hall PO Box 111 East Greenwich, RI 02818 TEL: 886-8619 FAX: 886-8652	13,146	6,000	1.7	0.8	RBC's BAF/Nutrient Removal UV Disinfection	Greenwich Cove
City of East Providence *serves*: East Providence Barrington **Tom Azevedo** E. Providence WWTF Crest Ave. Riverside, RI 02915 TEL: 433-6363 FAX: 433-4059	 47,037 16,300	46,100 31,400 14,700	14.2	6.7	Activated sludge BNR/Nutrient Removal Chlorination Dechlorination	Providence River
Town of Jamestown **Douglas Ouellette** Jamestown Sewer Division 44 Southwest Ave. Jamestown, RI 02835 TEL: 423-7295 FAX: 423-7229	5,405	2,100	0.75	0.4	Extended Aeration Chlorination	Dutch Island Harbor/ Narragansett Bay East Passage

[1] http://www.dem.ri.gov/programs/benviron/water/permits/wtf/potwops.htm

Narragansett Bay Comm. **Bucklin Point** *serves*: Central Falls Cumberland East Providence Lincoln Pawtucket Smithfield **Carmine Goneconte** NBC-Bucklin Point WWTF 102 Campbell Ave. East Providence, RI 02914 TEL: 434-6350 FAX: 438-5229	 19,376 33,506 47,037 21,105 71,148 21,430	 120,000 19,400 11,100 8,900 9,400 72,600 150	 46.0	 23.1	Activated sludge BNR UV Disinfection	Seekonk River
Narragansett Bay Comm. **Fields Point** *serves*: Johnston North Providence Providence **Paul Desrosiers** NBC-Fields Point 2 Ernest St. Providence, RI 02905 TEL: 461-8848 FAX: 461-0170	 28,769 32,078 178,042	 226,000 15,900 32,100 178,000	 65.0	 45.5	Activated sludge Chlorination Dechlorination	Providence River
Town of Narragansett **Scarborough Facility** **Peter Eldridge** Narragansett Town Hall 25 Fifth Ave., P.O. Box 777 Narragansett, RI 02882 TEL: 782-0682 FAX: 782-0681	15,868	7,300	1.4	0.6	Oxidation Ditch Chlorination Dechlorination	RI Sound
City of Newport **(United Water)** *serves*: Middletown Newport U.S. Navy Base **Steve Lambalot (Interim)** Newport WWTF 250 J.T. Connell Highway Newport, RI 02840 TEL: 845-2000 FAX: 845-2014	 17,334 26,475 --	41,600 5,200 26,400 10,000	10.7	8.4	Activated sludge Chlorination Dechlorination	Narragansett Bay East Passage
New Shoreham **Chris Blane** New Shoreham Sewer Commission PO Box 220 New Shoreham, RI 02807 TEL: 466-3231 FAX: 466-3237	1,010	300-700-winter 4,000-summer	0.3	0.1	Extended aeration BNR Chlorination Dechlorination	RI Sound
Quonset Point RI Dept. of Economic Development **Dennis Colberg** Quonset Development Corporation 95 Cripe Street North Kingstown, RI 02852 TEL: 294-6342	N/A	10,000	1.78	0.492	RBC's Chlorination	Narragansett Bay West Passage
Town of Smithfield **(Veolia Water)** **Karen Goffe** PO Box 17249 Smithfield, RI 02917 TEL: 231-1506	21,430	14,000	3.5	1.4	Activated sludge BNR Tertiary Treatment Chlorination Dechlorination	Woonasquatucket River

South Kingstown Regional WWTF *serves*: Narragansett South Kingstown University of RI **Kathy Perez** South Kingstown Town Hall 180 High St. Wakefield, RI 02879 TEL: 788-9771 FAX: 789-3070	15,868 30,639 --	29,400 13,000 9,800 6,600	5.0	2.4	Activated sludge Chlorination Dechlorination	RI Sound
Town of Warren **(United Water)** **David Komiega** 427 Water St. Warren, RI 02885 TEL: 245-8326 FAX: 245-8713	10,611	8,000	2.01	1.8	Activated sludge Chlorination Dechlorination	Warren River
City of Warwick **Scott Goodinson** Warwick Sewer Authority 125 Arthur W. Devine Boulevard Warwick, RI 02886 TEL: 739-4949 FAX: 739-1414	82,672	60,200	7.7	4.5	Activated Sludge BNR Chlorination Dechlorination	Pawtuxet River
Town of Westerly **(United Water)** **Scott Duerr** P.O. Box 2924 Westerly, RI 02894 TEL: 596-2847 FAX: 348-9504	22,787	16,500	3.3	2.5	Activated Sludge BNR Chlorination Dechlorination	Pawcatuck River
Town of West Warwick *serves (portions of)*: Coventry Cranston East Greenwich Warwick West Greenwich **Tom Ciolfi** **Superintendent** West Warwick Regional WWTF 1 Pontiac Ave. West Warwick, RI 02893 TEL: 822-9228 FAX: 823-3620	29,191 35,014 80,387 13,146 89,672 6,135 29,191	31,600 1,200 200 20 930 30 29,200	7.9	5.2	Activated Sludge BAF/Nutrient Removal UV Disinfection	Pawtuxet River
City of Woonsocket **(CH2MHILL)** *serves*: North Smithfield Woonsocket Blackstone, MA **Jim Lauzon** Woonsocket WWTF 11 Cumberland Hill Rd. (rear) Woonsocket, RI 02895 TEL: 356-1468	11,967 41,186 4,854 9,026	51,400 5,200 41,200 2,000 3,000	16.0 (12.8) (1.92) (0.8) (0.48)	9.3	Activated Sludge BNR, Tertiary Treatment Chlorination Dechlorination	Blackstone River
SYNAGRO **(@ Woonsocket WWTF)** **Wes Plummer, Manager** 15 Cumberland Hill Road Woonsocket, RI 02895 TEL: 765-6764	-	-	-	-	Sludge incineration	NA

Package Treatment Plants

FACILITY/SUPT.	ESTIMATED POPULATION SERVED BY SEWERS	DESIGN FLOW (MGD)	AVERAGE DAILY FLOW (MGD)	MAJOR TREATMENT SYSTEMS	RECEIVING WATERS
Zambarano Memorial Hospital Route 100 - Wallum Lake Pascoag, RI 02859 TEL: 568-2551	450	0.12	0.06	Extended aeration Sand filters UV Disinfection	Clear River

Industrial Facilities

FACILITY INFORMATION	OFFICIAL IN CHARGE
Blount Seafood Corporation. Warren, RI 245-8800 Receiving Water: Warren River	**John Cavanagh, Director of Engineering** Blount Seafood Corp. 383 Water Street Warren, RI 02885
Exxon/Mobil Pipeline Company East Providence, RI 434-2900 Receiving Water: Narragansett Bay	**Stan Olson** Mobil Pipeline Company 1001 Wampanoag Trail East Providence, RI 02915
Kenyon Industries-Kenyon Piece Dye Works Richmond, RI 364-7761 Receiving Water: Pawcatuck River	**John Donlon** Kenyon Industries WWTF Main Street Kenyon, RI 02836
Manchester Street Station Providence, RI 455-3610 Receiving Water: Providence River	**Christopher O'Connell** 40 Point St., PO Box 6607 Providence, RI 02940

Appendix G
SWAP Habitat Assessments

2015 Key Habitats for Species of Greatest Conservation Need – Ranked by Wildlife Action Plan Habitat Team

System	Community	Type	Importance to Biodiversity	Current Condition	Degree of Threat	Vulnerability to Climate Change
Estuarine	Salt Marsh	Low salt marsh; High salt marsh; panne; salt scrub	High	Fair	High	High
Estuarine	Brackish Marsh	Brackish Marsh	High	Fair	High	High
Estuarine	Intertidal Shore	Rocky Shore	High	Fair	High	High
Estuarine	Intertidal Shore	Mud Flat	High	Fair	High	High
Estuarine	Intertidal Shore	Sand Flat	High	Fair	High	High
Estuarine	Tidal River	Tidal River	High	Fair	High	High
Estuarine	Brackish Subtidal Aquatic Bed	Brackish Subtidal Aquatic Bed	High	Fair	High	High
Estuarine	Coastal Salt Pond	Coastal Salt Pond	High	Fair	High	High
Palustrine	Forested Mineral Soil Wetlands	Silver Maple/Sycamore FF; Red Maple/pin oak FF	High	Fair	High	High
Palustrine	Forested Mineral Soil Wetlands	Vernal Pools, Seeps, Springs	High	Fair	Medium	High
Palustrine	Open Peatlands	Black Spruce Bog	High	Fair	Medium	High
Palustrine	Open Peatlands	Sea Level Fen	High	Poor	High	High
Palustrine	Open Mineral Soil Wetlands	Seasonally Flooded; Semi-permanently flooded	High	Fair	Medium	High
Palustrine	Forested Peatlands	White Cedar Hardwood Swamps	High	Fair	High	Medium
Palustrine	Forested Peatlands	White Cedar – Rhododendron Swamp	High	Fair	High	Medium
Palustrine	Open Mineral Soil Wetlands	Emergent Deep Marsh	High	Fair	Medium	High

Palustrine	Open Mineral Soil Wetlands	Emergent Shallow Marsh	High	Fair	Medium	High
Palustrine	Open Mineral Soil Wetlands	Freshwater Tidal Marsh	High	Poor	High	High
Palustrine	Forested Mineral Soil Wetlands	Hemlock/ Hardwood Swamp	High	Fair	Medium	High
Estuarine	Tidal Creek	Tidal Creek	High	Fair	Medium	High
Marine	Subtidal	Nearshore-Soft Bottom	High	Good	Medium	Medium
Marine	Subtidal	Nearshore Hard Rocky Bottom	High	Good	Medium	Medium
Palustrine	Open Peatlands	Graminoid Fen	High	Fair	Medium	Medium
Palustrine	Forested Mineral Soil Wetlands	Red Maple Swamp	High	Fair	Medium	Medium
Palustrine	Open Mineral Soil Wetlands	Shrub Swamp	High	Fair	Medium	Medium
Palustrine	Open Peatlands	Dwarf Shrub Fen/Bog	High	Fair	Medium	Medium
Palustrine	Open Peatlands	Coastal Plain Quagmire	High	Fair	Medium	Medium
Palustrine	Forested Mineral Soil Wetlands	Swamp White Oak Swamp	High	Fair	High	Medium
Palustrine	Open Mineral Soil Wetlands	Wet Meadow	High	Fair	High	Medium
Marine	Subtidal	Offshore Soft Bottom	High	Good	Low	Medium
Marine	Subtidal	Offshore Hard Rocky Bottom	High	Good	Low	Medium
Riverine	Upper perennial	Cold water (fine sediment)	Medium	Fair	Medium	High
Riverine	Lower perennial	Cold Water (Coarse sediments)	Medium	Fair	Medium	High
Riverine	Lower perennial	Cold Water (Fine Sediment)	Medium	Fair	Medium	High
Estuarine	Subtidal	Nearshore Soft Bottom	High	Poor	High	Medium
Estuarine	Subtidal	Nearshore Hard Rocky Bottom	High	Poor	High	Medium
Estuarine	Subtidal	Offshore – Soft Bottom	High	Poor	High	Medium
Estuarine	Subtidal	Offshore Hard Rocky Bottom	High	Poor	High	Medium
Palustrine	Open Mineral Soil Wetland	Managed Marsh/Impoundment	High	Good	Low	Low
Marine	Subtidal	Pelagic	Medium	Good	Low	Medium

Riverine	Upper perennial	Warm Water (coarse sediment)	Medium	Fair	Medium	Medium
Riverine	Upper perennial	Warm Water (fine sediment)	Medium	Fair	Medium	Medium
Riverine	Lower perennial	Warm Water (coarse sediment)	Medium	Fair	Medium	Medium
Estuarine	Subtidal	Pelagic	Medium	Poor	High	Medium
Riverine	Upper perennial	Cold Water (coarse sediment)	Medium	Poor	Medium	High
Riverine	Lower perennial	Warm Water (fine sediment)	High	Poor	Medium	Medium
Lacustrine	Shallow Ponds	Warm Water	High	Poor	Medium	Low
Lacustrine	Deep Ponds/Lakes	Cold/Warm Water	Medium	Poor	Medium	Medium
Palustrine	Open Mineral Soil Wetlands	Ruderal Marsh (Managed)	Medium	Fair	Low	Low