Narrow River Watershed Plan

for the Protection and Restoration
of the Quality of Water Resources throughout the Watershed

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Introduction

The Narrow River Watershed has long been recognized as a special place. The scenic beauty of the Narrow River (aka the Pettaquamscutt Estuary), the ecological resources of the estuary and wetlands, the historic and cultural resources along the rivers, and the opportunities for water-based recreation, including fishing, shellfishing, and swimming in the watershed are important values to the local communities and to the State of Rhode Island. In some areas of the watershed, these water resources (both groundwater and surface water) are of excellent quality. However, in other areas, waterbodies are not meeting their designated water quality goals.

View of Narrow River from Bridgetown Bridge looking south. (Google Maps)

Purpose of Plan

This plan is for the purpose of guiding actions to protect and restore the quality of the water resources and aquatic habitats in the Narrow River watershed. A description of the water resource conditions, and the pollutants and other stressors and threats to water resources are discussed, along with a history of key actions that have been taken to protect and improve the water resources in the watershed. Recommended actions and responsible parties are presented in Table 9 later in this report, while high priority recommended actions are summarized in this executive summary.

This plan was developed by the RIDEM Office of Water Resources Nonpoint Source Pollution Management Program staff to fulfill the requirement of the US Environmental Protection Agency (EPA) that a watershed plan meeting the criteria of the "Nonpoint Source Program and Grants Guidelines for States and Territories," issued on April 12, 2013, must be approved by the EPA in order for such grant funds to be applied to projects within the watershed. The Nonpoint Source Program is also referred to as the '319 Program' or the '319 Grant Program,' in reference to its section in the federal Clean Water Act (CWA). Not all projects proposed in this plan are eligible for 319 grant funds. The RIDEM 319 Program intended for watershed plans to address a broad, comprehensive approach to water quality management in the watershed, which is not limited to nonpoint sources of water pollution.

Watershed planning recognizes the geographical watershed as the appropriate unit for understanding and managing the water resources within it, and takes a comprehensive look at the land uses, water uses, and human activities within the watershed that influence the quality of its water resources. Watershed plan development incorporates water quality monitoring information and input from stakeholders across all levels of government and non-government organizations involved within the watershed in order to identify priority goals and action items to more effectively manage the water resources in the watershed.

Informing the Plan

Information for this plan was obtained from existing water quality reports, aquatic habitat reports, and pertinent plans and studies. Information was also obtained through discussions and input from staff from the local municipalities and state government, the Narrow River Preservation Association, and the other organizations involved in protecting and restoring the water resources in the watershed.

Goals for the plan were prioritized based on interest in particular water resource concerns and needs in the watershed and stakeholder input at the workshops. Implementation action items were prioritized based on the goal priorities, professional judgement of the direct applicability of the action to address the concern, relative ease of implementing the measure, and stakeholder input during meetings and workshop exercises.

Narrow River Watershed Locus

Watershed Description

The Narrow River watershed is located on the southwest side of Narragansett Bay and encompasses a portion of the towns of North Kingstown, South Kingstown, and Narragansett. The watershed drains an area of approximately 8,650 acres into the Narrow River, which is an estuary approximately 6 miles long, with an approximately 1.3 mile long cove southwesterly of its outlet/tidal inlet, and with three major freshwater tributaries. The Narrow River is mostly very shallow, with the exception of two very deep basins at its north end. There are three major freshwater lakes and a number of small and intermittent streams and freshwater wetlands in the uplands of the watershed, two salt ponds, and coastal wetlands along the estuary. The watershed supports a public drinking water groundwater supply; popular fishing, swimming, and boating areas; shellfish growing areas; and fish and wildlife habitats.

Aerial image showing developed and undeveloped areas adjacent to the Narrow River

In general, the watershed has a rural to suburban development pattern, with just under 12% impervious surface coverage. Over 60% of the watershed is forested or wetlands and 33% of the watershed area is protected conservation land. The most densely developed area in the watershed is along the Narrow River within the Town of Narragansett, which is residential development that has been sewered over the past 25 years. The least developed area is within the Town of North Kingstown where there is no public water or sewer available. The watershed area contains only 4% commercial development land uses and about 4% agricultural development land uses, while the predominate developed land use in the watershed is residential, at 24%.

Key Issues in the Watershed

Oysters in Narrow River. Photo by David Borkman.

One of the most prominent issues facing the watershed is the permanent closure, since 1986, of the entire Narrow River to shellfishing due to historically high bacteria concentrations impairing this waterbody. Despite the amount of investment in both wastewater and stormwater improvements in the watershed over the past 25 years, this problem of high bacteria is not yet fully resolved, though evidence exists that it is improving. The shape and geology of the watershed influences the susceptibility of this river to pollutant accumulation, while the capacity of the natural system is overburdened by the impact of the development and associated activities in the watershed. As depicted in the Narrow River Special Area Management Plan, approximately 22% of the watershed is considered "Land Developed Beyond Carrying Capacity. A more concerted and continued effort is needed to reverse this negative impact of development.

Other concerns include protecting the high-quality groundwater drinking water source; addressing high nitrogen levels in the estuary which threatens aquatic habitat; addressing excess phosphorus and aquatic invasive species in the freshwater lakes; and protecting and restoring freshwater and coastal wetlands and their buffers to promote resiliency to climate change and retain the valuable benefits and functions they provide to clean water, stormwater flood and erosion control, and wildlife habitat.

The predominant sources of water pollution in the watershed today come from stormwater runoff, improperly treated wastewater, and pet and wildlife/waterfowl waste. (In the past, wastewater from the magnitude of failing septic systems was the major source.) The watershed is also confronting the adverse impacts of sea level rise.

Example of an algae bloom in Slack's Reservoir in Smithfiled, RI.

Watershed Plan Goals

Goals for the Narrow River Watershed Plan are to:

1. Improve water quality of the Narrow River (including its tributaries) to meet the shellfishing criteria of the Water Quality Regulations, which is currently not met due to bacteria (pathogens) sources in the watershed. Strive to have this impairment delisted on the State's List of Impaired Waterbodies.

2. Protect and maintain good water quality of drinking water supplies of the Pettaquamscutt Aquifer.

3. Improve water quality in the Narrow River (including its tributaries) for fish and wildlife habitat, which is currently threatened by excess nitrogen.

4. Improve water quality of the Silver Spring Lake and the Silver Lake, which are currently impaired for fish and wildlife habitat due to excess phosphorus.

5. Reduce and control Aquatic Invasive Species (AIS) in the Silver Spring Lake and Carr Pond, which has impaired these waterbodies for fish and wildlife habitat, and interferes with their aesthetic enjoyment and recreational uses.

6. Protect and restore wetlands and their buffers throughout the watershed for water quality protection, fish and wildlife habitat, and as a resiliency strategy for flooding, sea level rise, and climate change impacts.

7. Restore stream connectivity, where possible, to improve fish and wildlife habitat in the watershed.

8. Protect swimming and fishing recreational opportunities.

Priority Action Items

The high priority action items necessary to adequately and effectively address the existing impairments and concerns in the watershed are listed below. These actions are in addition to many existing, on-going actions that are taking place in the watershed to monitor, protect, and improve conditions. The full list of recommended action items is included in Section VIII.

Stormwater Management Actions

- Eliminate illicit sanitary and gray-water connections to storm sewers.
- Install stormwater BMPs per the Narrow River TMDL as resources allow.
- Continue to install stormwater BMPs per South Kingstown stormwater implementation strategy to implement the Narrow River TMDL.
- Conduct feasibility and prioritization study for mitigation actions/ BMPs identified in the Crooked Brook TMDL. (Narragansett)
- Implement stormwater mitigation to treat runoff from outfalls identified in the Crooked Brook TMDL as prioritized by feasibility study. (Narragansett)
- Consider adopting local stormwater requirements, including soil erosion control, for development projects smaller than one acre (smaller than the state minimum requirement) for new and redevelopment applications.
- Review existing planning and development ordinances to evaluate what Low Impact Development (LID) techniques are included, decide what LID techniques would be appropriate for the community to incorporate, and adopt the use of the selected LID techniques into local development regulations for use in proposed development and redevelopment projects.
- Ensure ordinances pertaining to Post Construction Stormwater Runoff Control are applied to all zoning districts; and also address the legal enforcement of operation and maintenance requirements, particularly for stormwater BMPs on private property. Prioritize requiring nature-based stormwater management solutions.
- Ensure adequate resources to properly maintain BMPs.
- Provide public education on 'good housekeeping' efforts that residents (and business owners) in the Narrow River Watershed can do to reduce pollutants in stormwater runoff.
- Increase and improve performance of street sweeping of entire watershed. Per the Crooked Brook TMDL, perform more frequent street sweeping of South Pier Road (to prevent sediment load observed in Sprague Brook at CB-14).

Wastewater Management Actions

- Continue to implement and enforce local OWTS wastewater management plans, ordinances, and programs.
- Strengthen each town's role in identifying and addressing failed OWTSs.
- Identify locations of failed septic systems and cesspools, and enforce repairs, upgrades (nitrogen removal), or connections to sewer. Priority areas include near Mumford Road, Mettatuxet Brook, and Middlebridge.
- Require homes or businesses in the sewered areas that are not connected to the sewer to connect. (Enforce existing connection requirements.)

Pet Waste Management Actions

- Towns enforce local ordinances and improve strategies requiring owners to pick up after their pets on all property.
- Implement Crooked Brook TMDL recommendations to enforce existing town pet ordinances at: stream channel running through Sprague Park, and Kingstown Road outfall to Sprague Pond.
- Control pet waste at Dog Island and around the Narrows.

Wildlife/Waterfowl Management Actions

- Provide public education on the negative impacts of feeding waterfowl.
- Identify a local group to devise a sustainable strategy to address waterfowl/wildlife management in the watershed. Perform a study of wildlife locations and concentrations in the watershed and their impact to water quality of the freshwater stream input to the Narrow River (bacteria and nitrogen).
- Encourage residents to allow tall, coarse vegetation to grow along the banks of the river segments frequented by waterfowl or install commercially available fencing to restrict waterfowl access to the water. (Consider a demonstration project to educate and spur interest.)

Lawn and Turf

- Educate residents why and how to limit application of fertilizers and pesticides to gardens and lawns to recommended doses and avoid application prior to rain events. Consider offering 'free' assessments and/or demonstrations.

Wetland Protection and Restoration Actions

- Target wetlands and ample buffers for open space protection strategies, including purchases, easements, and through alternative zoning techniques that require open space. Focus on assemblage of large areas of protected land in order to provide better protection for wetlands.
- Protect marsh migration areas on the Narrow River as identified by the RI SLAMM Project through land acquisition and conservation easements, and where possible, remove barriers to migration (such as parking lots, hardened shorelines, etc.).
- Incorporate Low Impact Development techniques in local regulations to the maximum extent practicable.
- Develop or update local conservation development ordinances to shift new construction and development projects away from SLAMM projected potential salt marsh areas.
- Expand the 'No Wake Zone' in the Narrow River to protect salt marsh and eelgrass bed habitats from increased erosion caused by motor boat wake energy.

Buffer Protection and Restoration

- Develop a watershed wide Buffer Protection and Restoration Plan
- Work with landowners to promote buffer protection and restoration where possible.
- Address horse farm property per Crooked Brook TMDL. (Lack of buffer on this property, also potential agriculture use.)

Aquatic Invasive Species Management Actions

- As opportunities arise, take actions to control and manage aquatic and wetland invasive species in the watershed.

Climate Change Resiliency Actions

- Municipal Boards and commissions educate themselves on the impacts of flooding and sea level rise. Recommended for all Board members to complete the PREP-RI on-line module series.

Open Space/ Conservation Management Actions

- Continue to pursue open space conservation, with a priority on areas that contribute to the protection and restoration of water quality and aquatic habitats, including wetlands and buffers, coastal marshes and salt marsh migration areas, groundwater reservoirs and recharge areas, and Conservation Opportunity Areas. Also focus on the connectivity of these areas.
- Continue to restrict development in Areas of Critical Concern identified in CRMC's Narrow River SAMP to low density residential use or acquire land as open space. Consider economic incentives for owners not to develop in these areas.
- Consider amendments to local development regulations to strengthen the use of cluster zoning and conservation zoning for the purposes of protection of water resources by conserving ample forested riparian buffers and maximizing the use of LID.

Groundwater/Drinking Water Protection

- Continue to acquire land and development rights, and to encourage land conservation in groundwater protection areas.

Monitoring and Evaluation Actions

- Continue monitoring to identify potential areas that can meet the water quality standard safe for shellfish consumption.
- Monitor bacteria in the Crooked Brook subwatershed in accordance with the Crooked Brook Bacteria TMDL.
- Monitor bacteria in Pettaquamscutt Cove in accordance with the Narrow River TMDL.

Public Education and Outreach Actions

- Promote actions that can be taken by homeowners or individuals to keep water clean.
- Promote support of watershed organizations.

Gaps in Information

- Re-evaluate bacteria loading concentrations to the Narrow River to determine the amount of progress made towards the TMDL required load reductions.

Plan Implementation

- Initiate regular meetings of all 3 community representatives and NRPA to discuss successes, coordinate plan implementation, and identify plan revisions.

Implementation

The Narrow River Preservation Association (NRPA) is a key partner to promote implementation of this watershed plan, as the state-designated watershed council for the Narrow River watershed. NRPA has taken the lead on monitoring water quality conditions in the watershed; and actively works, together with its partners, including the Narrow River Land Trust, to preserve, protect, and restore the natural environment. Implementation of this plan will involve many stakeholders, each with identified action items. Coordination and communication across the municipalities, the State, the NRPA, and other entities involved in protecting and restoring the water quality and aquatic habitats in the Narrow River Watershed is critical in order to achieve the goals of this plan.

Implementation takes a lot of effort. It involves everything from research and monitoring to spreading public awareness and taking the actions identified in this plan. It involves regulation and enforcement in conjunction with voluntary actions and celebrations. The forward movement to protect and improve the Narrow River watershed ultimately depends on the care and willingness of individuals to take action, and is magnified by individuals working together.

I. *Introduction*

A) Purpose of Plan

The Narrow River is the common name for the Pettaquamscutt Estuary. The Narrow River Watershed has long been recognized as a special place. The scenic beauty of the Narrow River, the ecological resources of the estuary and wetlands, the historical and cultural resources along the rivers, and the opportunities for water-based recreation, including fishing, shellfishing, and swimming in the watershed are important values to the local communities and to the State of Rhode Island. This watershed also supports a drinking water supply, a coastal National Wildlife Refuge, and is home to many residents and some local businesses.

Protecting these water resources is important for the quality of life for the surrounding communities and to the well-being of the State of Rhode Island. In some areas of the watershed, these water resources (both groundwater and surface water) are of excellent quality. However, in other areas, waterbodies are not meeting their designated water quality goals. For example, the Narrow River has a shellfishing ban due to high levels of bacteria.

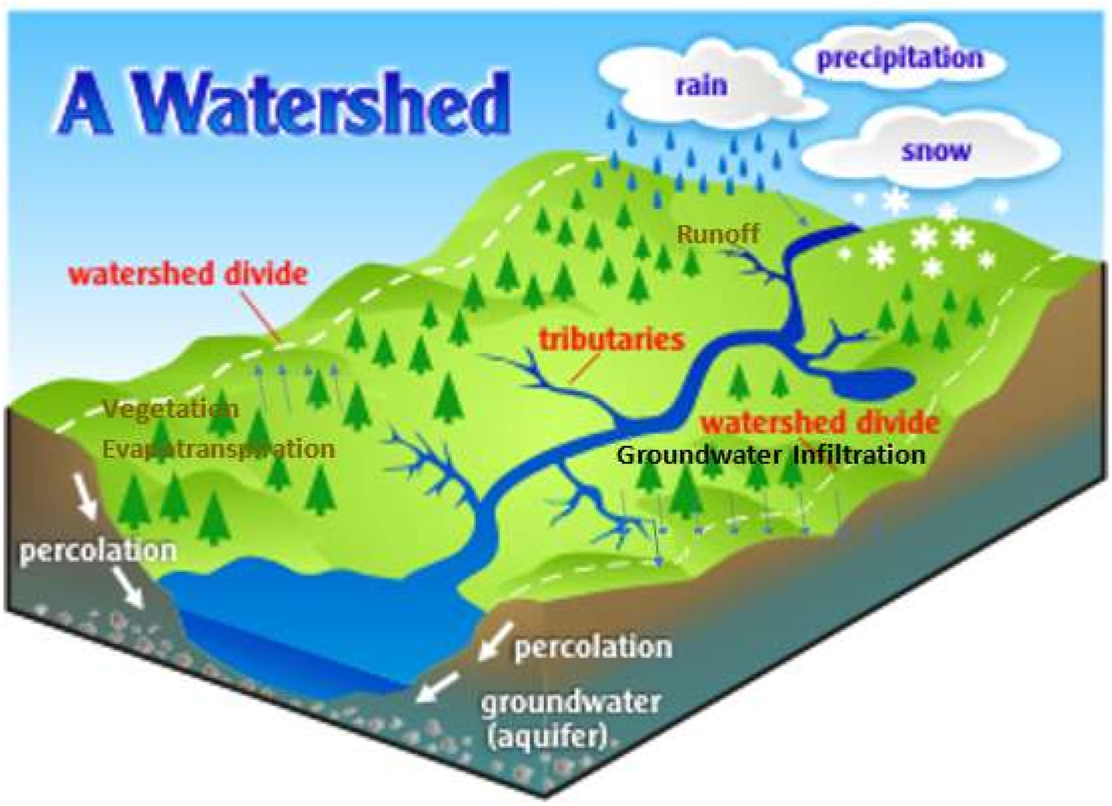
Kayaking on the Narrow River

The purpose of this watershed plan is to identify strategies and actions to protect, and where necessary, to restore the water resources and aquatic habitats in the Narrow River Watershed. A watershed plan takes a comprehensive approach by considering all aspects of the hydrologic system (See **Figure 1**). Known and potential sources of pollution and stressors to aquatic environments are identified and existing and needed efforts to address these problems in each community are evaluated. The key element of the plan is the determination and prioritization of protection and restoration actions while making the most efficient use of financial, administrative, and organizational resources.

Watershed – is the total area of land where all the water that is under it or drains off it goes to the same waterbody. Topography is the key element to establishing watershed boundaries. See **Map 1** for Narrow River Watershed boundary.

Watershed-Based Plan – is a strategy and a work plan for achieving water resource goals in a watershed. It includes a description of the existing water quality conditions, identifies and prioritizes problems, and outlines what needs to be done to restore and protect the water resources and aquatic habitats of the watershed.

Figure 1. Watershed and Hydrologic Cycle Diagram

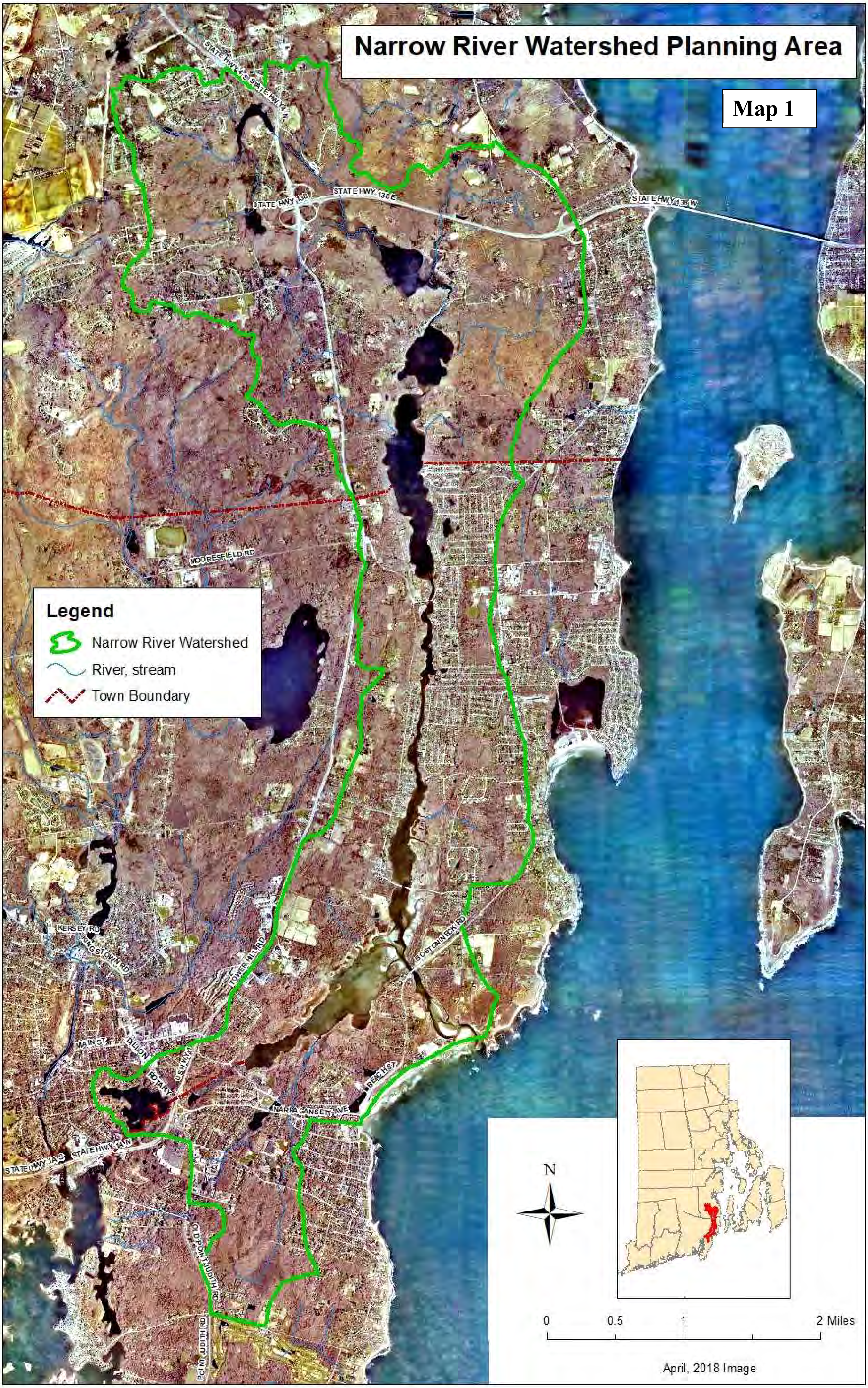


Source: modified from https://www.dep.pa.gov/Citizens/JustForKids/Water/Watershed/Pages/WhatIs.aspx

This plan was developed by the RIDEM Office of Water Resources Nonpoint Source Pollution Management Program staff to fulfill the requirement of the US Environmental Protection Agency (EPA) that a watershed plan meeting the criteria of the "Nonpoint Source Program and Grants Guidelines for States and Territories," issued on April 12, 2013, must be approved by the EPA in order for such grant funds to be applied to projects within the watershed. The Nonpoint Source Program is also referred to as the '319 Program' or the '319 Grant Program,' in reference to its section in the federal Clean Water Act (CWA). Not all projects proposed in this plan are eligible for 319 grant funds. The RIDEM 319 Program intended for watershed plans to address a broad, comprehensive approach to water quality management in the watershed, which is not limited to nonpoint sources of water pollution.

The Narrow River Watershed is fortunate to have been the focus of considerable study and funding to improve water quality and aquatic habitats. Previously developed regional management plans, most notably the *Narrow River Special Area Management (SAM) Plan* by the RI Coastal Resources Management Council (CRMC), have involved extensive research and stakeholder participation. Large areas of the watershed have been sewered to greatly reduce the impact from failed septic systems, and over $2,111,531 in state and federal grant funds have been invested for planning and installing stormwater best management practices (BMPs). This speaks to the magnitude of the problem, the sensitivity of the watershed, and the dedication towards improving the conditions. Of course, state regulatory agencies, particularly the RI CRMC and RIDEM also serve an instrumental role in protecting the watershed. However, the work is not complete, and a more concerted and proactive effort is needed to counteract the negative impacts development has had on the water quality and aquatic habitats of the watershed.

This watershed is also fortunate to have a number of very dedicated local groups committed to protecting and celebrating the land and water resources in the Narrow River Watershed. The most prominent organization is the state-designated watershed council for the watershed—the Narrow River Preservation Association—who has volunteered to help guide implementation of this plan. The Narrow River Land Trust is another prominent local organization dedicated to serving the entire watershed. In addition to volunteer organizations, the local governments also have a role. The Comprehensive Plans for the three communities in the Narrow River Watershed recognize the value of water resources and include goals and policies to protect and restore water quality. These existing efforts should take the recommendations from this watershed plan and implement them in order to accelerate success in restoring and protecting the Narrow River Watershed for current and future generations.


Narrow River Watershed Planning Area
Map 1
Legend
Narrow River Watershed
River, stream
Town Boundary
STATE HWY 138
STATE HWY 138 E
STATE HWY 138 W
MOORESFIELD RD
KERSEY RD
TOWER HILL RD
BOSTON NECK RD
MAIN ST
NARRAGANSETT AVE
STATE HWY 1A S
STATE HWY 1A N
OLD POINT JUDITH RD
N
0
0.5
1
2 Miles
April, 2018 Image

B) Water Quality and Aquatic Habitat Goals for the Watershed

This plan is structured in line with the state's overall water quality management framework as articulated in the *Rhode Island Nonpoint Source Management Program Plan* (DEM, 2019), which has prioritized the Narrow River Watershed for development of a watershed plan. The nonpoint source management priorities for this watershed are:

- restoration of water quality of the shellfish growing area waters;
- protection and restoration of water quality for public recreation; and
- protection and restoration of aquatic habitats, including estuarine habitat.

These priorities stem from the list of state priorities for water quality, as reflected in *State Guide Plan for Water Quality 2035*. The state list of priorities emphasizes protection of public health and are related to the use of surface and groundwater. The full list of state priorities are:

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

The above state and NPS program water quality priorities have been translated into the following more specific actionable goals for this watershed plan in response to the issues pertaining to the Narrow River watershed.

Goals:

1. Improve water quality of the Narrow River (including its tributaries) to meet the shellfishing criteria of the Water Quality Regulations, which is currently not met due to bacteria (pathogens) sources in the watershed. Strive to have this impairment delisted on the State's List of Impaired Waterbodies.

The entire Narrow River is closed to shellfishing because it exceeds the water quality standard for safe shellfish consumption for bacteria (fecal coliform). Improving the water quality in these waters could result in a consideration to re-open these shellfish beds, or to consider the idea of an estuarine sanctuary for shellfish. The primary goal is to improve the water quality, while the ultimate use under improved water quality circumstances would need much greater dialog, beyond the scope of this plan. The Rhode

Island Shellfish Initiative states, "Shellfish are central to our history and culture in Rhode Island. They support our environment, health, family traditions, and economy; and they are an important part of our future." Since the shellfish water quality standard is more stringent than the contact recreation standards, meeting this standard should be protective for other uses of the waterbody, and most likely the tributaries, as well. Currently, many of the tributaries are impaired for their designated uses of primary and secondary contact recreation and they contribute to the high bacteria levels causing the impairment to shellfishing in the Narrow River. Evidence shows that ongoing efforts have made improvements, however, the river still exceeds the bacterial levels for the shellfishing standard. The charge is to further reduce or eliminate bacteria sources in the watershed.

2. ***Protect and maintain good water quality of drinking water supplies of the Pettaquamscutt Aquifer.***

The Pettaquamscutt Aquifer in North Kingstown supplies high quality drinking water to portions of the Towns of North Kingstown and Narragansett. The Pettaquamscutt Aquifer has been designated by the US EPA as a Sole Source Aquifer, as part of the Hunt-Annaquatucket-Pettaquamscutt Aquifer. This means that it is the only viable source of drinking water for the area it serves. Drinking water is vital to the health of our citizens and in providing economic prosperity. Protecting the source of supply is far cheaper than treating the water to remove contaminants. As such, it is necessary that it continue to be well protected.

3. ***Improve water quality in the Narrow River (including its tributaries) for fish and wildlife habitat, which is currently threatened by excess nitrogen.***

Excess nitrogen in salt waters fuels algae growth. Nitrogen levels in the Narrow River estuary are high. Algae blooms can result in conditions that can harm fish and other aquatic life. The charge is to reduce excess nitrogen in the watershed.

4. ***Improve water quality of the Silver Spring Lake and the Silver Lake, which are currently impaired for fish and wildlife habitat due to excess phosphorus.***

Excess phosphorus in freshwater bodies can cause algae blooms which can lead to low oxygen conditions, posing a threat to fish and other aquatic life. (Additionally, some types of blue-green algae produce a toxin, which is harmful to humans and pets, which is of growing concern in Rhode Island.) Silver Spring Lake in North Kingstown and Silver Lake in South Kingstown are not meeting their water quality standards for fish and wildlife habitat due to excess phosphorus. The charge is to reduce excess phosphorus in the watersheds to these two lakes.

Image of an algal bloom, example from Turner Resrvoir in East Providence.

5. ***Reduce and control Aquatic Invasive Species (AIS) in the Silver Spring Lake and Carr Pond, which has impaired these waterbodies for fish and wildlife habitat, and interferes with their aesthetic enjoyment and recreational uses.***

Aquatic invasive species (AIS), also called 'non-native aquatic species,' out-compete native plants, disrupt the ecosystem, and create a nuisance for recreation. Once established, AIS are difficult and expensive to control. Management of AIS is needed to improve habitat and prevent the further spread of invasive plants. Prevention of AIS from spreading is an equally important goal. It is much easier to intervene and contain a small population than attempt to abate and control a widespread, well-established population of aquatic invasive species. Silver Spring Lake in North Kingstown and Carr Pond in North Kingstown both are impaired by invasive fanwort and variable milfoil and are not meeting their water quality standards for fish and wildlife habitat.

6. ***Protect and restore wetlands and their buffers throughout the watershed for water quality protection, fish and wildlife habitat, and as a resiliency strategy for flooding, sea level rise, and climate change impacts.***

Freshwater wetlands and coastal salt marshes, along with the adjacent upland buffers, provide significant and economically valuable contributions to clean water, flood and storm surge protection, recreation, scenic beauty, and wildlife habitat. They provide critical habitat for many of Rhode Island's rare and threatened wildlife species; and are among the most productive natural systems regionally and worldwide. In the coastal zone, high productivity supports the food chains that subsequently support the fish and shellfish industries. Further, the protection wetlands provide through flood and storm surge mitigation and carbon sequestration is an important component in a climate change resiliency strategy.

7. ***Restore stream connectivity, where possible, to improve fish and wildlife habitat in the watershed.***

Human made structures, including dams and road crossings (bridges and culverts), can obstruct the full functioning of river, stream, and wetland ecosystems. Barriers to stream connectivity prevent the free movement of aquatic life up and down a river system, resulting in a fragmented aquatic habitat, particularly for migratory River herring and American eel. These barriers can also increase the potential for flooding. The culverts where roads cross the streams at Route 1 and Route 138 could be considered for habitat upgrades.

8. ***Protect swimming and fishing recreational opportunities.***

There are many popular recreational activities that occur in the Narrow River Watershed. The condition of the water quality or the aquatic habitat can negatively affect the recreational experience or the number of opportunities that are safely available for the public to enjoy. For example, aquatic invasive plants can smother native habitats and overtake a pond, negatively affecting fishing, boating, and swimming enjoyment, and aesthetic values. Therefore, taking actions to improve water quality and aquatic habitats can also improve recreational value.

(a) Swimming

There is one beach in the Narrow River Watershed—at Camp Grosvenor (which is privately owned and used as a summer camp for children). This beach was closed to swimming 5 days during the 2018 swim season due to high levels of bacteria. Additionally, there are some private beaches (such as Mettatuxet Beach) and homes on the river where swimming does occur, which are not tested by the State. Water quality sampling data has been collected and supplied by volunteers organized through the Narrow River Preservation Association's Riverwatch program for over 30 years to the URI Watershed Watch program for analysis. This program is a volunteer water quality monitoring network administered at URI. The data shows that while average bacteria levels in the Narrow River are below the safe swimming standard, the bacteria levels sometimes exceed the safe swimming standard following major rain events.

(b) Fishing

Popular recreational fishing areas in the Narrow River watershed include the Narrow River, Silver Spring Lake in North Kingstown, and Little Neck Pond/Lake Canonchet in Narragansett. Striped bass fishing is enjoyed in the Narrow River in the spring when the bass chase the herring during their annual spawning run upstream to Carr Pond, in the fall when the baitfish return to the sea, and in the winter. Many of the strategies in this plan for protecting and restoring water quality and habitat will benefit fishing opportunities.

Fishing at Sedge Island by the Narrows and Pettaquamscutt Cove

C) Approach for Developing the Plan/ How this Plan was Developed

As stated before, the Narrow River has been the focus of considerable study, monitoring, and reports. Development of this watershed plan relied heavily on such existing information. No new research or water quality monitoring has been conducted to inform this plan.

This plan compiles relevant existing information in one place to provide a comprehensive overview of the conditions in the watershed, actions taken, and the issues facing the watershed.

State and local plans were reviewed for current and planned activities pertaining to the protection and restoration of water quality and aquatic habitats in the watershed. Key action items from local Comprehensive Plans, Stormwater Management Plans and programs, On-site Wastewater Management Plans, and other relevant plans have been incorporated into this watershed plan.

Noteworthy watershed-wide plans containing a wealth of relevant background information on the geology, hydrology, and history of development in the watershed, along with sources of pollution and thoughtful recommendations for land use policy and actions to improve water quality and prevent further degradation are the 1979 "A Plan for the Narrow River Watershed: Tri-Town Narrow River Plan," prepared by River Landscapes for the Tri-Town Narrow River Planning Committee, and the 1999 "Narrow River Special Area Management Plan," by the RI CRMC. These plans may be slightly out of date, however they exemplify the history of concern and dedication to this watershed, and many of the key concepts are just as relevant today. A complete list of existing documents referenced for this watershed plan are included in the Bibliography. Sources of water quality data used in this plan are included with the relevant section.

Stakeholders were also involved in the development of this plan, providing input on current concerns, activities, and data; reviewing goals; and the identification and prioritization of implementation activities (See **Appendix 1**.).

Narrow River Watershed Plan stakeholder meeting

Goals for the plan were prioritized based on interest in particular water resource concerns and needs in the watershed and stakeholder input at the workshops. Implementation action items were prioritized based on the goal priorities, professional judgement of the direct applicability of the action to address the concern, relative ease of implementing the measure, and stakeholder input during meetings and workshop exercises.

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II. *Watershed Description*

Quick Facts about the Narrow River Watershed:

- **Watershed Area:** 8,650 acres (13.5 sq. miles, or approx. 35 square kilometers)
  Towns:
  - North Kingstown: 4,188 acres (48.4%) (~17 sq km)
  - Narragansett: 2,841 acres (32.8%) (~11.5 sq km)
  - South Kingstown: 1,621 acres (18.7%) (~6.6 sq km)
- **Major Waterbodies:** Narrow River Estuary, Mattatuxet River, Crooked Brook, Mumford Brook, Silver Spring Lake, Carr Pond, Silver Lake

A) Hydrology Overview

For purposes of this plan, the RIDEM has defined the planning area for the Narrow River Watershed as that area delineated and depicted on Map 1. This planning area is referred to as the 'watershed' for this plan, however, there are other topographically or hydrologically defined delineations for the Narrow River Watershed which differ. Most notably, for example, the Silver Lake in South Kingstown has been included in the watershed for planning purposes in this plan, whereas it is not included in other delineations for the watershed of the Narrow River itself.

1) *Surface Water*

The watershed of the Narrow River is approximately 8,650 acres (or about 14 square miles, or 35 square kilometers) draining from portions of the Towns of North Kingstown, South Kingstown, and Narragansett out into the western side of the mouth of the Narragansett Bay (see **Map 2**). The watershed has freshwater streams that flow into a tidally influenced saltwater estuary. The Narrow River, or Pettaquamscutt Estuary, is the estuarine portion of the watershed.

The Narrow River is approximately 5.9 miles long (approximately 10 kilometers) and starts at the north end of Upper Pond in the Town of North Kingstown, where it flows south and then forms the boundary between the Towns of South Kingstown and Narragansett. Southwesterly of the river's outlet/tidal inlet to Rhode Island's coastal waters (at the mouth of Narragansett Bay) is the Pettaquamscutt Cove section of the river. Three perennial and seven intermittent streams discharge into Narrow River. The principal tributaries are Gilbert Stuart Stream, which discharges into Upper Pond at the northern extremity of the river, and Mumford and Crooked brooks that discharge to Pettaquamscutt Cove, near the southern extremity. Gilbert Stuart Stream contributes about 34% of the total freshwater flow to the watershed. Crooked Brook and Mumford Brook represent about 19% of the total freshwater flow. Upstream of the Gilbert Stuart Stream, and all within the Town of North Kingstown, are Carr Pond, Mattatuxet River, Shady Lea Pond, and Silver Spring Lake. There are also unnamed streams and tributaries flowing to these waterbodies, and an unnamed pond off Pendar Road.


Gilbert Stuart Museum and mill spillway

Narrow River Watershed Planning Area
Surface Water Resources
Map 2
Legend
Narrow River Watershed
Lake, Pond
River, stream
Wetlands
Town Boundary
Major Road
Local Road
NORTH KINGSTOWN
SOUTH KINGSTOWN
NARRAGANSETT
JAMESTOWN
Pettaquamscutt River
West Passage
Mackerel Cove
East Passage
Wesquage Pond
Indian Lake
Carr Pond (N. Kingstown)
Silver Spring Lake
Silver Lake
Sprague Pond
Point Judith Pond
Champlin Cove
Coastal Waters
Crooked Brook
Deadman Brook
Indian Run Brook
Indian Run Reservoir
Mumford Brook
Saugatucket Pond
Mattatuxet River
STATE HWY 138 W
STATE HWY 138 E
STATE HWY 1A S
TOWER HILL RD
BOSTON NECK RD
POINT JUDITH RD
0 0.5 1 2 Miles
N

In the southern portion, the watershed encompasses Silver Lake, Sprague Pond, and Lake Canonchet/Little Neck Pond. Silver Lake has no surface water inlet or outlet, though it is hydrologically connected with the Narrow River watershed via groundwater. It is sometimes included in the Saugatucket watershed.

The Lower and Upper Ponds are kettle hole ponds in the body of the river, at 60 and 40 feet deep, and approximately 1,500 feet and 1,800 feet at their widest, respectively. They are both stratified in temperature and salinity with permanently anoxic bottom layers, and separated from each other and the downstream river by shallow sills less than one meter deep. Occasionally they overturn, bringing nutrients and hydrogen sulfide gas to the surface. The last time this was documented was in 2007, and partial overturns have occurred in 2010, 2012, and two partial overturns in 2020.

The period of lowest flow of surface waters typically occurs in late summer to early fall, which coincides with the period of lowest groundwater table. Flows gradually increase through the fall and winter months to peak during the early spring wet season. Many of the smaller tributaries, such as Mettatuxet, Walmsley, and Crew brooks and Girl Scout and Seven Farms streams stop flowing or run completely dry during the warmest summer months. (These small tributaries are not labeled on **Map 2**, but are discussed in the Narrow River Bacteria TMDL.)

The watershed is narrow and oriented in a north and south direction. It is underlain by a steep walled bedrock valley, which is overlain by a shallow layer of glacial unstratified deposits. The steep shape of the valley is prominent today. The flatter areas and river bottom have more stratified deposits. Tidal deltas form the sediment deposits within and around the 'Narrows' inlet.

The shape and geology of the watershed influences the susceptibility of this river to pollutant accumulation. The amount of pollution entering the system has been too much for the natural flushing of the system given the tidal inflow and the amount of freshwater inflow from the tributaries and groundwater. The capacity of the natural system is overburdened by the impact of the development and associated activities in the watershed.

2) *Groundwater*

Groundwater and surface water in the watershed are closely interconnected. Groundwater is recharged by precipitation that filters down through the soils and then moves underground to lower places in the landscape. At some point the groundwater will discharge to a river, stream, pond, or wetland. Any pollutants in the groundwater are thus delivered to the surface water. During periods of drought, it is the groundwater that makes up the flow in the streams. Overall, 65% of the total freshwater flowing into the Narrow River ecosystem is from groundwater.

Most of the groundwater in the Narrow River watershed is classified as GA, and the portion of the watershed which contains the Pettaquamscutt aquifer and its associated recharge area in the

Narrow River Watershed Planning Area
Groundwater Resources
Map 3
Legend
Narrow River Watershed
Groundwater Recharge Area
Groundwater Reservoir
Lake, Pond
River
Town Boundary
Major Road
Local Road
NORTH KINGSTOWN
NARRAGANSETT
SOUTH KINGSTOWN
JAMESTOWN
Pettaquamscutt River
West Passage
East Passage
Mackerel Cove
Wesquage Pond
Coastal Waters
Point Judith Pond
Champlin Cove
Carr Pond (N. Kingstown)
Silver Spring Lake
Indian Run Brook
Indian Run Reservoir
Saugatucket Pond
Saugatucket River
Crooked Brook
Sprague Pond
Lake Conochet
STATE HWY 138 E
STATE HWY 138W
MOORESFIELD RD
TOWER HILL RD
MAIN ST
KERSEY RD
OLD POINT JUDITH RD
POINT JUDITH RD
N
0
0.5
1
2 Miles

Town of North Kingstown is classified as GAA (see **Map 3**). According to the DEM Groundwater Class Summary, groundwater classified GA or GAA are groundwater resources that are known or presumed to be suitable for drinking water use without treatment. The difference between the GA classification and the GAA classification is that GAA is used for aquifers (and their recharge areas) that are potentially capable of serving as a significant source for public water, or are the wellhead protection areas for a public community well.

B) Land Use

The type of land use in a watershed has a direct effect on water quality. In an undeveloped watershed natural processes occur, such as soil infiltration and plant uptake of water and nutrients, providing reduced runoff and groundwater recharge. As watersheds become more developed with commercial, residential, and industrial land uses, the amount of stormwater runoff increases due to increasing areas of impervious surfaces, such as rooftops, roads and parking lots. This stormwater carries pollutants such as bacteria, nutrients, metals, oils, sediment and chemicals that negatively affect nearby waterbodies. Agricultural land use activities, such as fertilizer and pesticide application and manure from livestock, can also increase pollutants in nearby waterbodies. The denser the development, or the more intensive the land use, the more opportunity for pollution to be generated and to enter our waterbodies and wetlands, unless these pollutant sources are properly managed.

The Narrow River watershed is approximately 8,650 acres, composed mostly (66%) of forest, wetlands, and open water bodies. (see **Map 4**, Land Use and Land Cover) The developed portions (34 %) within the watershed are predominantly residential (24.1%), with some agricultural (4.5%), commercial and industrial (3.7 % non-residential developed), and open developed land uses (1.8% open, such as ball fields and parks). (See Pie Chart, **Figure 2**. and **Table 1** for acreage.)

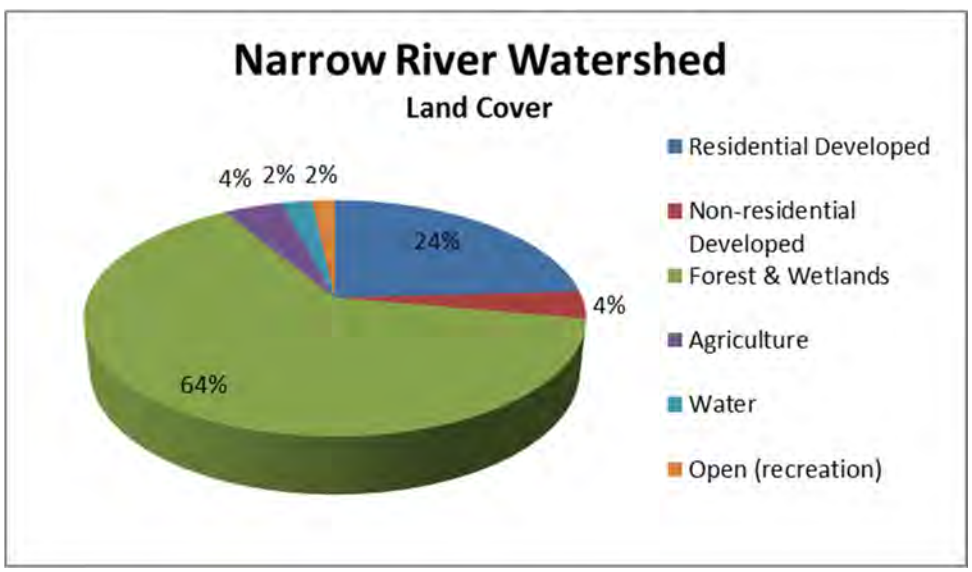
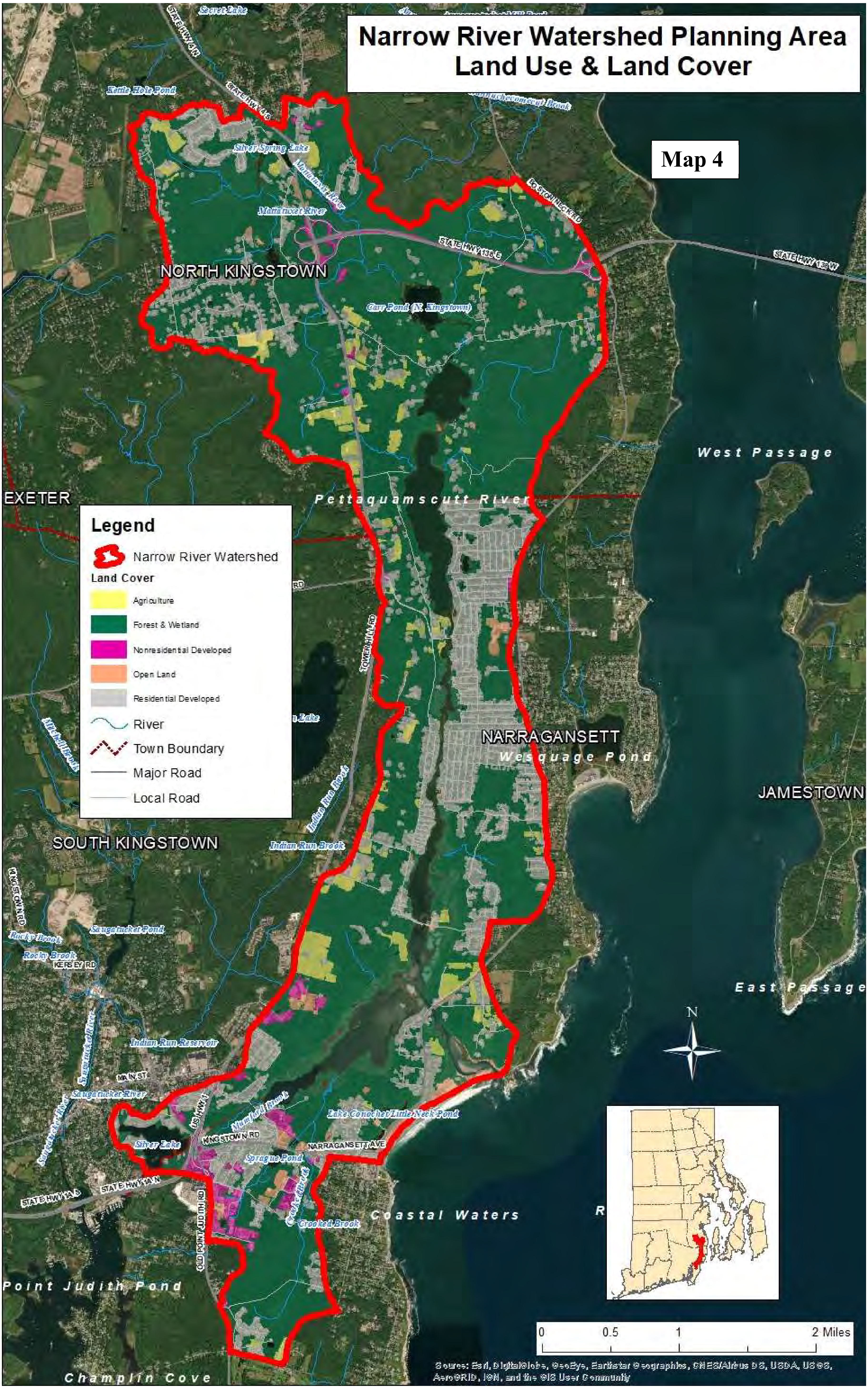


Figure 2.


Narrow River Watershed Planning Area
Land Use & Land Cover
Map 4
Legend
Narrow River Watershed
Land Cover
Agriculture
Forest & Wetland
Nonresidential Developed
Open Land
Residential Developed
River
Town Boundary
Major Road
Local Road
NORTH KINGSTOWN
EXETER
SOUTH KINGSTOWN
NARRAGANSETT
JAMESTOWN
West Passage
East Passage
Pettaquamscutt River
Wesquage Pond
Coastal Waters
Point Judith Pond
Champlin Cove
Carr Pond (N. Kingstown)
Silver Spring Lake
Kettle Hole Pond
Mattatuxet River
Indian Run Brook
Indian Run Reservoir
Saugatucket Pond
Saugatucket River
Silver Lake
Sprague Pond
Crooked Brook
Lake Conochet/Little Neck Pond
Mumford Brook
Rocky Brook
STATE HWY 138 E
STATE HWY 138 W
STATE HWY 1A S
STATE HWY 1A N
TOWER HILL RD
BOSTON NECK RD
KINGSTOWN RD
NARRAGANSETT AVE
KERSEY RD
MAIN ST
N
0
0.5
1
2 Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Developed areas are often characterized by relatively high levels of impervious cover—areas such as roofs, roads, and parking lots that prevent water from infiltrating into the soil. In the Narrow River watershed, impervious surfaces cover 11.8% (1,018 acres) of the total land area (see **Map 5**, Impervious Surface, which includes a Table of impervious surface by town.). Impervious cover percentage is a useful indicator for assessing overall watershed quality. As the amount of hard surfaces in a watershed increases, water pollution increases. Studies indicate that watersheds with an impervious cover under 10% generally have streams that experience little to no significant impact from development, whereas watersheds with impervious cover over 10% start to have greater and greater negative impacts to streams.

Table 1. Land Use and Cover Acreage and Percent

Land Use / Land Cover	Area (acres)	Percent of Watershed
Residential Developed	2,086	24.1%
Non-residential Developed	322	3.7%
Agriculture	393	4.5%
Open Developed (i.e., recreation)	152	1.8%
Water	198.7	2.3%
Forest & Wetlands	5,498	63.6%
Total Watershed	**8,649.7**	**100%**
Impervious Cover	1,018	11.8%

However, impacts from impervious cover can be very local, depending on where the impervious surfaces are. Narrow River watershed is not uniformly built up, therefore the impacts from impervious cover will differ depending on where it is in the watershed. For example, the upper parts of the watershed in North Kingstown have a much lower impervious cover percent than the area around Mettatuxet Brook in Narragansett, and the resulting water quality reflects this. **Table 2** (on **Map 5**) shows the amounts of impervious surface in the watershed by town.

Table 2.	Impervious Surface Area (Acres)	% of Watershed Planning Area
Narragansett	557.8	6.4%
North Kingstown	287.1	3.3%
South Kingstown	173.2	2.0%
Grand Total	1018.1	11.8%

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Most of the high density, residential development in the watershed is located along the central section of the Narrow River within the towns of Narragansett and South Kingstown (see **Map 4**). In this area, residential lots varying from 1/8 to 1/2-acre directly abut the river, and there is little to no buffer protecting the river where these neighborhoods exist. Most of the forested portion of the watershed lies to its north in the Town of North Kingstown, though there are also some large portions of undeveloped land within the towns of South Kingstown and Narragansett, and some protected areas abutting the river. The commercial and industrial lands are located in areas of good access to major roads, mostly on the outer edge of the watershed. The agricultural lands are located mostly along Route 1 in South Kingstown and North Kingstown, along the western side of the watershed.

Map 4, Land Use/ Land Cover, shows the location of developed areas and agricultural lands in the watershed. Note the relation of developed land types and agricultural land to the proximity of waterbodies in the watershed.

Additionally, the Coastal Resources Management Council has classified the land use in the watershed in terms that describe the environmental impact associated with the existing development patterns. These classifications, as described in the Narrow River Special Area Management Plan, are currently used for management purposes and local land use regulations. These areas are mapped (**Figure 3**) for each town and described as follows:

> "<u>Lands Developed Beyond Carrying Capacity</u> are developed at densities of one residential or commercial unit on parcels of less than 80,000 square feet, and frequently at higher densities of 10,000 square feet or 20,000 square feet. Intense development associated with Lands Developed Beyond Carrying Capacity is the result of poor land use planning and predates the formation of the Council. High nutrient loadings and contaminated runoff waters from dense development have resulted in a high incidence of polluted wells and increased evidence of eutrophic conditions and bacterial contamination in the Narrow River. Most of the OWTS in these areas predate RIDEM regulations pertaining to design and siting standards, and have exceeded their expected life span.
>
> "<u>Lands of Critical Concern</u> are presently undeveloped or developed at densities of one residential unit per 120,000 square feet. These lands may be adjacent to or include one or more of the following: sensitive areas of the Narrow River that are particularly susceptible to eutrophication and bacterial contamination; overlie wellhead protection zones or aquifer recharge areas for existing or potential water supply wells; areas designated as historical/archaeological sites; open space; areas where there is high erosion and runoff potential; habitat for flora and fauna as identified through the Natural Heritage Program, large emergent wetland complexes, and U.S. Fish & Wildlife lands; and fisheries habitat.
>
> "<u>Self-Sustaining Lands</u> are undeveloped or developed at a density of not more than one residential unit per 80,000 square feet. Within these areas, the nutrients discharged to groundwater by septic systems, fertilizers and other sources associated with residential activities may be sufficiently diluted to maintain on-site potable groundwater. However, the one residential unit per two acre standard is not considered sufficient to reduce groundwater nitrogen concentrations to levels which will prevent eutrophication, or mitigate for dense development in other portions of the watershed."

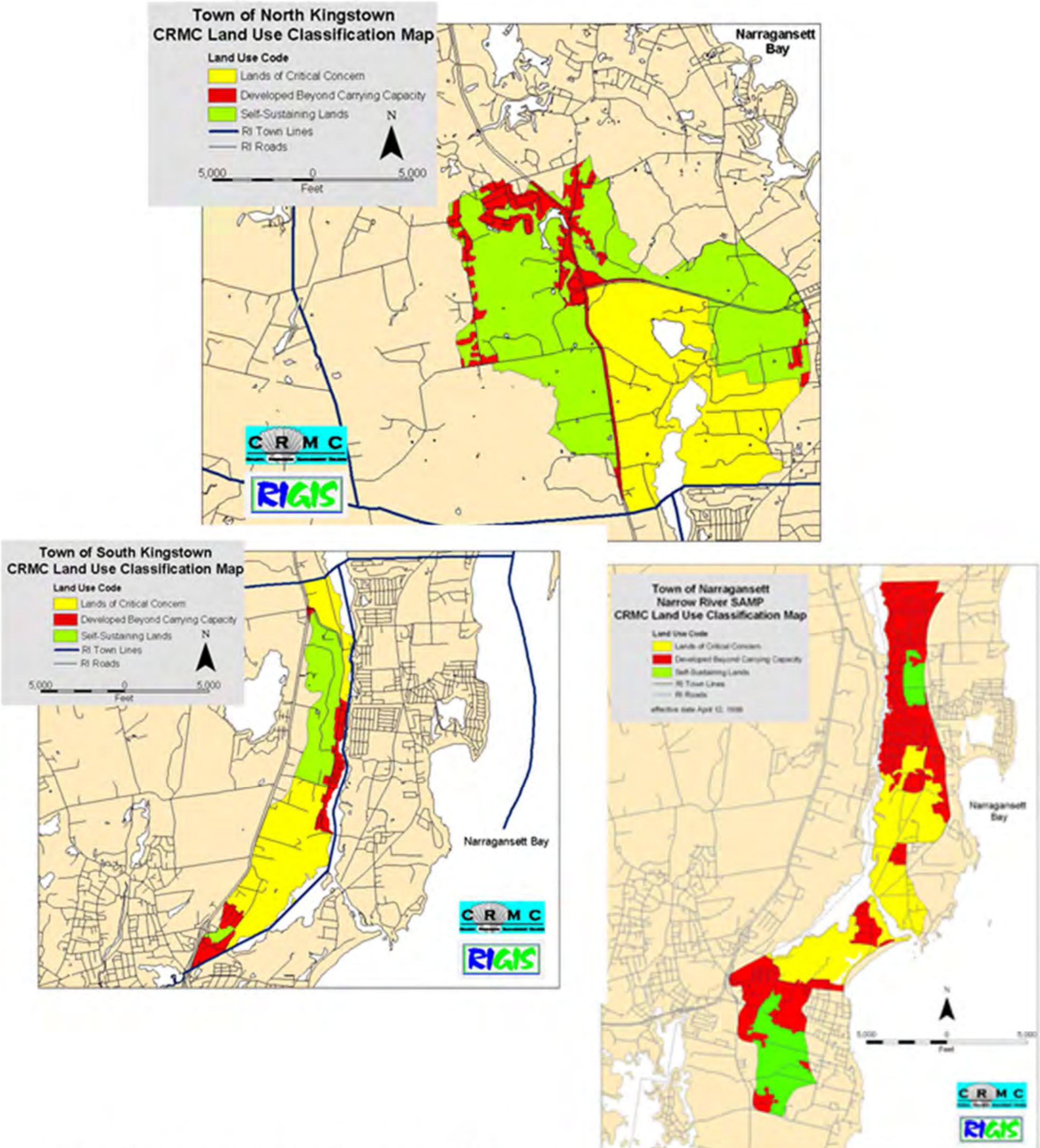


Figure 3. CRMC Land Use Classification Maps for North Kingstown, South Kingstown, and Narragansett

According to these maps, approximately 22% of the watershed has been "Developed Beyond Carrying Capacity." In order to reverse the impact that this development has caused, more concerted efforts to prioritize stormwater treatment retrofitting, buffer restoration, more intensive wastewater management, and public education to target source reduction is needed. Not only is there a need to reverse the impact on water quality that this overdevelopment has caused, but there is also a need to prevent further degradation with new development to this sensitive system. The "Lands of Critical Concern" make up approximately 40% of the watershed. Here, the priorities are on meeting the SAMP regulations, ensuring greater protection from stormwater and erosion than the State minimums, ensuring minimal impact from wastewater, providing public education on residential source reduction strategies (ie, fertilizer use, pet waste, impervious surfaces, etc.) as discussed later in this plan, and taking advantage of open space conservation opportunities.

Future development has the potential to further impact water quality and aquatic habitat by generating more impervious cover and pollutants from added land uses. To calculate a rough estimate of the remaining developable land in the watershed, we must factor the land that is already developed, land that has further development potential (forest and agriculture), land that has physical constraints to development (wetlands, open water), and land that is protected from future development (legally protected conservation land). There are roughly over 1,000 acres of potentially developable land remaining in the watershed, and most of this land is zoned for residential land uses. See **Table 3** for factors used in this estimate calculation.

Table 3: Remaining Developable Land Estimate

Land Use	Area (acres)	Percent of Watershed
Total Watershed	**8,650**	**100%**
Residential Developed	2,086	24%
Non-residential Developed	322	4%
Open Developed (i.e., recreation parks)	152	2%
Total Developed	2,560	30%
Water	199	2%
Wetlands	1,877	22%
Protected Conservation	2,887	33%
Total Constraints	4,963	57%
Remaining Developable Land	1,127	13%

<u>Recommended Actions:</u>
Local development regulations determine how this remaining land will be developed. It is critical to prioritize adopting and implementing as many Low Impact Development site planning and design techniques as possible, and to adopt Conservation Development Design zoning for the purpose of protecting water resources. It is also important to prioritize requiring nature-based stormwater management solutions.

C) Drinking Water

Residents and businesses in the watershed are supplied with high quality drinking water from groundwater sources both within and outside of the watershed. The majority of the public water supplied in the watershed comes from wells outside the watershed. Likewise, groundwater from within the watershed serves areas outside of the watershed. The area supplied by a public water system in the Narrow River watershed is shown on **Map 6**.

Public Water Supplies within Narrow River Watershed

There are 6 public drinking water well sources in the watershed, all within the Town of North Kingstown. "Public" water suppliers are those systems that are monitored by the RI Department of Health to ensure they provide safe drinking water, and which have at least 15 service connections or regularly serve an average of at least 25 individuals daily at least sixty days out of a year. Protecting these sources of supply is far cheaper than treating the water to remove contaminants.

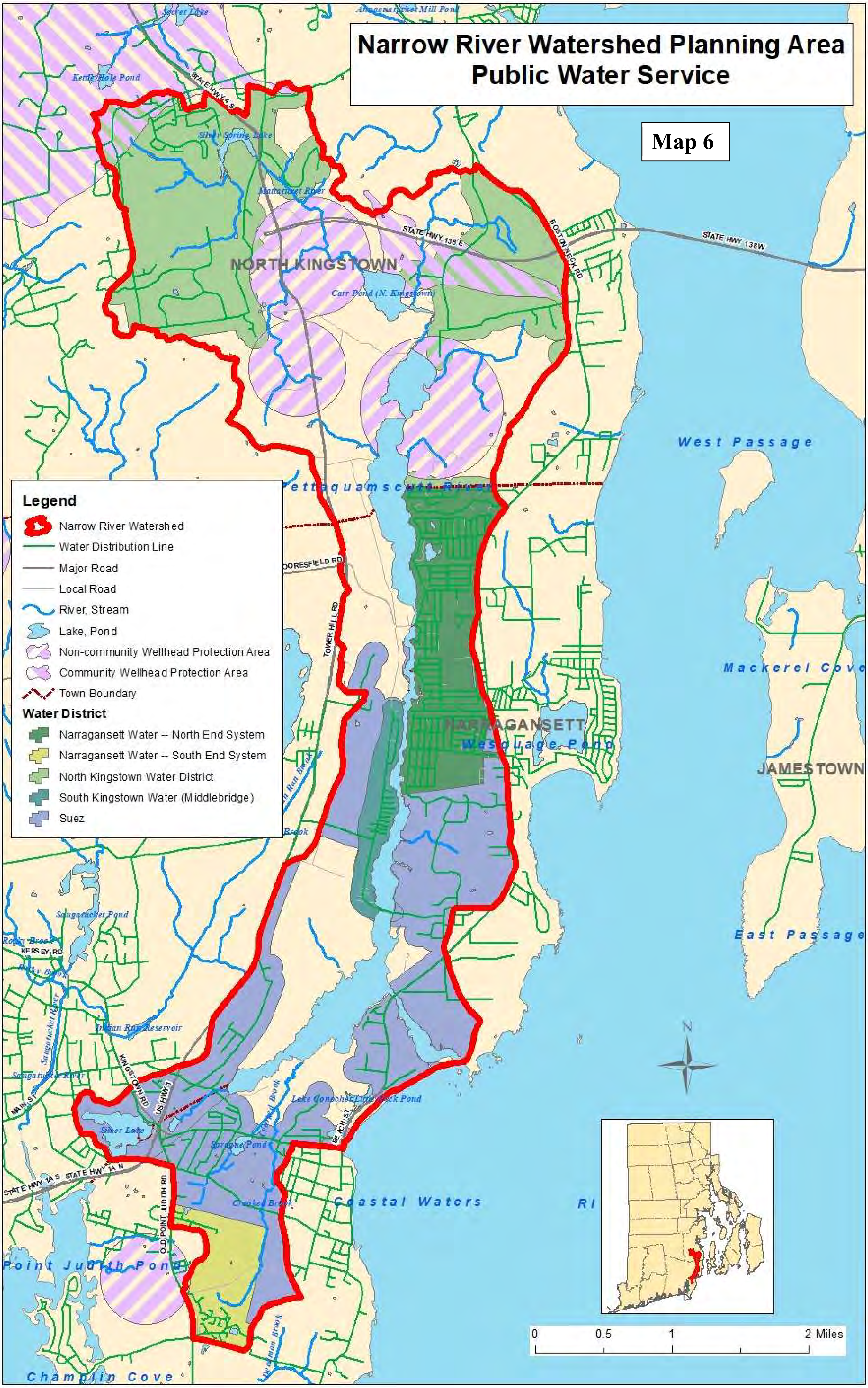
A portion of the Narrow River Watershed—the Pettaquamscutt Aquifer—supplies public drinking water to portions of the Towns of North Kingstown (Saunderstown area) and Narragansett that are both within and outside the Narrow River watershed. The Pettaquamscutt Aquifer is located in the Town of North Kingstown and has been designated by the US EPA as part of the Hunt-Annaquatucket-Pettaquamscutt Sole Source Aquifer. This means that it is the only viable source of drinking water for the area. This supply is owned and managed by the North Kingstown Water Department.

The Town of North Kingstown's water system has 3 public wells in the watershed on the northeast shore of Carr Pond. These are termed "community" public wells because they provide water to year-round residents.

[It is in the Town of Narragansett's interest to support water supply protection efforts in the Town of North Kingstown; however, water supply to the residents and businesses in the watershed is also provided from sources outside the watershed, which are not discussed in this plan. Coordination on drinking water supply protection and planning transcends the watershed. The task of coordinating planning is covered as a required element of the local comprehensive plans, which is likewise acknowledged in the required Water Supply System Management Plans for the individual suppliers.]

There are also 3 privately owned businesses in North Kingstown with wells that provide water to the public. These are referred to as "non-community" public wells. The distinction between a community and non-community well determines the types and frequency of well testing required by the Department of Health.

The wellhead protection areas for these 6 public wells are shown on **Map 6**. These well-head protection areas are defined by RIDEM as areas that contribute groundwater to these wells.



Narrow River Watershed Planning Area
Public Water Service
Map 6
Legend
Narrow River Watershed
Water Distribution Line
Major Road
Local Road
River, Stream
Lake, Pond
Non-community Wellhead Protection Area
Community Wellhead Protection Area
Town Boundary
Water District
Narragansett Water -- North End System
Narragansett Water -- South End System
North Kingstown Water District
South Kingstown Water (Middlebridge)
Suez
NORTH KINGSTOWN
NARRAGANSETT
JAMESTOWN
West Passage
Mackerel Cove
East Passage
Pettaquamscutt River
Wesquage Pond
Coastal Waters
Point Judith Pond
Champlin Cove
Silver Spring Lake
Carr Pond (N. Kingstown)
Kettle Hole Pond
Saugatucket Pond
Indian Run Reservoir
Silver Lake
Lake Canonchet/Little Neck Pond
Crooked Brook
STATE HWY 138 E
STATE HWY 138W
STATE HWY 4 S
BOSTON NECK RD
TOWER HILL RD
MOORESFIELD RD
KINGSTOWN RD
US HWY 1
STATE HWY 1A S
STATE HWY 1A N
OLD POINT JUDITH RD
BEACH ST
KERSEY RD
MAIN ST
N
0
0.5
1
2 Miles

Private Wells
Homeowners that are not connected to a public water system depend on an on-site drinking water well for their own water supply, which is primarily the North Kingstown portion of the watershed and the northeast corner of South Kingstown. Homeowners are responsible for testing their own water supply and taking actions to protect it on their property from septic systems, lawn care, and other homeowner activities that may involve potential pollutants.

D) Wastewater

Public sewer services portions of Narragansett and South Kingstown within the watershed. It is provided through the Town of South Kingstown Wastewater Division's regional wastewater treatment facility located on Westmoreland Street in Narragansett. The sewer system is not a combined system with stormwater. The discharge from this system is outside of the watershed, to a point east of South Pier Road in the Narragansett Bay. See **Map 7** for areas in the watershed that have public sewer.

Most of the developed properties in the watershed within the Town of Narragansett are now sewered, although there may be some properties within the sewered area that have not connected to the public system. Some densely developed neighborhoods immediately adjacent to the Narrow River within the Town of South Kingstown are also sewered, though not all of the properties in the Middlebridge area between Lafayette (west) Ave and Riverside Drive (verify) are connected to the public system. Some areas south of Pettaquamscutt Cove in South Kingstown and Narragansett are also sewered.

The rest of the watershed, including the entire portion within the Town of North Kingstown, and the less densely developed areas of South Kingstown, relies exclusively on private individual on-site wastewater treatment systems (OWTS).

29% (2,467 acres) of the total watershed area is served by a municipal public sewer system:
- 73% of the watershed area in Narragansett (2068 acres)
- 0 % of the watershed area in North Kingstown
- 23% of the watershed area in South Kingstown (371 acres)

Narrow River Watershed Planning Area
Public Sewer Service
Map 7
Legend
Narrow River Watershed
Public Sewer Service Area
River, Stream
Town Boundary
Major Road
Local Road
NORTH KINGSTOWN
SOUTH KINGSTOWN
NARRAGANSETT
JAMESTOWN
Secret Lake
Kettle Hole Pond
Silver Spring Lake
Mattatuxet River
Carr Pond (N. Kingstown)
Pettaquamscutt River
West Passage
Mackerel Cove
East Passage
Wesquage Pond
Indian Run Brook
Saugatucket Pond
Indian Run Reservoir
Saugatucket River
Silver Lake
Sprague Pond
Crooked Brook
Lake Conochet/Little Neck Pond
Coastal Waters
Point Judith Pond
Champlin Cove
STATE HWY 4 N
STATE HWY 4 S
STATE HWY 138 E
STATE HWY 138W
BOSTON NECK RD
MOORESFIELD RD
TOWER HILL RD
KINGSTOWN RD
US HWY 1
MAIN ST
NARRAGANSETT AVE
STATE HWY 1A S
STATE HWY 1A N
OLD POINT JUDITH RD
0
0.5
1
2 Miles
N

[This page intentionally left blank]

E) Wetlands

In the Narrow River watershed, there are both freshwater and saltwater wetlands. Wetlands provide key links in the water cycle between surface water and groundwater. Freshwater wetlands exist in areas where the groundwater table is close to the surface and often in proximity with other surface waters, while coastal wetlands interact with estuarine and marine waters in the intertidal zone. Vegetated wetlands support both aquatic and terrestrial species many of which have specially adapted to the conditions present in wetlands. See **Map 2** for the location and extent of wetlands in the watershed.

Wetlands perform specific functions and processes, which can be broken up by broader categories of 'hydrologic,' 'water quality,' and 'wildlife habitat' functions. We also put values on the services, goods, and qualities that wetlands provide us through those functions. We now recognize that these 'ecoservices' provide significant value to society, however in the past, when the role of wetlands was not understood, wetlands were considered a nuisance and so were filled in, ditched and drained, or otherwise destroyed. Wetlands are also being recognized for the role they play in mitigating climate change by sequestering carbon out of the atmosphere where it contributes to global warming.

<u>Water quality functions and values</u>:

- Wetland plants and soils can store, filter, and naturally treat nutrients and other stormwater pollutants that may otherwise reach rivers, streams, and lakes.
- Coastal wetlands filter and trap pollutants, nutrients, and sediments from freshwater overland flows.

<u>Wildlife habitat functions and values</u>:

- Wetlands are important habitats for aquatic, terrestrial, and avian species, and particularly important for endangered, threatened, and migratory species.
- Wetlands are a critical habitat for many of Rhode Island's rare and threatened wildlife species.
- Freshwater wetlands and salt marshes are among the most productive natural systems regionally and worldwide, producing more plant and animal biomass than upland forests and grasslands.

<u>Hydrologic functions and values</u>:

- Wetlands store water during rainy periods and slowly release it, thereby helping to control flooding and also keeping streams flowing when they might otherwise be dry.
- Coastal and freshwater wetlands stabilize shores to provide erosion protection from the forces of overland flow, wave action, tidal action, and storm surge.

<u>Other wetland values</u>:

Wetlands provide us with:

- protection from climate change through carbon sequestration.
- educational, scenic, and historic resources.
- recreational resources such as hunting, fishing, and bird watching.

Wetlands in the Narrow River Watershed

Because of its wetland resources, the Narrow River has been designated by the RIDEM (in the State's Water Quality Regulations) as a 'Special Resource Protection Waters' due to its 'unique freshwater wetlands,' 'ecological habitat,' 'conservation areas,' and 'critical habitat for rare and endangered species.'

There are approximately 1,910 acres of wetlands (freshwater and coastal, not including freshwater ponds) in the Narrow River watershed. This represents 22% of the land area in the watershed.

The freshwater wetlands in the Narrow River watershed consist predominantly of deciduous forested wetland, which is also the most common wetland type in Rhode Island. The watershed also contains approximately 148 acres of rare and sensitive types of freshwater wetlands, including emergent marsh or wet meadow, emergent fen or bog, scrub-shrub fen or bog, and cedar swamps (coniferous forested wetland). Freshwater wetlands and ponds make up about 20% of the watershed's land area. To compare, wetlands and ponds comprise about 13% of the State's land area.

Estuary systems, including the Narrow River, contain a number of different types of saltwater wetlands, including tidal creeks, tidal flats, low salt marshes, high salt marshes, salt panne, salt scrub, and brackish marshes. There are approximately 262 acres of coastal wetlands in the Narrow River watershed. Rare coastal wetlands present in the watershed include sea level fens and brackish marshes.

The Narrow River SAMP and the Rhode Island Wildlife Action Plan point out the Narrow River estuarine wetlands as important habitat for a number of species. Of note is the Pettaquamscutt Cove and its salt marshes, which are internationally important for the conservation of waterfowl, particularly the American Black Duck; and for the conservation of salt marsh birds, such as the Salt Marsh Sparrow, which is considered by Partners in Flight to be a species of highest conservation priority in the Northeast (due to habitat loss from sea level rise and human development of coastal habitats). According to the State Wildlife Action Plan, "Salt marshes are universally considered to be among the most important wildlife habitats in North America, and Rhode Island's contribution to the regional distribution and conservation of this habitat is significant."

Most of the salt marshes in the Narrow River watershed are located in the southern portion of the estuary in the Pettaquamscutt Cove. Pettaquamscutt Cove is almost completely surrounded by broad expanses of salt marsh with several marsh islands present in the shallow waters. Smaller salt marsh patches extend up the river, on both sides, as far north as Middlebridge. Vegetation type within the estuary changes with salinity and tidal inundation. Salt pannes (depressions in the high marsh) present in the lower estuary are hyper-saline and partially submerged.

Salt marsh in the Narrow River.

Brackish marshes occur in the upper reaches of tidal rivers and the upland edges of salt marshes where salinity levels are reduced, allowing for a higher diversity of plants than in a salt marsh. Brackish marshes are primarily transitional habitats that occupy limited areas for a combined total of less than 300 acres statewide. Brackish marshes dominated by cattails are present within the Narrow River system (Enser and Lundgren 2007, citation from RI Wildlife Action Plan, 2015). Also of note, is the presence of a very unique and rare coastal wetland, the Sea Level Fen at Narrow River, which is one of only two known locations in the State. Sea level fens are an emergent wetland community that occupies the interface at the upper end of tidal marshes where there is an upland freshwater source, typically groundwater seepage.

Freshwater wetlands contiguous to the salt marshes which surround the estuary account for almost half of the freshwater systems within the watershed. The remaining freshwater wetlands can be found along the Mattatuxet River and Gilbert Stuart Stream in the headwaters region, and in an extensive trellis network of small streams and wetlands which effectively reach every corner of the watershed.

It is important to note that while wetlands perform certain functions, their deterioration or destruction has the opposite effect. Likewise, restoring a wetland has the ability to bring those functions back. Not all wetlands perform all functions. Performance depends on the characteristics of the wetland, including its position in the landscape, and the condition of the wetland. Wetlands can be classified according to their location in the landscape, and this classification system can be used to identify wetlands with a probability of performance for certain functions, which can be used to prioritize wetlands for protection and restoration efforts on a watershed basis, depending on the goals of the watershed plan.

In 2014, a project that enhanced Rhode Island wetland mapping data from the National Wetlands Inventory (NWI) was developed to be able to predict wetland functions at the landscape level. Hydrogeomorphic-type descriptors were added to the standard NWI data to create what is now called an “NWI+ database,” which was used to construct an on-line mapping tool. Use of this mapping tool, which is beyond the scope of this watershed plan, could be used to help describe and predict the landscape-level functions of the wetlands in the watershed.

III. *Water Quality*

The primary water quality concerns within the Narrow River Watershed are **bacteria** levels, which have resulted in a permanent closure to shellfishing in the estuary, and excess **nutrients** which negatively affect the aquatic habitats in the watershed. This section provides a summary of the water quality of the waterbodies (that have an assigned RIDEM Waterbody ID number) and groundwater aquifer in the Narrow River watershed, including identification of which waterbodies are not meeting water quality standards. (For a discussion of conditions by each surface waterbody in the watershed, see Appendix 8, Assessment of Waterbodies).

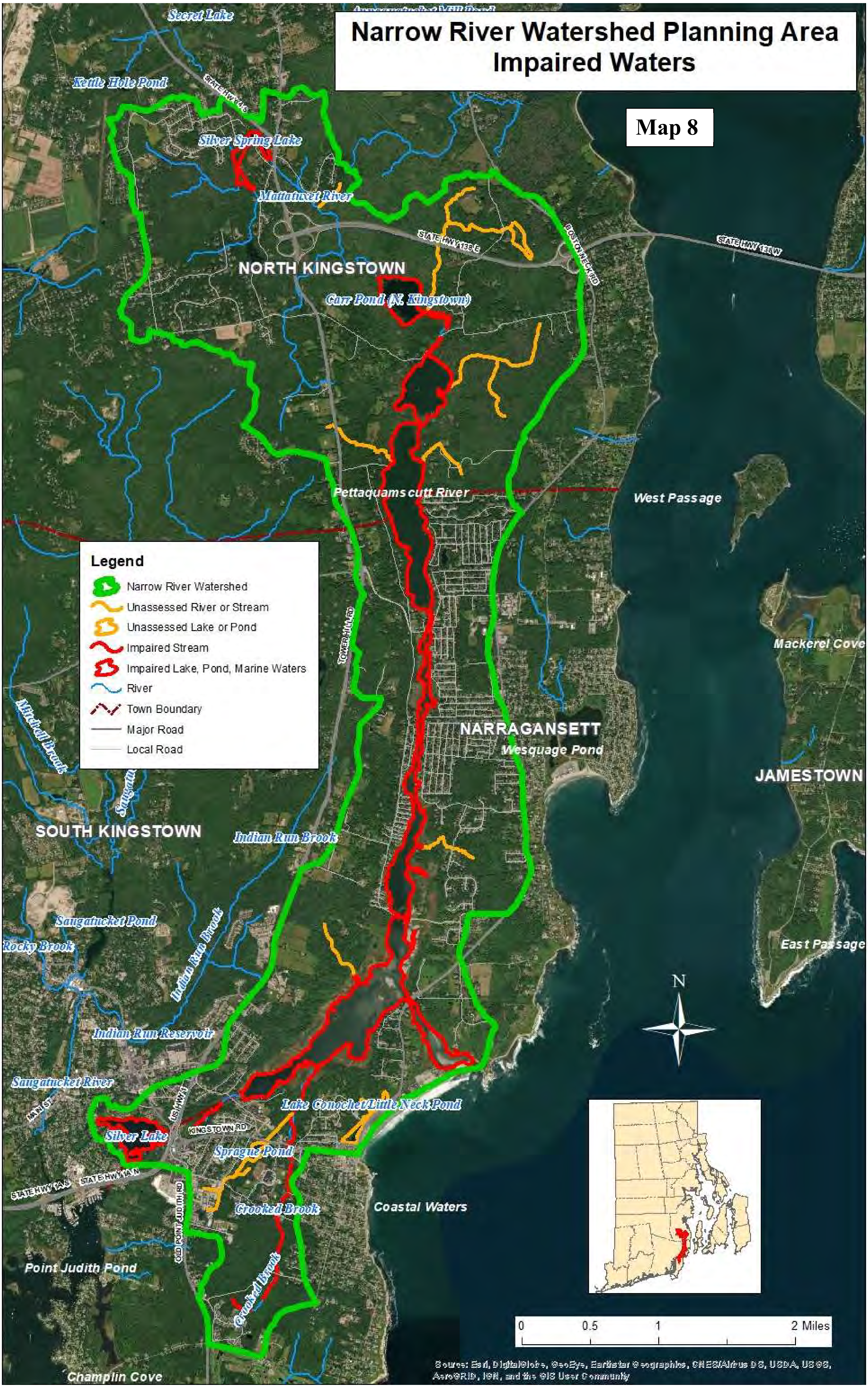
A) Surface Waters

1) *Impaired Water Quality Segments*

The State of Rhode Island Water Quality Rules specify the criteria each waterbody in the State shall meet. The Narrow River has a designated saltwater use classification of SA, which means that 'these waters are designated for shellfish harvesting for direct human consumption, primary and secondary contact recreational activities, and fish and wildlife habitat, among other uses, and that the river shall have good aesthetic value.' All of its freshwater tributaries, and the lakes and ponds within the Narrow River Watershed have a freshwater classification of either A or B, which means that these waters are designated for primary and secondary contact recreational activities and for fish and wildlife habitat, and that they shall have either excellent ('A') or good ('B') aesthetic value. However, the Narrow River itself, and six of the freshwater bodies (that have been assessed) in the watershed do not meet the water quality criteria to actually support one or more of these designated uses. When a waterbody does not meet a designated use, it is considered "impaired" for that use, and the cause of the impairment is identified. (More detailed descriptions of the State waterbody water quality classification system and the designated uses are provided in **Appendix 2**.)

A list of each waterbody segment, as defined by RIDEM, in the Narrow River Watershed, along with its Classification and status of supporting its designated uses, is presented in **Table 4**., below. The determination on impairments to date in the Narrow River watershed is based on the data from the Watershed Watch water quality monitoring program, which is reviewed and compared to the state's Water Quality Standards by RIDEM Office of Water Resources Water Quality Assessment Program. This is for waterbodies that are identified and tracked by the state to report under its Clean Water Act obligations. Not all waterbodies in the watershed are covered for this reporting, which explains why some waterbodies in the watershed do not have a waterbody segment ID, or are not listed in the table.

A discussion of the pollutants and stressors causing impairments follows. See also **Map 8**, Impaired Waters.



Narrow River Watershed Planning Area
Impaired Waters
Map 8
Secret Lake
Kettle Hole Pond
Silver Spring Lake
Mattatuxet River
NORTH KINGSTOWN
Carr Pond (N. Kingstown)
STATE HWY 138 E
STATE HWY 138 W
BOSTON NECK RD
Pettaquamscutt River
West Passage
Legend
Narrow River Watershed
Unassessed River or Stream
Unassessed Lake or Pond
Impaired Stream
Impaired Lake, Pond, Marine Waters
River
Town Boundary
Major Road
Local Road
TOWER HILL RD
Mackerel Cove
NARRAGANSETT
Wesquage Pond
JAMESTOWN
Mitchell Brook
SOUTH KINGSTOWN
Indian Run Brook
Saugatucket Pond
Rocky Brook
East Passage
Indian Run Reservoir
Saugatucket River
Lake Conochet/Little Neck Pond
Silver Lake
KINGSTOWN RD
Sprague Pond
STATE HWY 1A S
STATE HWY 1A N
Crooked Brook
Coastal Waters
OLD POINT JUDITH RD
Point Judith Pond
0
0.5
1
2 Miles
N
Champlin Cove

When a waterbody is determined to be impaired by RIDEM and listed on the State of RI's 'Impaired Waterbody List,' a Water Quality Restoration Plan, also called a Total Maximum Daily Load (TMDL) analysis, is scheduled to be developed for that waterbody for its specific pollutant and impairment. However, for impairments not caused by a pollutant, such as non-native invasive species, a TMDL is not required. Key elements of a TMDL include identifying the pollutant sources and the degree of pollutant reduction necessary to attain the applicable water quality standards. Additionally, TMDL's include important recommended mitigation actions to achieve the necessary water quality improvements.

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Table 4. Narrow River Watershed Water Quality Use Assessment Status (From 2016 Integrated Report) (from North to South)

Name of Water Body (Segment ID)	**Town**	**Cause of Impairment(s)**	**Use Not Supported due to impairment**	**Status of TMDL**	**Notes**	**Classification**
Silver Spring Lake (RI0010044L-02)	North Kingstown	Phosphorus, Non-Native Aquatic Plants (Fanwort and Variable Milfoil), and Mercury in Fish Tissue	Fish and Wildlife Habitat Fish Consumption	Scheduled for 2023 Scheduled for 2020	Fully supporting Primary and Secondary Contact Recreation **Trophic Status:** Mesotrophic	B
Mattatuxet River and Tributaries (RI0010044R-02)	North Kingstown				Fully supporting Primary and Secondary Contact Recreation and Fish and Wildlife Habitat. Not assessed for fish consumption.	B
Unnamed Tributary to Carr Pond (RI0010044R-04)	North Kingstown				Not Assessed	B
Carr Pond (RI0010044L-03)	North Kingstown	Non-Native Aquatic Plants (Fanwort and Variable Milfoil)	Fish and Wildlife Habitat	N/A	Fish Consumption not assessed; Fully supporting primary and secondary contact recreation. **Trophic Status:** Mesotrophic	B
Gilbert Stuart Stream (RI0010044R-01)	North Kingstown				Fully Supporting Fish habitat and Primary and Secondary Contact Recreation. Fish consumption not assessed.	A

Name of Water Body (Segment ID)	Town	Cause of Impairment(s)	Use Not Supported due to impairment	Status of TMDL	Notes	Classification
Unnamed Tributaries #1 through #5 to Pettaquamscutt River (RI0010044R-05, -06, -07, -08, -09)	North Kingstown, South Kingstown, and Narragansett				Not Assessed	A
Mettatuxet Brook (tributary to Pettaquamscutt River) (no ID)	Narragansett	(Fecal Coliform)	(Primary and Secondary Contact Recreation* not officially listed)	(included in Narrow River Bacteria TMDL, 2001)	*This waterbody has not been assigned an ID, therefore, it is not included in the state's 303d list, however, it is known to have high bacteria, as documented in the TMDL.	N/A
Pettaquamscutt River (RI0010044E-01A)	North Kingstown, South Kingstown, and Narragansett	Fecal Coliform	Shellfish Consumption	Approved 4/29/2002	Fully supporting primary and secondary contact recreation. Not assessed for Fish habitat and consumption.	SA
Pettaquamscutt River (RI0010044E-01B)	Narragansett	Fecal Coliform	Shellfish Consumption	Approved 4/29/2002	Fully supporting primary and secondary contact recreation. Not assessed for Fish habitat and consumption.	SA{b}
Crooked Brook (RI0010044R-03	Narragansett	Fecal Coliform	Primary and Secondary Contact Recreation	Approved 2/19/2003	Fish Habitat and Fish Consumption not assessed.	A

Name of Water Body (Segment ID)	**Town**	**Cause of Impairment(s)**	**Use Not Supported due to impairment**	**Status of TMDL**	**Notes**	**Classification**
Mumford Brook (RI0010044R-10)	South Kingstown, Narragansett	Fecal Coliform	Primary and Secondary Contact Recreation	Approved 4/29/2002	Fully supporting Fish and Wildlife Habitat; Fish Consumption not assessed	A
Lake Conochet / Little Neck Pond (RI0010042E-03)	Narragansett				Not Assessed	SA
Sprague Pond (RI0010044L-04)	Narragansett				Not Assessed	A
Sprague Brook (RI0010044R-11)	Narragansett				Not Assessed	A
Silver Lake (RI0010045L-05	South Kingstown	Phosphorus, Dissolved Oxygen	Fish and Wildlife Habitat	Scheduled for 2023	Fish Consumption not assessed; fully supporting primary and secondary contact recreation; Surveyed for AIS in 2017- no AIS observed. **Trophic Status:** Mesotrophic	B

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2) *Pollutants and Stressors in the Narrow River Watershed*

The major water quality pollutants and stressors in the Narrow River Watershed are:

- Bacteria (Fecal Coliform)
- Phosphorous (excess nutrients)
- Nitrogen (excess nutrients)
- Non-native Aquatic Plants/Species (stressor)
- Mercury
- Low Dissolved Oxygen (stressor)

Each of these pollutants and stressors are discussed below.

(a) Bacteria (fecal coliform)

As indicated above, major water quality impairments in the Narrow River watershed are the result of fecal coliform. Fecal coliform is often utilized as an indicator bacterium to measure a waterbody's potential for disease transmission. Elevated fecal coliform levels in surface waters increase the likelihood that associated pathogens are also present. Pathogens can adversely affect human health through skin contact, such as swimming, or through ingestion of water, contaminated fish, or shellfish. The fecal coliform levels that have been found in the Narrow River have led to the River being permanently closed to shellfishing since 1986.

Water quality data indicates that the concentrations of fecal coliform peak in the warmest summer months (usually August or September) and are highest immediately following a significant rainfall event.

Primary sources of fecal coliform to waters in the Narrow River watershed are:

- Stormwater runoff

  Stormwater transports bacteria to the receiving waters from domestic animals (pet waste), wildlife, and failed septic systems that has accumulated on streets, lawns, parking lots, storm drain systems, docks, and along the shoreline.
- Inadequately treated wastewater from septic systems in close proximity to the water.
- Leaking sewer lines and/or illicit connections.
- Direct loadings from waterfowl
- Animal waste from farm operations (a horse farm on Crooked Brook was suspected in 2001)

The RI DEM has developed two TMDL's for **Fecal Coliform bacteria** in this watershed- one approved in 2001 for the Pettaquamscutt (Narrow) River including the Narrow River Estuary, Gilbert Stuart Stream, and the Mumford Brook; and the other approved in 2002 for the Crooked Brook. The TMDL's contain calculated reductions in the amount of bacteria needed to meet the water quality standard for shellfish consumption, along with important recommended mitigation measures to achieve the necessary water quality improvements.

The required pollutant load reductions as originally listed from the 2001 and 2002 TMDL's for bacteria are in **Table 5**.

Table 5. Pollutant Load Reductions Needed

Waterbody Section	Reduction Needed
Narrow River: all sections (saltwater)	**90%**
Freshwater Tributaries:	
Gilbert Stuart Stream:	**98.9%**[1]
Mumford Brook:	**99.9%**
Crooked Brook: (mouth at discharge to cove)	**99%**
Crooked Brook: (freshwater)	**99+%**

The percent reductions are a measure of the severity of the pollution and the amount of pollution abatement actions needed to meet water quality standards.

In general, both bacteria TMDL's recommend structural and non-structural stormwater best management practices (BMPs), homeowner education on stormwater pollution, illicit discharge detection / correction of failing septic systems, and waterfowl management. (Since stormwater is a significant source of the bacteria, the TMDL's must also be addressed in the applicable MS4 Stormwater Management Programs. See Section IV. A.)

Progress on the implementation of the Narrow River TMDL has involved addressing the stormwater outfalls in the Towns of Narragansett and South Kingstown with the development of two stormwater design strategies:

- *Narrow River Stormwater Abatement Study Final Report, November 2006* by Fuss & O'Neill, prepared for RIDEM, for outfalls in the Town of Narragansett
- *Stormwater Attenuation and Source Reduction Strategy for the Pettaquamscutt River: Revised Final Plan, December 2016* by Fuss & O'Neill, for the Town of South Kingstown

These studies include conceptual design plans and provide the basis for subsequent structural BMP construction projects, discussed below. Construction of these recommended BMPs is on-going in Narragansett and is nearing construction start in South Kingstown. One outfall has recently been discovered in North Kingstown, which should also be addressed.

Over the past seventeen years since the Narrow River TMDL plan was developed, significant progress has been made towards its implementation, resulting in improved water quality conditions. However, these improvements have not been enough to reduce the bacteria to levels safe for shellfish consumption, and the entire area remains closed. Five of the twelve stormwater

[1] In 2008 Gilbert Stuart Stream was removed from the list of impaired waterbodies. See Appendix 8 under Gilbert Stuart Stream for Section 319 Nonpoint Source Program Success Story.

outfall locations identified in the Narrow River Bacteria TMDL for needing stormwater BMPs still need to be addressed. Additionally, no analysis has been performed to update the current bacteria inputs to the river at the outfall locations. Such an assessment would be useful to determine the effectiveness of the BMPs that have been installed, if the BMPs are properly functioning as intended, whether interim milestone improvements in water quality have been made, or if other changes in water quality conditions have occurred. This information is necessary in order to evaluate if adjustments are needed to the water quality improvement strategy. This is a gap in the monitoring and evaluation part of the process that needs to be addressed. Adaptive management is an integral part of watershed planning.

No progress has yet been made on implementation of the Crooked Brook Bacteria TMDL.

Remaining mitigation action items from the bacteria TMDLs are incorporated in the Implementation Action Item Table in Section VIII. of this watershed plan. Since many of the original mitigation measures have been implemented over the years, and water quality improvements have been observed through the NRPA Watershed Watch monitoring program, it is recommended that the bacteria loading concentrations to the Narrow River be re-evaluated to determine the amount of progress made towards the required reductions, and that RIDEM continue to conduct shellfish monitoring to determine whether certain areas of the river may meet the water quality standard for shellfish consumption.

A table tracking implementation of the TMDLs, which includes the bacteria pollutant loads by area and sources of bacteria, is provided in **Appendix 3**.

(b) Excess Nutrients

In surface waters, excess nutrients feed 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 (Harmful Algae Blooms (HABs)) may result in the release of natural toxins that can be harmful to humans, pets, marine mammals, fish and shellfish.

[While the primary concern with excess nutrients is ecological, toxic algae species have been documented in the Narrow River/Pettaquamscutt Cove in 1980/1981 (C. Polykrikoides) and in 2013 (Alexandrium fundyense). (Both species names have changed since then.) In this sense, excess nutrients can impact human health. However, it must be noted that the DEM shellfishing program does not monitor for HABs in the Narrow River because the area is closed to shellfishing. No cyanobacteria blooms resulting in an advisory have been reported for the freshwater bodies.]

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. As discussed in the Narrow River SAMP, signs of nutrient enrichment have been observed in the Narrow River as early as 1972. Sources of excess nutrients in the watershed are discussed below. For additional information on nutrient pollutant sources and cumulative effects in the Narrow River watershed, see the Narrow River SAMP.

Image of example algae bloom from RIDEM's webpage: http://www.dem.ri.gov/programs/water/quality/surface-water/lake-nutrients.php

Nitrogen

Excess nitrogen in the watershed is from wastewater discharges (including septic systems, cesspools, and illicit discharges), stormwater runoff, fertilizer used on lawns and crops, pet and farm animal waste, waterfowl and wildlife waste, and atmospheric deposition (from combustion of fossil fuels and vaporized agricultural sources (fertilizer/manure). There is no numeric surface water quality standard for nitrogen, rather, there is narrative criteria in the Water Quality Regulations. Therefore, this pollutant is not usually directly used to list a waterbody as impaired. Instead, the adverse effects of excess nitrogen identified above are used to determine and measure impairment for inclusion on the List of Impaired Waters. Indications of cultural eutrophication (excess nutrients) can be measured using dissolved oxygen, chlorophyll-a, and water clarity.

Unlike bacteria, which enters surface waters via direct deposition and stormwater flow, nitrogen also enters the surface waters by means of groundwater discharging to the surface waters. As noted earlier in the 'Hydrology Overview' section, groundwater flow provides a significant contribution to the fresh water flow into the Narrow River. A large proportion of the Narrow River watershed is now sewered, however the legacy of the previous septic systems may still be contributing nitrogen to the estuary through groundwater flow. Onsite wastewater treatment systems (OWTSs) and fertilizers are the primary sources of excess nitrogen in the groundwater, while fertilizers, atmospheric deposition and animal waste are the primary sources of excess nitrogen in stormwater flow.

Ammonia, nitrate and nitrite nitrogen levels have decreased for all monitoring locations in the Narrow River, however, average Total Nitrogen (organic nitrogen specifically, by deduction), has gone up slightly in all areas except Upper Pond. Additionally, eel grass habitat was expanding in the river in the area north of Middlebridge Bridge, which may have been related to the declining levels of ammonia and nitrate. Excess nitrogen is a continuing concern to the health of the ecosystem that needs to be monitored.

It is important to note that nitrate-nitrogen levels in the North Kingstown groundwater source are routinely monitored and the wells within the Narrow River Watershed (Wells #3, #7, and #8) have been consistently low.

Since there is no numeric water quality standard for Nitrogen, a pollutant load reduction cannot be calculated for the Narrow River. However, nitrogen is present in sufficient amount to cause a concern in this sensitive estuarine watershed, such that policies and regulations for OWTS and other sources of excess nitrogen have been instituted to keep the nitrogen levels from increasing, and to help reduce overall nitrogen loads.

In order to effectively target reductions in nitrogen loading, the sources of nitrogen to the estuary and their magnitude should be analyzed. Therefore, it is recommended that the sources of nitrogen to the river (and its freshwater tributaries) be estimated through modelling, and prioritized. (One model suggestion is SWAT land use modelling). Sources of nitrogen should include a groundwater assessment.

Based on one study, excess nitrogen is suspected of weakening salt marsh soil structure, thereby causing loss and degradation of salt marshes. Stakeholders may be interested in further studying the impacts of high nitrogen level on salt marsh edge stability in order to evaluate the potential need for water quality standards.

Phosphorus

Excess phosphorus can lead to eutrophic conditions in freshwater lakes and ponds. It can also promote algae growth, including Harmful Algae Blooms. Unlike nitrogen, the State of RI has a numeric water quality standard for phosphorus in fresh waterbodies. Silver Spring Lake in North Kingstown and Silver Lake in South Kingstown exceed the water quality standard for phosphorus.

Phosphorus in the freshwater lakes and ponds can be from both external sources and an internal source from nutrient recycling from the bottom sediments. Specific phosphorus sources and loading rates to the two impaired lakes, however, have not yet been determined. The most significant external source for most ponds is stormwater runoff. Wastewater and waste-derived nutrients from pets, waterfowl, and other wildlife are also a significant external source for most ponds. Other external sources of phosphorus may include sedimentation from erosion (phosphorus binds to soil particles), and to a lesser extent, atmospheric deposition.

As indicated in the above table, the RIDEM is scheduled to complete TMDL's for phosphorus by the year 2023 for the Silver Spring Lake in North Kingstown and the Silver Lake in South Kingstown. These TMDL's will include the necessary pollutant load reductions needed to restore these waterbodies to conditions that meet their water quality standards, along with important recommended mitigation measures to achieve the necessary water quality improvements.

Until the phosphorus TMDL's are complete, measures to reduce phosphorus include:

- Implementation and enforcement of OWTS maintenance and local Wastewater Management Plans for areas around the impaired ponds.
- Enforce local soil erosion and sediment control (SESC) requirements.
- Education targeted to residents around the ponds on topics including proper lawn maintenance to protect water quality (no phosphorus fertilizers, etc.), pet waste, waterfowl, etc.
- Ensure adequate vegetated buffers around ponds.
- Develop Lake Management Plans

(c) Non-native Aquatic Plants (Aquatic Invasive Species)

Non-native aquatic plants, also known as invasive species, are plants that come from other countries, regions, or continents. They are adaptable to new habitats, grow aggressively, and have a high reproductive capacity. They often have no environmental checks and balances such as the seasonal weather, diseases, or insect pests that kept them under control in their native range. This allows them to out-compete the native species. Adverse impacts from non-native aquatic plants include excessive growth that smothers and degrades native habitat and interferes with recreational enjoyment. Aquatic invasive plants enter a waterbody from fragments stuck on boat trailers, propellers, or in bait wells. They are often mislabeled plants by water gardeners, aquarium keepers, and landscapers. They can also arrive here either as whole plants or fragments in ballast water from foreign ships in our ports.

(d) Mercury in Fish Tissue

Mercury is a naturally occurring metal that is toxic to living organisms. Mercury in the Narrow River watershed primarily comes from atmospheric deposition of emission sources from coal-fired power plants. It is typically also found in thermometers, barometers, and fluorescent light bulbs. Mercury bioaccumulates up the food chain and is found in fish tissue in its most toxic form—methylmercury. Concentrations of mercury in fish tissue can be over one million times higher than in the water. Fish consumption advisories are in place for freshwaters across the state due to elevated levels of mercury.

3) *Other Contaminants of Concern in the Watershed*

Contaminants of emerging concern are compounds, such as pharmaceuticals and personal care products (PPCPs), and industrial chemicals, that are not commonly monitored, therefore significant gaps in available water quality data exist. Additionally, their health and environmental impacts have not been completely determined due to their "emerging" nature. Currently there are no US EPA/state ambient water quality criteria, water quality standards, or drinking water standards for most of PPCPs or other emerging contaminants of concern. 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.

Other contaminants of emerging concern include microplastics and 'forever chemicals.' Plastics break down in our environment into microplastics. Microplastics, microfibers, and nanoplastics are an emerging concern not discussed in this plan.

One large class of emerging contaminants, which has actually been a concern for quite some time now, includes per- and poly- fluoroalkyl substances (PFAS). PFAS are a class of chemicals that are widely used in a variety of products and applications including non-stick cookware, upholstered furniture, clothing, food packaging, and firefighting foam. EPA has adopted a health advisory for two of the thousands of PFAS chemicals – perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS).

Although PFOA and PFOS are no longer produced in the United States, they remain in the environment due to their persistence and use in outdated products. For this reason, they are sometimes called 'forever chemicals.' RI DEM established a groundwater quality standard for PFOA and PFOS in 2017 at 70 ppt (parts per trillion), which is consistent with the federal health advisory. These determinations will drive future efforts to regulate and remediate those facilities that may have or may be using or disposing of PFAS including numerous types of commercial and industrial operations, airports, fire training academies, landfills and other waste disposal facilities.

B) Groundwater

No groundwater monitoring network has been established in RI. The best source of available information on ambient groundwater quality in the Watershed is the Department of Health's data on public drinking water wells that are regularly tested to ensure compliance with drinking water standards. (See previous discussion in Section II. C) Drinking Water.)

The quality of the public drinking water from all six public wells in the watershed is currently good, such that it needs no treatment. The North Kingstown Water Department reports water quality testing to the RIDOH. This groundwater source is fairly well protected today through targeted open space conservation, town regulatory measures (further discussed below), and an educational program.

It was noted earlier that despite installation of sewers in Narragansett and South Kingstown, nitrogen from earlier septic system inputs may still remain in the groundwater and may be a source of excess nitrogen to the estuary today.

Threats to groundwater can include contamination from the following sources:

- Failing and sub-standard septic tanks and/or leaking sewer pipes
- Storage Tanks- above and below ground
- Fertilizers and pesticides
- Non-sanitary discharges to groundwater (process water, floor drains)
- Old landfills and waste disposal sites

- Stormwater infiltration (untreated)
- Road salt storage and application

The groundwater source can also be threatened by future development, which poses risks by adding more of these sources. See Section IV. for the presence and management of these individual threats in the Narrow River Watershed.

IV. *Threats to Water Quality*

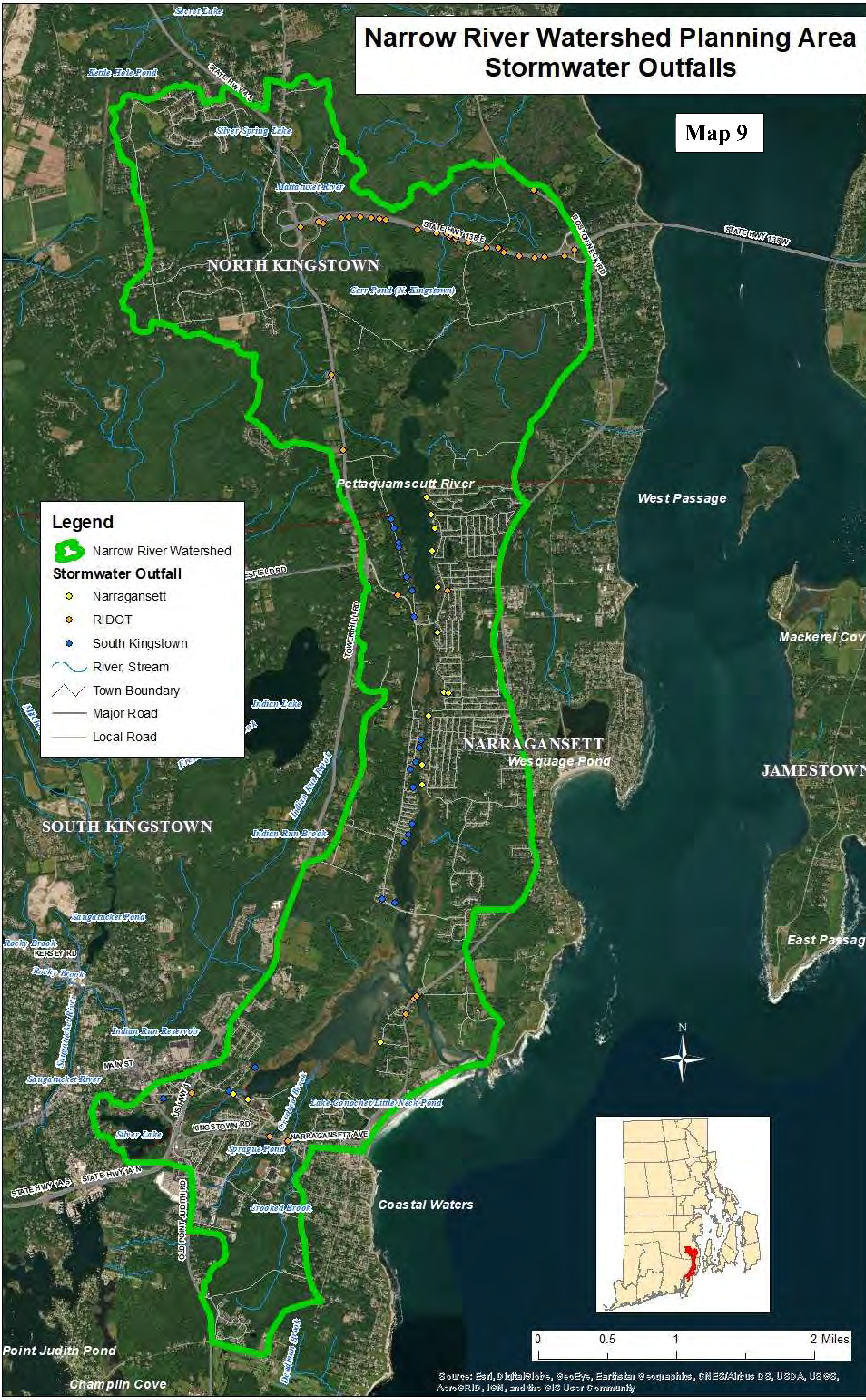
This section provides an overview of the sources of the pollutants impairing water quality and how they are being managed in the Narrow River watershed. Recommendations are included to fill gaps in management. A tremendous amount of concerted effort has been on-going to improve conditions in the Narrow River watershed for the past 50 years.

A) Stormwater Runoff

Stormwater runoff is a major conveyor of pollutants into the Narrow River and its tributaries. Stormwater runoff is rain and melted snow that washes over the land surface into nearby rivers, streams, lakes, ponds, coastal waters, and freshwater and coastal wetlands. Stormwater runoff is most often carried to waterways by publicly owned drainage networks. Historically, these storm drain networks were designed to carry stormwater away from developed land as quickly as possible to prevent on-site flooding with little to no treatment of pollutants. The pollutants typically washed off the ground and carried by stormwater come from all around us – fertilizers (nutrients) and pesticides from residential and commercial lawns and agricultural land; nutrients and bacteria from pet waste left on the ground; petroleum products from automobiles and gas stations; metals from automobile brake dust; salt and sand from winter road safety maintenance; nutrients and bacteria from failing septic systems and cesspools; nutrients and bacteria from farm animal and wild animal waste (in particular, resident Canadian geese are a problem in RI); soil and sediment from construction sites, plowed farm land, and eroding areas; heat absorbed from pavement; and trash.

Combustion of fossil fuels also contributes nitrogen, phosphorus, mercury, and other contaminants that are deposited from the atmosphere directly into waterbodies or on the ground where it is transported in stormwater.

Stormwater runoff is identified in both the ‘Fecal Coliform TMDL for the Pettaquamscutt (Narrow) River Watershed’ and the ‘Fecal Coliform TMDL for Crooked Brook’ as the major wet weather source of bacteria to the Narrow River estuary and tributaries. Stormwater may also be the most significant wet weather source of excess nitrogen to the estuary, and of excess phosphorus to Silver Spring Lake and Silver Lake. See **Map 9** for location of stormwater outfalls in the watershed.


Narrow River Watershed Planning Area
Stormwater Outfalls
Map 9
Legend
Narrow River Watershed
Stormwater Outfall
Narragansett
RIDOT
South Kingstown
River, Stream
Town Boundary
Major Road
Local Road
NORTH KINGSTOWN
NARRAGANSETT
SOUTH KINGSTOWN
JAMESTOWN
Pettaquamscutt River
West Passage
Mackerel Cove
East Passage
Wesquage Pond
Coastal Waters
Point Judith Pond
Champlin Cove
Silver Spring Lake
Kettle Hole Pond
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Carr Pond (N. Kingstown)
Indian Lake
Indian Run Brook
Saugatucket Pond
Rocky Brook
Indian Run Reservoir
Saugatucket River
Silver Lake
Sprague Pond
Crooked Brook
Lake Canonchet/Little Neck Pond
STATE HWY 138 E
STATE HWY 138 W
BOSTON NECK RD
TOWER HILL RD
KINGSTOWN RD
NARRAGANSETT AVE
STATE HWY 1A N
MAIN ST
KERSEY RD
N
0
0.5
1
2 Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1) *Impervious Surfaces*

In developed areas, large areas of natural landscape cover have been replaced with non-porous, or impervious, surfaces (e.g. buildings, streets, and parking areas, and even highly compacted soils from over use or poor landscaping). Impervious surfaces significantly change both the *quality* and *quantity* of runoff. As water is unable to infiltrate into the soil, the volume of stormwater runoff increases (often causing downstream flooding) and that water picks up pollutants and transports them to nearby waterbodies. Impervious surfaces can also raise the temperature of that water. Any pollutant that is on an impervious surface will likely end up in stormwater runoff and if untreated, will end up in the water.

This greater volume of water also moves much faster, increasing soil erosion from the land surface (especially where natural vegetation is no longer present), and increasing erosion of stream banks and bottoms, which destabilizes the stream channel and transports sediment downstream where it further affects aquatic habitat. Vegetated buffers and stormwater treatment best management practices (BMPs) are very important for protecting water bodies from these pollutants and erosive forces.

The barrier that impervious surfaces create also reduces the amount of natural infiltration of stormwater into the ground where it would replenish the groundwater. This negatively affects available drinking water quantity, soil moisture for plants, and stream base flows for aquatic organisms.

For additional information see the RIDEM publication entitled, "The Need to Reduce Impervious Cover to Prevent Flooding and Protect Water Quality," May, 2010 available here: http://www.dem.ri.gov/programs/bpoladm/suswshed/pdfs/imperv.pdf

Further, rain events are becoming "flashier" due to climate change—they are often shorter in duration but produce much more rain than in the past. This causes the negative impacts of impervious surfaces to be even greater.

As noted earlier, impervious surfaces cover approximately 11.8% of the Narrow River watershed (see **Map 5**). Data suggests that water quality impacts can occur when impervious surfaces are as low as 10% of a watershed.

2) *Sediment*

Sediment is another threat to water quality and aquatic habitat, including wetlands, that is transported via stormwater. Accelerated erosion occurs when the surface of the land lacks stabilizing vegetation, and the exposed soil is subject to erosive forces. As with nutrients, naturally occurring sediment is an important input into an ecosystem, such as sediment transported down rivers into estuaries to build up salt marshes. However, excess sediment, such as may be caused from human activity, negatively affects a system and becomes a pollutant.

Excess sediment can come from construction activities, winter road sand application, erosion of plowed or overgrazed agricultural land, or from other areas with exposed soil, such as dirt driveways or eroding road shoulders. Sediment acts in physical, chemical, and biological ways to impair ecosystems and waterbodies. Sediment can carry with it other pollutants (such as phosphorus, pesticides, and heavy metals) that are attached to soil particles and released into the water body. Small particles can remain suspended in the water column directly affecting organisms by:


Example of erosion from a construction site.

- reducing water clarity (called 'turbidity'), which impedes sunlight from reaching submerged aquatic vegetation;
- irritating and clogging fish eyes and gills;
- confusing diurnal cycles of prey species who may mistake the conditions for night, thereby exposing themselves to increased risk of predation; and
- raising water temperatures by absorbing heat from the sun (which otherwise would not occur in clear water).

Excess sediment in streams physically alters the freshwater ecosystem by smothering the river bottom, thereby altering the characteristic textured habitat that organisms depend on to lay their eggs, seek refuge, and support their life. Waterbodies that get loaded with sediment become more shallow, which affects water temperature, and also diminishes capacity to store and transport floodwaters.

There are still about 1,000 acres of land available for future development within the Narrow River watershed, which means that construction will continue to disturb the land, more impervious surfaces will be created, the amount of naturally vegetated areas will decrease, and the more pollution sources will be created.

Stormwater is a widespread 'source' of water quality degradation in RI, and in the Narrow River Watershed. Addressing this threat to water quality is complex and involves:

- addressing the sources that contribute pollutants to the stormwater;
- designing projects with low impact techniques and requiring the design and installation of stormwater treatment systems as property is developed or redeveloped;
- retrofitting existing developed areas by improving or installing effective stormwater systems;
- properly maintaining stormwater infrastructure;
- managing construction activity for erosion; and
- managing agricultural activities with conservation practices for water quality.

3) *Stormwater Management Activities in the Watershed*

(a) *State Site Permitting*

Individual Stormwater Permits

New development and re-development projects subject to State water quality permitting under DEM and CRMC programs must comply with the RI Stormwater Management, Design, and Installation Rules (State Stormwater Rules), which includes specific provisions to ensure stormwater is treated to protect water quality and is managed to meet certain standards, including, but not limited to:

- 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
- Use low impact development (LID) site planning and design techniques as the primary method of stormwater management to the maximum extent practicable (this provision relies on the enactment of local LID requirements)
- Control of soil erosion from construction activity in accordance with the Soil Erosion and Sediment Control Handbook (SESC Handbook)

Additionally, all RI municipalities have the authority to adopt ordinances requiring any new developments and redevelopments to be in compliance with the design standards of the State Stormwater Rules and the SESC Handbook, including projects that disturb areas smaller than the minimum threshold that triggers a State permit. It is important to note that projects that are too small to require a State permit (i.e. under one acre) still have an impact and cumulatively contribute to water quality and quantity problems in the local communities.

Industrial Activity Stormwater General Permit

In 2006, DEM issued the Rhode Island Multi-Sector General Permit (MSGP) to cover stormwater discharges associated with industrial activity, excluding discharges from construction sites (which is a different permit). This general permit establishes standards for certain listed industrial activities to minimize impacts from stormwater, by addressing potential sources 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. At this time, there are no facilities in the watershed covered under this permit.

(b) *MS4 Municipal Separate Storm Sewer System (MS4) Program (RIPDES Phase II)*

In order to address stormwater from municipal systems, the US EPA finalized its Stormwater Phase II rule in 1999, which required the operators of small 'municipal separate storm sewer systems' (MS4's) to obtain permits and to implement a stormwater pollution control management program. In Rhode Island, the Phase II MS4 stormwater program is administered through the RIDEM Rhode Island Pollutant Discharge Elimination System (RIPDES) Program using a General Permit that was established in 2003. Most Rhode Island municipalities (including Narragansett, North Kingstown, and South Kingstown), the Rhode Island Department of Transportation (RIDOT), and federal, state, and quasi-state agencies serving more than 1,000 people per day (e.g. University of Rhode Island) are regulated under the Phase II MS4 Stormwater program.

This permit requires the development and implementation of a Storm Water Management Program Plan (SWMPP), which involves measurable goals and schedules, and methods for addressing the following six 'minimum measures:'

1. A public education and outreach program- to inform the public about the impacts of stormwater on surface waterbodies and what the public can do to reduce pollutants in stormwater runoff.
2. A public involvement/participation program- which includes a strategy to actively involve the community in the development and implementation of the program.
3. An illicit discharge detection and elimination program- which is a program to detect and eliminate illicit discharges or flows other than stormwater into the stormwater drainage system, including illegal connections and illegal dumping; and must also address pet waste, litter, yard waste, and other waste, such as household hazardous waste.
4. A construction site stormwater runoff control program- for sites disturbing 1 or more acres to address sediment and other construction site pollutants.
5. A post construction stormwater runoff control program- for new development and redevelopment sites disturbing 1 or more acres, to address long term control of stormwater and pollutants generated by the developed site.
6. A municipal pollution prevention/good housekeeping program- to address pollution prevention for all municipal facilities, maintenance activities, and operations that have the potential to introduce pollutants to stormwater runoff. This includes but is not limited to a regular catch basin inspection and cleaning program, a regular stormwater BMP inspection and maintenance program, and a regular street sweeping program.

Additionally, if a TMDL has been approved for any water body into which storm water discharges from the MS4 contribute directly or indirectly the pollutant(s) of concern, the MS4 operator's SWMPP must address the TMDL provisions or other provisions for storm water discharges from the MS4. Due to this provision of the RIPDES MS4 General Permit, the towns of Narragansett and South Kingstown must both address the bacteria TMDLs in their MS4 programs.

This General Permit prompts a very detailed and comprehensive program to address stormwater pollution. For further information, refer to the State's RIPDES Stormwater MS4 website: http://www.dem.ri.gov/programs/water/permits/ripdes/stormwater/ms4s-program.php.

Each municipality in the watershed has an ongoing RIPDES Phase II MS4 Program, and submits reports annually to RIDEM to document progress.

(c) Municipal Stormwater Implementation Projects

There has been a concerted effort in the Narrow River watershed to implement stormwater retrofit projects. These projects and associated feasibility and design studies have been implemented to address the Narrow River Bacteria TMDL discussed in Section III. A) 2) (a), (and the MS4 stormwater program discussed above). To date, over $2.1 million in state and federal grant funding (not including local matches or other funds) has been invested in stormwater improvements to the watershed. A listing with details of the significant projects is included in **Appendix 4** (see also, Appendix 3). Most recent activity includes:

- The Town of Narragansett has been actively installing structural stormwater water quality BMPs to address the Narrow River Bacteria TMDL.
- The Town of South Kingstown has received a state grant in the amount of $658,130 and will also be installing stormwater water quality treatment swales in the Narrow River neighborhoods in the near future.

Mettatuxet Beach Stormwater BMP

4) *What Needs to be Done to Improve Stormwater Management in the Watershed?*

Over time, with continued development, the amount of impervious cover <u>will</u> increase. Recall that there are over 1,100 acres of undeveloped land in this watershed. However, this does not mean that water quality has to decrease accordingly. If stormwater from this increased impervious cover is properly treated and managed, negative impacts can be prevented. In watersheds with degraded water quality due to existing large areas of impervious cover, some of this impervious cover will have to be retrofitted with stormwater treatment best management practices (BMPs) in order to improve water quality. It is equally important to retrofit existing developments as it is to ensure that new development is doing its part to be protective of water quality and aquatic habitats. In addition to the Stormwater Management efforts discussed above, the following actions will improve stormwater management in the watershed:

(a) Low Impact Development Regulations

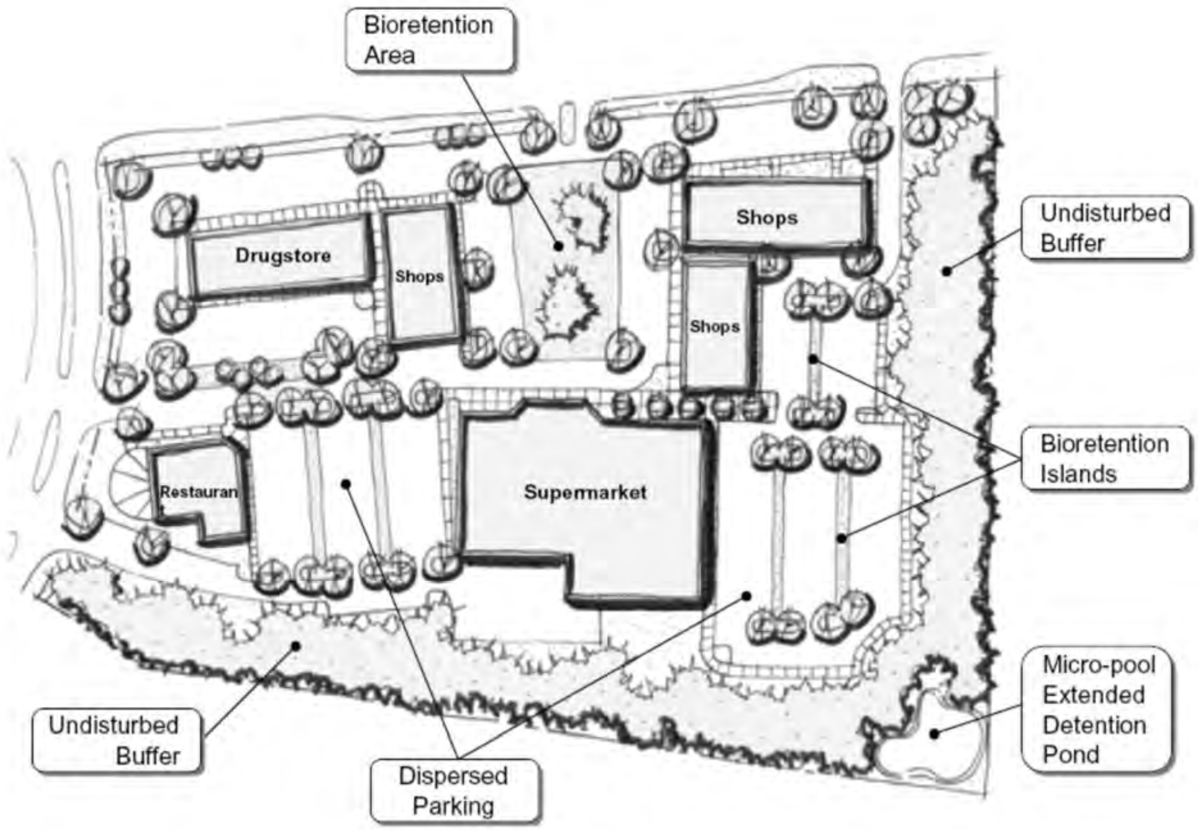
The Smart Development for a Cleaner Bay Act of 2007 articulated in State Law that in order to prevent the future degradation of the state's waters, the State stormwater design and installation standards manual should implement comprehensive stormwater standards for development that will maintain natural hydrological systems and reduce pollution to the maximum extent possible by requiring the use of modern non-structural low impact design practices and techniques. This is not possible without LID requirements being integrated into the local development regulations.

LID provides a comprehensive approach to project design which involves both a process that considers stormwater management during the conceptual stages of a project; and a strategy that utilizes and maintains the natural hydrology, minimizes site disturbance and impervious cover, and plans for groundwater infiltration.

The site planning and design aspects of a LID project involve site layout that works with the natural drainage, use of landscaped areas, and site construction techniques to minimize disturbance and protect areas of natural infiltration from compaction. Areas of impervious surfaces are minimized through both thoughtful site planning and local dimensional requirements pertaining to road widths, parking lot design, setbacks, and other zoning and land development design standards. This approach is different from conventional stormwater management that was only designed to quickly move water off of a site.

Implementation of LID begins at the community planning level. The Rhode Island "Low Impact Development Site Planning and Design Guidance Manual" (March 2011) ("LID Manual") provides examples for local officials of how to amend their town's ordinances and development regulations to incorporate LID requirements. The LID Manual contains over 45 specific techniques that can be required by communities to avoid and reduce the stormwater impacts of development on water quality. These techniques can also preserve community character, reduce flooding, and save money.

The first step in integrating LID techniques into local development regulations involves municipal boards learning what the full range of LID techniques are. The next step is to perform an evaluation of local ordinances and development regulations (Land Development and Subdivision Regulations, Zoning Ordinance, etc.) to identify which techniques the town has already incorporated, and which techniques would be appropriate for the town to consider adopting or modifying in order take full advantage of a LID strategy. The next step is to amend the local regulations to integrate the LID site planning and dimensional design techniques so that they may be implemented in new development applications. LID may also be required for re-development projects.



The LID design leaves undisturbed buffers of native vegetation, incorporates landscaped islands that treat stormwater, and disperses the parking into smaller areas. (Georgia Stormwater Manual, 2001) (taken from RI LID Manual, 2011)

Recommended Actions:
The Towns of Narragansett, North Kingstown, and South Kingstown review its existing planning and development ordinances to evaluate what LID techniques are already included, decide what LID techniques would be appropriate for the community to incorporate, and adopt the use of the selected LID techniques into local development regulations for use in all proposed development and redevelopment projects.

(b) Stormwater Retrofits and Green Infrastructure

Providing stormwater management for existing impervious cover will improve water quality in the watershed. The Town of Narragansett and, more recently, South Kingstown have been actively pursuing prioritized stormwater retrofit opportunities within the Narrow River watershed through implementation of the 2001 Narrow River Bacteria TMDL. The TMDL calls for all direct discharge outfalls that contribute to the impairment of the Narrow River to be addressed. (A listing of significant projects completed is in **Appendix 4**.) A reassessment is recommended to determine priorities for the remaining outfalls. It should be noted that the two highest bacteria concentration source outfalls as identified in the 2001 TMDL have not yet been outfitted with stormwater BMPs. These are the outfall at Mettatuxet Road (Sumac Trail), which was not included in the 2006 *Narrow River Stormwater Abatement Study*, and the outfall at Shadbush Trail (Pettaquamscutt Lake Shore). There may be an opportunity for the Town of Narragansett to work with the Pettaquamscutt Cove National Wildlife Refuge to do a water quality project to address the outfall at Mettatuxet Road and Sumac Trail on land owned by the Refuge here.

Installing retrofit stormwater BMPs throughout the watershed should be pursued to address the water quality issues identified in Section III. as warranted and as technically and financially feasible. Green infrastructure techniques can be integrated as municipal stormwater infrastructure is improved throughout the watershed.

In addition to retrofits on municipal owned land, the Towns should consider programs to encourage the use of small scale on-site (e.g., rain gardens, dry wells, etc.) nature-based BMPs throughout the watershed at existing individual residential and commercial properties and/or the replacement of lawn or pavement with natural vegetation to retain water on-site, reduce runoff, and promote infiltration.

There are also opportunities for the municipalities to work with RIDOT to treat or reduce stormwater runoff from state roads, particularly where outfalls direct water towards impaired waterbodies. (One area to take a closer look at is the interchange and rotary at Route 1 and Kingstown Road in Narragansett.)

RIDOT is required by a Consent Decree with EPA to comply with conditions of the RIPDES Phase II MS4 General Permit and address its discharges to impaired waters statewide. RIDOT will prepare a Stormwater Control Plan (SCP) that specifies structural and non-structural controls to address the causes of a specific impairment in a watershed. RIDOT is pledging more than $100 million over a 10-year period to ensure compliance with the Clean Water Act and a number of remedial measures under this consent decree. This initiative will reduce pollution from stormwater flowing into Narragansett Bay and hundreds of lakes, ponds and rivers throughout Rhode Island. The impaired waterbody ID segments applicable to RIDOT in the Narrow River watershed will be addressed together in a Stormwater Control Plan, which is projected by RIDOT to begin development in late 2021.

Recommended Actions:

- Reassess remaining outfalls identified in the Narrow River TMDL to determine priorities for stormwater BMP installation, and install as resources allow. (Narragansett) [Note: of the remaining outfalls in Narragansett that must be addressed, the two outfalls with the highest bacteria concentration sources which should be prioritized are at the Mettatuxet Road outfall (at Sumac Trail) and at Shadbush Trail (Pettaquamscutt Lake Shore). See Appendix 3 for status of implementation of TMDLs.]
- Install stormwater BMPs, including, but not limited to those in the TMDL, to intercept and treat stormwater before it flows into the Narrow River or its tributaries.

- Conduct feasibility and prioritization study for mitigation actions/ BMPs identified in the Crooked Brook TMDL, and implement as resources allow. (Narragansett)
- Continue to install stormwater BMPs per South Kingstown stormwater implementation strategy to implement the Narrow River TMDL.
- Ensure adequate resources to properly maintain BMPs.
- Promote installation of rain gardens and dry wells or cisterns on neighborhood properties.
- Consider requiring a smaller minimum threshold (than the State minimum) for project size to trigger stormwater management and LID requirements (and soil erosion control requirements) for new and redevelopment applications before the town.
- Work with RIDOT to develop Stormwater Control Plan for prioritized discharges to impaired waterbodies in the watershed, as applicable under the Consent Decree with EPA.

(c) Stormwater Utility/ Feasibility

Many municipalities have expressed concerns with lack of funding, staff, equipment, and capacity to run their MS4 programs, particularly for operation and maintenance of the infrastructure; conducting inspections for soil erosion and proper construction of BMPs; for retrofitting stormwater treatment facilities on public property; and for finding ways to accelerate the retrofitting of BMPs on privately owned developments. Applying for competitive grants for equipment needs or projects to improve water quality is not a reliable source of funding. Grants also require a local match, and often involve timing of projects to be ready when the Request for Proposals (RFP) is announced, which can be disruptive to the work schedules of the departments running the MS4 program.

There is State enabling legislation (RIGL 45-61) for a municipality to create a stormwater utility district in order to finance the development and management of the stormwater infrastructure and water quality program, in much the same way as a sewer, potable water, or electric utility service operates. Each contributor of runoff to the system would pay based on the amount of runoff contributed. The first step is to do a study that provides the community with enough information to decide if implementing the utility is sensible. The feasibility study will typically address preliminary revenue requirements (usually from current stormwater budgets) and develop options for billing within the service area. Such a study can include a consideration of credits for private properties that implement and properly maintain acceptable stormwater pollution treatment and runoff reduction methods. To date, no municipality in the Narrow River watershed has explored the feasibility of creating a Stormwater Utility to finance stormwater management, although it is considered in some of their Comprehensive Plans, or otherwise included as a recommendation in a local stormwater strategy.

For more information, resources are listed in Implementation Tools Section IX. B) 8).

<u>Recommended Actions</u>:

- Town's to seek support to conduct a stormwater utility feasibility study. Such an effort should include extensive public outreach from the very beginning to express the problem and the need, to hear people's concerns about a utility and stories pertaining to local water problems and values, and to envision the types of improvements and benefits such a program would generate. Municipalities may wish to conduct such study or utility jointly, or individually.

(d) Soil Erosion and Sediment Control

Soil erosion and sediment control plans are required for most projects that will disturb one acre or more of land, however, many sites that are smaller than one acre of disturbance cumulatively contribute to sediment pollution problems and should be considered for inclusion in local permitting programs.

Additionally, sediment from existing eroding areas should be addressed (such as through stabilization projects), as well as prompt removal of winter sand.

Recommended Actions:

- Consider requiring a smaller minimum threshold (than the State minimum) for project size to trigger soil erosion and sediment control requirements for new and redevelopment applications before the town.
- Continue to enforce the construction site stormwater runoff control requirements of the MS4 program for plan review and site inspections.
- Require erosion and sediment control training for contractors to work in Town. (Such training is available through RIDOT/URI NEMO and other entities.)

(e) MS4 Programs

Recommended Actions:

- Each municipality should evaluate the following areas for improvement under the MS4 Phase II program requirements to ensure:
    - Ordinances pertaining to Post Construction Stormwater Runoff Control are applied to all zoning districts; and also address the legal enforcement of operation and maintenance requirements, particularly for stormwater BMPs on private property. Prioritize requiring nature-based stormwater management solutions;
    - Low Impact Development site planning and design requirements are fully incorporated and implemented at the local level by tailoring and adopting specific techniques in the local regulations in accordance with the community's needs;
    - Construction Site Runoff Control ordinances address the requirements of the MS4 permit for other sources of pollutants associated with construction sites, such as concrete washouts, fueling stations, litter, etc.
    - Implementation of non-structural BMPs throughout the watershed.
- RIDOT to comply with MS4 requirements and improve maintenance of BMPs and road sweeping, catch basin cleaning, and other good housekeeping measures in the watershed.

- Increase and improve performance of street sweeping of entire watershed. Per the Crooked Brook TMDL, perform more frequent street sweeping of South Pier Road (to prevent sediment load observed in Sprague Brook at CB-14).

(f) Local Stormwater Control Requirements

Recommended Actions:

- Consider adopting local stormwater requirements for development projects smaller than one acre (smaller than the state minimum requirement).

B) Wastewater

Wastewater is the spent or used water from homes, communities, farms and businesses, including both domestic sewage and industrial waste from manufacturing sources. Pollutants such as excess nutrients (nitrogen and phosphorus), pathogens (bacteria and viruses), pharmaceuticals, personal care products, chemical pollutants (including household hazardous materials), metals, and other contaminants of emerging concern may all be found in wastewater. When wastewater goes down the drain, it either goes into the sewer lines to a local wastewater treatment plant or into an Onsite Wastewater Treatment System (OWTS, also referred to as a 'septic system') on the property. Wastewater that is not properly treated can have a significant impact on our surface water and groundwater resources.

1) *Sewers*

The high density and use of failed septic systems and cesspools within the Narrow River Watershed had been an identified problem causing high fecal coliform bacteria levels for many years. Addressing this source of pollution through extending sewer lines was one of the first actions taken to improve water quality of the river. Today, the majority of the densely developed areas near the river have been sewered (see **Map 7**). The sewer lines transport this wastewater to the Town of South Kingstown regional wastewater treatment facility, which is located in the watershed, and discharges treated wastewater to a point outside of the watershed (off shore at end of South Pier Road in Narragansett).

Efforts to sewer the most densely developed areas along the river were initiated over 25 years ago. Today, 28.5% of the watershed area is sewered. Major investments by the Towns of Narragansett and South Kingstown were supported by State bond funds in the early 1990's that made available low-interest revolving loan funds and grants to implement the sewering projects of the North End Sewer Project in Narragansett and the Middlebridge Project in South Kingstown. Based on the map, some low-lying neighborhoods directly on the river do not appear to be sewered. However, there are also lots within the sewered area which have not been connected to the system, though connection was mandatory per ordinance in both Narragansett and South Kingstown.

Another potential concern in the watershed is that sewer lines have the potential to leak wastewater (from cracked or leaking pipes) into the groundwater, where it can either enter through cracks into the storm drainage system and be transported directly to a waterbody, or be transported with the groundwater flow into a surface waterbody.

Another concern expressed in the past, is that constructing sewers brings the potential for further development to an area, which may bring with it new sources of added pollution, such as from lawns, pets, vehicles, and erosion from construction sites. There are currently no plans for the Town of Narragansett to further extend sewer service due to their capacity limits with the treatment plant. The Town of South Kingstown has excess capacity and has delineated a limited sewer extension boundary around the Middlebridge area of the watershed. As noted in the sections on LID and green infrastructure, however, the issues of development can be addressed proactively by implementing strong BMPs and other approaches to reduce or avoid the impacts. It is particularly important to apply such standards to projects disturbing less than one acre. This would capture those areas typically serviced by public sewer.

2) *Onsite Wastewater Treatment Systems (OWTSs)*

Wastewater from any structure <u>not</u> served by a sewer system is disposed of onsite using an Onsite Wastewater Treatment System (OWTS). As noted previously, developed areas, including residential neighborhoods, cover approximately 34% of the watershed, and approximately 28.5% of the watershed is sewered. Although most of these developed areas are serviced by a municipal sanitary sewer system, many residents in the watershed rely on OWTS.

A properly sited, designed, installed and maintained OWTS will provide decades of use and provide treatment of wastewater such that the system does not adversely impact public health or the environment. Wastewater from an OWTS moves downward through the soil into groundwater, and can carry with it the pollutants noted above, and other contaminants that may be improperly disposed of into the system. The level of treatment provided depends on many factors, including system design and installation, system use and maintenance, and the local soil characteristics.

OWTS can fail if they are improperly sited, designed, installed and/or maintained, 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. Lack of maintenance is considered to be the primary cause of system failure. Operation and maintenance of existing systems is the responsibility of the property owner. Towns can play a major role in ensuring OWTS maintenance through a local ordinance and other incentives.

In the Narrow River Watershed, an additional concern with wastewater is the contribution of excess nitrogen to the marine environment. As discussed in Section III., nitrogen is the limiting nutrient in marine and estuarine water and can cause algal blooms. Nitrogen in the nitrate form travels easily in groundwater, however that groundwater may take years to reach the river, and therefore it can take years to see improvements in water quality after sewering an area.

Therefore, it is possible that the legacy of the septic systems (among other sources) is contributing nitrogen to the river.

Climate change also poses a concern for the use of OWTS. The impacts of projected climate change through sea level rise and warmer soil temperatures may decrease the effectiveness of OWTS in treating wastewater by means of:

- 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; and
- warmer soil temperatures will potentially reduce available oxygen for wastewater treatment in the soil.

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. These systems must be inspected and maintained in order to protect public health and the quality of our environment. However, RIDEM does not inspect systems after they are installed. Owners of OWTS's are responsible for maintaining their systems, and each municipality has the opportunity to establish a management program to support property owners in these efforts (discussed further, below)

Denitrification OWTS systems - Due to impacts of nitrogen on the coastal environment, all new, altered, and repaired OWTSs in the Narrow River watershed must be systems to reduce nitrogen in the wastewater (denitrification systems), in addition to bacteria reduction. These are more complex systems that require a greater level of oversight to ensure that they operate as designed in order to achieve the desired level of treatment. This policy derives from the Narrow River Special Area Management Plan and is enforced by regulation through the RIDEM OWTS rules—the entire watershed is considered an 'OWTS Critical Resource Area' by RIDEM for septic system design purposes. However, it is unknown how many previously existing conventional septic systems remaining in the watershed have been upgraded to the nitrogen removal technology. It is important to note that denitrification systems reduce nitrogen compared to conventional systems, but they do not fully eliminate it.

Rhode Island has established the programs below to limit the impact of pollutants from OWTS to nearby waterbodies and assist municipalities with the repair and replacement of malfunctioning OWTS.

Onsite Wastewater Management Plan (OWMP) - RIDEM approval of a town OWMP enables a municipality to qualify for the State's **Community Septic System Loan Program** (CSSLP). The CSSLP is part of the State Clean Water Revolving Loan Fund program that provides low-interest loans to municipalities so that they may issue low interest loans to homeowners to repair or replace failed, failing, or substandard OWTSs. All 3 towns in the watershed have a DEM approved Onsite Wastewater Management Plan, and a program for maintaining properly functioning OWTS. There are minimum required elements of a municipal OWMP that are necessary in order for the plan to be approved by RIDEM. It should be noted that none of the elements are required by state or federal rule or law. Municipalities choose to develop OWTS programs to improve proper operation and maintenance of OWTS facilities in their jurisdictions and to access state-provided funding assistance for their citizens for system repairs and replacement.

Each municipality's efforts to manage OWTSs has been evaluated based on criteria established by RIDEM, which represents the preferred local management scenario. See **Table 6.**, below.

Table 6. Elements of Local OWTS Programs

OWTS Program Element	**Narragansett**	**North Kingstown**	**South Kingstown**
Does the town have an approved Onsite Wastewater Management Plan?	Yes	Yes	Yes
Does the town participate in the Community Septic System Loan Program?	Yes	Yes	Yes
Has the town adopted an ordinance to address OWTS management?	Yes	Yes	Yes
Does the OWTS management ordinance have mandatory inspections?	No	Yes	Yes
If inspections are required, has the town taken enforcement actions in cases of non-compliance?	NA	No	?
Does the town have a web-based tracking system?	Yes	Yes	Yes
Does the town have a website for information and education on OWTS issues?	No	Yes	Yes
Does the town have a staff person whose primary responsibility is management of the municipal onsite wastewater management program?	No	No	No
Does the town have a cesspool phase-out program?	No	No	Yes
Has the town adopted an ordinance for more stringent OWTS standards than the DEM rules?	Yes	No	Yes

Narragansett: Narragansett has an approved OWMP and participates in the CSSLP. The town does not have an onsite wastewater management ordinance based on a model OWTS management ordinance, rather, the town's utilities ordinance requires septic system pumping at least every 4 years, with records submitted to the town. The zoning ordinance sets more stringent standards than the state regulations for septic system siting. **CSSLP funding to Narragansett to date: $250,000**

North Kingstown: The Town of North Kingstown has an approved OWMP and has a municipal onsite wastewater management program in place. The town onsite wastewater management ordinance requires septic system inspection and maintenance at regular intervals. The town also participates in the CSSLP with loan funds administered by the Water Department. Additionally, all new commercial and industrial development in the town's designated Groundwater Protection Zone, which includes portions of the Narrow River watershed, must show they can meet 5 ppm of nitrate at the property line.
CSSLP funding to North Kingstown to date: $3,800,000

South Kingstown: South Kingstown has an approved OWMP and has an onsite wastewater management program in place. The town wastewater management ordinance requires inspection of onsite systems. South Kingstown also has a town-wide cesspool phase-out, which is nearly complete with all required deadlines having passed. Cesspools discovered via the inspection program had to be upgraded within 5 years of discovery. Cesspools were also required to be upgraded within 12 months of the sale of a property. South Kingstown uses a web-based inventory and tracking program and participates in the CSSLP.
CSSLP funding to South Kingstown to date: $2,200,000

3) *Cesspools*

Cesspools are a substandard means of onsite wastewater treatment and disposal that should be eliminated in the watershed. They are essentially just a hole in the ground which does not provide an acceptable level of treatment and is more likely to fail. 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 by state and federal rules. Towns can play a role in identifying these systems as part of their inspection programs.

Cesspool Replacement- Failed cesspools anywhere in RI are required to be replaced under the State's OWTS rules. The OWTS rules also require the replacement of cesspools that serve commercial facilities or multifamily dwellings. The Rhode Island Cesspool Act of 2007 requires the replacement of cesspools located within 200 feet of the inland edge of a coastal shoreline feature bordering a tidal area, within 200 feet of all public drinking water wells, and within 200 feet of a waterbody with an intake for a drinking water supply. In the Narrow River watershed, DEM identified 3 cesspools subject to the act, one of which has been removed and replaced with an OWTS. Amendments to the Cesspool Act in 2015 requires any property sold or transferred that uses a cesspool to have that cesspool replaced within one year of the sale or transfer.

The Town of South Kingstown has an ordinance to remove all cesspools within 5 years of a required maintenance inspection, and now there are only a handful of cesspools remaining in town. Narragansett and North Kingstown do not have a cesspool removal provision.

4) *Illicit Connections and Direct Discharges of Wastewater to Waterbodies*

Pollutants can also be transported directly into waterbodies through illicit connections of wastewater to the storm drain pipes or to a stream, rather than to the sewer pipes. This can be through direct connections, or indirect connections, such as through cracked and leaking sewer pipes. Illicit discharge detection is a required component of the MS4 stormwater program.

A few monitoring studies have been conducted to detect the presence of human waste in the watershed, however, they were inconclusive at detecting any potential sources. A canine field investigation was conducted in June 2018 to seek out and further pinpoint these potential human sources of bacteria to the Narrow River. The canines are scent trained to detect the presence or absence of sewage in water samples and in the field. Three locations were chosen for field investigation based on a history of high bacteria counts and canine water sample screening for sewage detections. These areas were around the bridge at Middlebridge Road on the Narragansett side, the Mettatuxet neighborhood around Mettatuxet Road and Mettatuxet Brook in Narragansett, and the storm sewer lines along Mumford Road and the adjacent neighborhoods in both South Kingstown and Narragansett. In these three areas, two canines working together with their handlers found many strong detections of sewage. A report has been prepared on this investigation. By April 2019, Narragansett and South Kingstown were to submit plans for further investigation of the Mettatuxet Brook and Mumford Brook areas to RIDEM. There are no plans to further investigate the Middlebridge area. Subsequently, South Kingstown has videotaped their storm drain line down Mumford Road and found no sources. Narragansett is also in the process of videotaping their storm drain lines for the Mumford area and the Mettatuxet area. Results of this investigation are forthcoming.

An additional concern expressed at the stakeholder meetings is the lack of sanitary facilities at heavily used outdoor recreation areas on the river.

5) *Wastewater Management: What Needs to be Done?*

<u>Recommended Actions</u>:

- Continue to implement local OWTS wastewater management plans, ordinances, and programs.
- Strengthen the town's role in identifying and addressing failed systems. Municipalities may need to amend local ordinances and/or increase local technical or administrative capacity to do so.
- Identify locations of failed septic systems and cesspools, and enforce repairs, upgrades (nitrogen removal), or connections to sewer. Priority areas include near Mumford Road, Mettatuxet Brook, and Middlebridge.
- Phase out conventional OWTS and replace with nitrogen removal and/or connect to sewer.
- Require homes or businesses in the sewered areas that are not connected to the sewer to connect. (Enforce existing connection requirements.) The municipalities should research and track this information and follow-up. An amendment to the tri-party wastewater

agreement may need to be considered to increase capacity for Narragansett in order to connect such properties. Connection is mandatory per ordinance.
- Evaluate the need for sanitary facilities at recreation areas.

See Implementation Table in Section VIII. for more action items pertaining to improving wastewater management in the watershed.

C) Residential Land Use

The predominate developed land use in the Narrow River watershed is residential development. Threats to water quality from residential land use include several of the topics that are further discussed elsewhere in this section (i.e., onsite wastewater treatment systems, lawn management, and pet waste). Other potential sources of groundwater and surface water contamination from residential uses include:

- Household cleaning chemicals, automotive fluids (oil and gasoline), paints and solvents disposed of down the drain or onto the land surface (aka, Household Hazardous Waste);
- Heating oil storage (above and below ground tanks, further discussed below), and spills; and
- Abandoned wells (can illegally be used as direct conduits for pollution into groundwater).

If taken on an individual basis, the threat from a single residence is normally less than the threat from other land uses, but when factoring them all together, they form a significant source of contamination. Many citizens are unaware of the effects of numerous potential contaminants stored, used, and disposed of around the home.

Education and outreach to the public is important in reducing this source of water pollution. See **Appendix 5** for ways individuals can reduce pollution from residential activities.

Although most heating oil tanks sized less than 1,100 gallons that are located at residences and on farms are likely above ground (outside or in a basement), an unknown, but suspected significant number of heating oil tanks are buried and will eventually leak. RI General Laws 46-12.1 enables municipalities to adopt ordinances providing for the regulation and control of underground tanks and establishing procedures for the registration, testing, and removal of such 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.

In order to prevent impacts to the water resources in the watershed from above ground and underground storage tanks leaks and spills, DEM recommends the following actions:

<u>Recommended Actions:</u>

- Educate homeowners on the threat to water quality from above-ground and underground home heating oil tanks and the potential financial consequences.

- Municipalities may also adopt ordinances prohibiting new heating oil USTs, particularly in areas dependent on private wells and in wellhead protection areas, and for phasing out and replacing existing underground home heating oil USTs.

D) Pet Waste

The Fecal Coliform TMDL's for the Narrow River and Crooked Brook identified pet waste as a source of bacteria to the river and its tributaries. Pet waste can be a significant contributor of bacteria, other pathogens, and excess nutrients (nitrogen and phosphorus) to surface waters. The primary issue is dog waste, although other backyard pets (horses, goats, etc.) can cause localized problems. Pet waste in urban and suburban areas that is left on the sidewalk or on grass near the street can then be washed into stormwater drainage systems. 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 to temporarily close a bay to swimming and shellfishing (EPA, 1993). 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 (Pacific Shellfish Institute).

Example of potential impact from pet waste that has been identified in the Watershed:

> 'Dog Island,' in the narrows inlet of the Narrow River, is a popular recreation location where people bring their dogs for extended periods of time, however there are no amenities available here to help people pick up and properly dispose of their pet's waste. Further, this island is flooded twice daily during high tide, washing any waste that accumulates directly into the water, most likely pushing it upstream with the incoming tide.The activity at this location is not mentioned in the bacteria TMDL and this potential source has not been studied to determine how significant, if any, an impact it has on water quality in the inlet, cove, or lower river. However, there is a low cost opportunity for public education here, and to prompt dog owners to be responsible with their pet waste.

Pet Waste Management in the Watershed

Current activities to address pet waste as available from town's website or as reported by each town in their 2017 Annual MS4 Report are as follows:

North Kingstown

The Town of North Kingstown provides educational material via its stormwater webpage, which includes a brochure titled, "What is Stormwater?" which notes 'pick up after your pet' as one of ten things that you can do to help prevent pollution. The town's 2017 MS4 Annual Report indicates that pet waste management was one of the topics that were included in the public education and outreach program during this reporting period.

South Kingstown
The Town of South Kingstown reports in its 2017 MS4 Annual Report that it has completed the following:

- Distribution of pet waste brochures to all licensed dog owners, and local veterinarians, groomers, and animal shelters and rescues. Pet waste brochures will continue to be distributed with dog license applications in future years.
- Installed 5 pet waste signs (3 include waterfowl) in the Narrow River watershed
- Responds to complaints regarding improper disposal of dog waste
- South Kingstown also has a stormwater management webpage with educational information and a link for 'pet waste and livestock manure.' https://southkingstownri.com/566/Pet-Waste-and-Livestock-Manure

Narragansett
The Town of Narragansett operates a Mutt Mitt Program in response to the Narrow River Bacteria TMDL. This program includes a notification sign educating the public of the town ordinance. The town's Animal Waste ordinance requires removal and disposal of the waste from any public area. The Town installs and maintains the mutt mitts year-round.

What Needs to be Done?
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 owners must act responsibly to control pet waste. Pet waste can be flushed, buried, or sealed in bags and put in the trash. A good time to directly target dog owners for pet waste education is during the annual municipal dog license renewal.

Recommended Actions:

- Towns enforce local ordinances and improve strategies requiring owners to pick up after their pets on all property.
- Educate the public about the impact of pet waste on water quality. Strategies include:
  - Municipalities could hand out or mail a pet waste or water quality brochure along with the license/tags.

- o Provide veterinarians and other pet services with water quality information (for dissemination to clients).
  - o Install watershed-wide pet disposal bags and system of collection.
- Adopt strategies for controlling pet waste at town public facilities.
- Control pet waste at Dog Island and around the Narrows. (It may be difficult to install a pet waste station here since it floods twice a day, however, signage may be a first step.)
- Install pet waste stations at known heavily used locations (such as dog parks, areas identified in TMDL's, etc.). Include signage citing local ordinances. Maintain stations.
- Implement Crooked Brook TMDL recommendations to enforce existing town pet ordinances at: stream channel running through Sprague Park, and Kingstown Road outfall to Sprague Pond.

E) Waterfowl and Wildlife

Waterfowl and wildlife are a natural part of our environment and are enjoyable to watch. However, when they congregate in excessive numbers due to human encouragement, they contribute pathogens and nutrients to water pollution. There is an important distinction between native and migrating waterfowl, which tend not to be a pollution problem, and nuisance waterfowl, such as resident Canada geese, which do not migrate and congregate for longer periods of time resulting in excess waste contributing to bacteria and nutrient pollution problems. Feeding of waterfowl, and large lawns near waterbodies that allow waterfowl to land and congregate can result in unnaturally high concentrations of waterfowl in these locations. Whether by direct excretion of waste into waterbodies, or the waste deposited on lawns and parking lots being transported by stormwater, the bacteria and nutrients in their waste end up in our waterbodies.

Recent concern has focused on the large numbers of resident Canada geese, whose populations have increased greatly over the last 50 years in southern New England. As reported by the Eastern RI Conservation District *(source: 'Resident Canada Geese Fact Sheet')*, a single Canada goose can eat up to 4 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 where they regularly feed and congregate. [consider deleting this paragraph?]

The Fecal Coliform TMDLs for the Narrow River and for Crooked Brook identify waterfowl and wildlife waste as a source of bacteria to the river and certain tributaries. According to these TMDLs, "birds contribute significant fecal coliform loadings to the river. They are present throughout the Narrow River watershed, however, the largest waterfowl populations are consistently seen in the heavily developed residential area between Bridgetown Bridge and Middlebridge Bridge, and within the Pettaquamscutt Cove National Wildlife Refuge located in the southern portion of Pettaquamscutt Cove." Wildlife and/or waterfowl is also identified as sources of bacteria at each segment of Crooked Brook, including the Sprague Brook tributary. Other areas where birds congregate that may be sources of bacteria and nutrient pollution include under road overpasses and bridges, where the structure provides areas for birds, such as pigeons, to roost in large numbers.

Waterfowl/ Wildlife Management in the Watershed

South Kingstown
The Town of South Kingstown has installed 3 "Do Not Feed the Waterfowl" signs along the river in the Watershed.

What Needs to be Done?
While waterfowl have been identified in the Narrow River Bacteria TMDL as a source of bacteria to the river, these observations were mostly made from the shoreline. At the stakeholder meetings, there was a lot of interest in what can be done to manage Resident Canada Geese.

Also, other areas where birds may congregate (such as pigeons roosting under overpasses) should be investigated to see if these are potential sources of bacteria and nutrients from wildlife. Potential areas to investigate include:

- Route 1 and Kingstown Road overpass
- Route 1 and the Bike Path overpass
- Bridgetown Bridge and Middlebridge Bridge

Both the Eastern and the Southern Rhode Island Conservation Districts have expertise in managing nuisance waterfowl. Municipalities may also contact the RI Department of Environmental Management for technical assistance on this issue. Educational materials are provided as links in **Appendix 5**.

<u>Recommended Actions:</u>

- Perform a study of wildlife locations and concentrations in the watershed and their impact to water quality of the freshwater stream input to the Narrow River (bacteria and nitrogen). Survey areas around the highway, including overpasses for potential roosting pigeons, and expanses of grass where waterfowl (and/or dogs) may be congregating, such as the overpass at Route 1 and Kingstown Road and the adjacent grassed land at the rotary. Also check at the Shady Lea picnic area and the Silver Spring Lake Fishing access area owned by RIDEM; and at Narragansett's Sprague Park and the Narragansett Indian Monument park. Ensure effective signage at these locations addressing dogs and waterfowl.

- Target areas identified in the TMDL between Bridgetown Bridge and Middlebridge Bridge, and at the southern end of Pettaquamscutt Cove for waterfowl management.
- Devise a sustainable strategy for waterfowl/wildlife management. For example, local conservation commissions could do a survey to find out where excessive populations of geese (and other wildlife, such as pigeons) are in the watershed, and then devise a plan to address it. Partner with SRICD, who has experience in Resident Canada Geese management.
- Identify a local group to work on this task. Contact SRICD and RIDEM Nonpoint Source Pollution Management Program for technical assistance to control nuisance waterfowl.
- Consider extending Goose Hunting Season at the National Wildlife Refuge to abate non-migratory Canada Geese- contact RI Fish and Wildlife (stakeholder meeting discussion)
- Provide public education on the negative impacts of feeding waterfowl
- Stop the public from feeding waterfowl (signs, ordinances)
- Modify habitat, where feasible. 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. Consider a demonstration project of planting along slope of river to discourage geese.
- Control goose populations, such as with hunting and nest disruption.

F) Commercial and Industrial Facilities- Facility Management

Threats to water resources are generally differentiated between residential, and commercial or industrial land uses because of the potential for diverse types and significant volumes of chemicals used by commercial and industrial facilities. The primary contaminants of concern from residential land use are nutrients, pesticides, and bacteria; whereas commercial and industrial land uses represent a greater risk from fuel and chemical spills and leaks.

While there is noticeably more commercial and industrial land just outside the watershed boundary (where the boundary aligns with major roads in the watershed), only 3.7% of the Narrow River Watershed contains some commercial and industrial areas. These areas are located at a few isolated sites and at some larger areas centered at:

- the Junction of Route 138 and Route 1
- a block between South Pier Road, Route 108, and Westmoreland Street

See the Land Use Land Cover **Map 4** in Section II. for locations of commercial and industrial land uses (included in legend under 'Nonresidential Developed') in the watershed.

Commercial facilities that handle hazardous material must be registered with the US EPA and RI DEM. **Map 10** shows the location of the following types of regulated facilities in the watershed—RIPDES Point Sources, Storage Tanks, Tier 2 Facilities, and Contaminated Sites. See also **Appendix 6**, for a list of these sites, excluding all residential and above ground storage tanks. Each type of regulated activity is further described below.

Narrow River Watershed Planning Area
Regulated Facilities
Map 10
Legend
Narrow River Watershed
EPCRA_Tier_II_Fac...
RIDEM Site Investigation & Remediation (2019)
RIPDES Permit
Storage Tank - Above Ground (2016)
Storage Tank - Underground (2018)
Storage Tank - Underground L-UST (2016)
River
Town Boundary
Major Road
Local Road
NORTH KINGSTOWN
NARRAGANSETT
JAMESTOWN
West Passage
East Passage
Mackerel Cove
Coastal Waters
Point Judith Pond
Champlin Cove
Pettaquamscutt River
Wesquage Pond
Secret Lake
Kettle Hole Pond
Silver Spring Lake
Mattatuxet River
Carr Pond (N. Kingstown)
Indian Lake
Indian Run Brook
Saugatucket Pond
Indian Run Reservoir
Saugatucket River
Silver Lake
Sprague Pond
Crooked Brook
Lake Canonchet/Little Neck Pond
STATE HWY 4 S
STATE HWY 138 E
STATE HWY 138 W
BOSTON NECK RD
TOWER HILL RD
US HWY 1
KINGSTOWN RD
NARRAGANSETT AVE
MAIN ST
STATE HWY 1A S
STATE HWY 1A N
OLD POINT JUDITH RD
N
0 0.5 1 2 Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1) *RIPDES (RI Pollutant Discharge Elimination System)*

These are point sources that are permitted by RIDEM for discharging treated wastewater to surface waters via a pipe, ditch, or other defined point of discharge. (Note that *stormwater* that may enter a waterbody via a "point" source (i.e, an outfall pipe) is a different program.) There are two types:

- Sanitary Wastewater: wastewater discharges from municipal wastewater treatment facilities or wastewater from toilets, sinks, showers at individual establishments
- Non-sanitary Wastewater: wastewater from industrial or commercial establishments.

There is one regulated facility in the watershed for a sanitary wastewater discharge, which is the South Kingstown Waste Water Treatment Facility on Westmoreland Street in Narragansett, however the discharge point is outside this watershed. This facility has a NPDES/ RIPDES Individual Permit. There are no regulated discharges of non-sanitary wastewater in the watershed.

2) *Storage Tanks*

Both above-ground storage tanks (ASTs) and underground storage tanks (USTs) are used throughout Rhode Island to store petroleum products such as motor fuels, heating oils and to a lesser degree other types of chemicals. Leaking underground storage tank systems (tanks, piping, and dispensers) were for many years considered the major threat to groundwater quality in RI. This threat has decreased dramatically since the first DEM UST Program regulations were enacted in 1984. UST's must comply with the comprehensive DEM "Rules and Regulations for Underground Storage Facilities Used for Petroleum Products and Hazardous Materials" (UST Rules). AST's are regulated via the RI "Oil Pollution Control Regulations." DEM regulates all USTs except home heating oil tanks sized less than 1,100 gallons that are located at residences and on farms. See discussion of home heating oil tanks in Section C), above.

3) *Tier 2 Facilities*

These are facilities that store large amounts of hazardous materials. Tier 2 facilities are required to prepare emergency response plans that are shared with local and state officials. The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 establishes requirements regarding emergency planning and 'Community Right-to-Know' reporting on hazardous and toxic chemicals, including annual submission of the Tier II Emergency and Hazardous Chemical Inventory form. There is one Tier 2 Facility in the Narrow River Watershed, which is the South Kingstown Regional Wastewater Treatment Facility located in Narragansett.

4) *Contaminated Sites*

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. This category of contaminated sites excludes LUST's. Most of the contamination that has been discovered is a result of activities that predated the environmental regulations that have been in place since the 1980s. There are about 14 DEM Site investigation sites in the watershed, 2 of which currently have Environmental Land Use Restrictions.

- RIDEM Site Investigation and Remediation: Sites of soil and water contamination with hazardous wastes and petroleum products that are undergoing remediation and monitoring that are not subject to the federal programs.
- Environmental Land Use Restrictions (ELUR): Sites that, because of soil and water contamination, have legal restrictions placed on the deed.

What Needs to be Done?
Recommended Actions:
Storage Tanks

- Continue enforcement of State Rules
- Consider local regulations or prohibitions of home heating oil tanks (Section C), above).

G) Lawn and Turf/ Grounds Management

The care and maintenance of landscaped areas such as golf courses, cemeteries, athletic fields, parks, corporate and institutional lawns and grounds, and residential lawns and gardens can contribute to water quality degradation. Turf is a major feature of all but the highest density urban landscapes, and how it is managed affects water quality. Excessive amounts of fertilizer (nutrients) and pesticides, inappropriate formulations of fertilizer, and poor timing of fertilizer and pesticide applications can result in losses to the environment via stormwater runoff and/or leaching to groundwater. 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. Unhealthy or compacted lawns essentially act as impervious surfaces generating more polluted runoff than properly maintained grounds. Lawn areas adjacent to waterbodies also attract geese and other waterfowl.

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. They are usually professionally managed for their individual situations, and represent a small fraction of the overall turf area compared to home lawns. There are over 152 acres (1.8%) of developed recreation land in the watershed, which includes ball fields such as those at the schools in Narraganset and Domenic Cristofaro Memorial Park, and parks such as Sprague Park and Bridgepoint Commons. In comparison, there are over 2,086 acres of residential land representing over 24% of the watershed.

Reducing the amount of lawn area is the first consideration to encourage via homeowner education for existing development and via Low Impact Development techniques (which can be required) for proposed development.

Many homeowners are not aware of the appropriate best management practices to reduce the impacts to water quality in managing their lawns. Landscape contracting businesses can also overapply fertilizers. Homeowners might assume landscape contractors use environmentally sound practices, however, aside from professional pesticide application (which requires a license) no certification or educational requirements exist for lawn care management. When hiring a contractor to perform yard work that involves application of fertilizer, pesticides, herbicides, or other chemicals, homeowners should look for voluntary certifications and membership in industry associations that promote environmental stewardship.

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. Since laws regarding turf management are difficult to enforce, strategies for managing fertilizer and pesticide use on turf are focused on education and training. Education of homeowners and landscape contractors on proper turf management continues to be the primary strategy to minimize water quality impacts.

The Town of South Kingstown participates in RIDEM's voluntary 'Sustainable Turf Management for Landscaping Certification' program for town managed facilities. This certification program is also available for landscaping businesses. The program checklist provides a menu of Best Management Practices (BMPs) covering a range of activities focusing on efficient turf management and water conservation in Rhode Island. The program focuses on pollution prevention, and participation provides an evaluation of current practices and low-cost recommendations to significantly reduce a company's environmental impact when managing turf.

What needs to be done?

Lawn, turf, and grounds management should target all the types of sectors that have to do with this maintenance, focusing on homeowner education and individual actions, municipal good housekeeping, and businesses. The URI Cooperative Extension Program and other associations have produced public information materials and provided onsite training and education on proper lawn management. Public educational materials are provided as links in Appendix 5. Additional resources are in Section IX. B) 2).

Recommended Actions:

- Provide education of homeowners on proper lawn management
- Consider participating in RIDEM's Green Certification / Sustainable Turf Management for Landscaping Certification program – for North Kingstown and Narragansett
- Consider implementing a local voluntary program for landscapers to commit to pollution prevention, such as the Town of Charlestown's Recommended Landscaper Process.
- Municipalities can adopt limits on residential lawn areas in new developments to minimize this source of pollution and promote infiltration of stormwater. (This is a Low Impact Development strategy.)

- Municipalities can adopt requirements for LID landscaping (native landscaping, xeriscaping, minimum undisturbed areas, etc. for both residential and commercial development projects.)
- Utilize low maintenance, low fertilizer grasses and plantings in all public facilities to minimize non-point source pollution and maintenance costs.

H) Agriculture

The potential surface water and groundwater pollutants from agricultural operations include excess nutrients (nitrogen and phosphorus) 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 negative effect on water resources.

There is very little active agriculture in the Narrow River watershed, which accounts for only 4.5% of the watershed area (393 acres). The location of most of the agricultural land is along Route 1 in South Kingstown and North Kingstown. Properly managing agricultural activities where they occur (or may occur in the future) is very important to protect water quality.

Farmers are encouraged to contact the local US Department of Agriculture Natural Resources Conservation Service (NRCS) office and their local Conservation District (Southern RI Conservation District, http://www.sricd.org/) for information on grants for installing best management practices (BMPs) and developing conservation plans to prevent impacts to water quality. The maintenance of vegetated buffers near surface waters helps to reduce the impacts of various land uses, including agriculture. NRCS has resources for the farming community to help with Nutrient Management Plans, Manure Management, Agricultural Waste Management, and other conservation programs.

The Town of South Kingstown reports in its 2017 MS4 Annual Report that it has sent letters to local farmers educating them about the importance of proper care and maintenance of livestock waste.

What Needs to be Done?

Recommended Actions:

- Encourage farmers to apply for funding from NRCS to install BMPs on their properties to prevent adverse impacts to water quality.
- Contact NRCS to target outreach to farmers (including the very small part-time farmers) in the watershed on best management practices to protect water quality.
- Farmers install BMPs.
- Adopt municipal ordinances with BMPs for backyard livestock owners to properly control animal wastes.

I) Road Salt and Sand

White stained pavement and piles of sand at the edge of the road are ample evidence of our efforts to maintain the safety of our roadways in winter. However, there is a water quality cost for the application of salt and sand. Salt and sand wash into surface waters impacting aquatic life. Salt can enter groundwater and contaminate drinking water wells. Road salt contamination of private wells has occurred in the Narrow River Watershed. Not only is the water not suitable for drinking, but the salt corrodes the pipes, and can cause harmful metals, such as lead, to leach out into the water.

The sand that is applied on the roads during winter is either washed into our waters, changing aquatic life and streambed habitat dramatically, or it becomes a major contributor to stormwater BMP failure by clogging the systems. RIDOT estimates that only about five to ten percent of the sand applied to the road is recovered as street sweepings (RIDOA, 2014).

Minimizing impacts to water resources from road salt and sand application while at the same time maintaining public safety presents a unique challenge. Improved technology and best management practices can be utilized to reduce the amount of salt and sand applied to roads without compromising winter travel safety. In addition, the sand and salt must be stored in a manner to reduce impacts to water quality, primarily by the covering of the salt pile in a structure and containing runoff from the site. DEM rules require that all stockpiles of road salt (state, town, and private) in the watershed be covered with, at minimum, a durable cover. There are 2 public salt piles in the watershed, both kept in covered structures at:

- State DOT at Route 1A and Route 108 rotary
- Narragansett Department of Public Works

RI DOT has taken the following steps:

- Use of 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.
- Pre-wetting the salt and sand mixture allows the material dispersed to stick to the road instead of bouncing and blowing off to the shoulder.
- Improved Spreader Technology that allows the operators to accurately administer and monitor the exact amount of salt applied.
- Using real-time information systems capable of monitoring road temperatures.

Another issue that Rhode Island has been experiencing is mild conditions and rain events interspersed between winter storms. This has the ability to accelerate the washing of winter sand and salt into our waterways prior to the typical time when street sweeping is conducted in the Spring. Increasing the frequency of street sweeping, particularly on mild winter days, can help prevent more of this sand and salt from entering waterbodies.

What Needs to be Done?

<u>Recommended Actions:</u>

- Upgrade equipment for more efficient application of road salt and sand. (municipalities)

- Ensure any private stockpiles of road salt are covered.
- Reduce the amount of salt added to the roads.
- Promptly remove winter sand (street sweeping).
- Consider increasing frequency of street sweeping between winter storms.

J) Marine and Riverine Debris

Styrofoam cups, plastic drinking water bottles, fishing line, cigarette butts, balloons, plastic bags, 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. Trash in our waters can:

- injure swimmers and beach goers.
- kill and injure wildlife. Many species accidentally ingest trash and degraded bits of plastic, mistaking it for food. Abandoned fishing nets and gear, discarded fishing line and other forms of debris can entangle marine wildlife, including sea turtles, sea birds, and fish.
- bioaccumulate up the food chain. In addition to causing physical harm to marine life, plastics contain endocrine disruptors and toxic chemicals, and also attract toxins to adhere to them. Micro plastics floating in the water are ingested by algae-eating organisms and bioaccumulate from there. Cumulative effects of ingestion are an emerging research topic in marine life and in humans.
- threaten tourism and recreation, and the dollars they add to local economies by limiting people's enjoyment of beach and water related activities.
- complicate boating by causing navigational hazards; and
- cause expensive costs for retrieval and removal.

The vast majority of waterway debris comes from land-based sources. It is either blown into the water or, most commonly, washed off our streets and into our waters via storm drains. Once in the water it can travel to the ocean. Debris also comes from recreational and commercial boaters. Debris (mostly plastic) is an often overlooked water quality issue best addressed through increased public awareness.

A noteworthy accomplishment is that a plastic bag ban has been implemented by all three towns in the watershed.

What Needs to be Done?

Recommended Actions:

- It is important to reduce the use of these types of products, to properly dispose of and recycle them, and to prevent them from getting loose in the environment where they can enter the water. Public education is key.
- Participating in coastal and river clean-ups helps to prevent these items from degrading our environment and threatening the health of aquatic organisms and our health.
- Making sure there are waste receptacles at public recreation areas and public water access locations in the watershed, and that they are well maintained, will help reduce debris in the Narrow River watershed.

- Implement and enhance litter control programs.
- Implement recommendations from Crooked Brook TMDL: Litter maintenance and policing of path connecting Kingstown Road to high school to minimize amount of trash dumping. (abundance of litter observed from station CB-04 thru CB-07).

K) Boating and Marinas

Boating is a major recreational activity on the Narrow River, which hosts a canoe and kayak rental business, three private marinas, a number of private docks and moorings, and a State fishing area with a boat ramp.

The primary water quality concern from boating is the illegal discharge of sanitary waste (pathogens and nutrients). 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 pump-out facilities available to RI boaters and that the pump-out facility infrastructure is in sound operating condition.

There are no sanitary waste pump-out facilities currently provided for the Narrow River, as the number and size of boats docking at the marinas are small. Demand from existing users would need to be evaluated in order to determine any future need for pump out facilities. However, all boats (of any size) are subject to RI's No-Discharge Law.

Since the three marinas in the Narrow River are for in season use only, there is no boat storage and maintenance. It is the boat maintenance that typically presents a water quality concern at a marina from the release of chemicals and metals. There are also no fueling docks available, however leaks and spills from portable fuel containers may pose a risk. Should portions of the Narrow River be deemed safe for shellfish consumption, the potential pollution impact on this use from boats and marinas would be required to be evaluated in more detail.

The Narragansett Harbor Management Plan includes policies and implementation items to encourage operation and maintenance measures for the marinas located in Town waters.

L) Atmospheric Deposition

Some pollutants that negatively affect water quality come from pollutants in the air due to the combustion of fossil fuels and from the off-gassing of agricultural fertilizer and livestock.

Mercury found in fish tissue in the Silver Spring Lake, is one such example of the impact of atmospheric deposition of pollutants into the Narrow River watershed. 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.

Nitrogen is another significant pollutant deposited from the atmosphere and impacting the Narrow River watershed. Combustion (motor vehicles, power plants) provides the high temperatures necessary to convert stable nitrogen gas into the reactive nitrogen oxides. Also, a large amount of nitrogen is released into the atmosphere as ammonia from fertilizer applications and livestock sources, primarily in the Midwest, which can be blown 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).

Phosphorus is also deposited from the atmosphere, although atmospheric deposition represents a smaller source of this nutrient pollution compared with other local sources found in our watersheds.

Since these particles fall from the air, some are deposited directly into our waterbodies, and some are deposited onto the land, where they can then be picked up and washed into our waterbodies in stormwater. Besides reducing these types of emissions at the source, installing stormwater quality treatment systems and strategically employing other methods of naturally filtering stormwater are the only way to manage atmospheric pollutant sources.

Combating water pollution from atmospheric deposition needs a regional and national (indeed global) approach. Residents, business owners, and decision makers in the Narrow River watershed can choose to take both personal action and also to support local, state, regional, and national policy and regulations to reduce emissions for everyone's benefit.

One such regional effort is the regional Mercury Task Force (MTF), which was formed by representatives of the New England states and Eastern Canadian provinces. Applicable to Rhode Island, the Northeast Regional Mercury TMDL was developed out of this effort, and included policies to reduce mercury in the environment and studied sources from both within the region, and from outside the region.

V. *Stressors to Aquatic Habitat*

Healthy aquatic ecosystems need to have clean water, but they also need to be free of other stressors that result in physical changes to aquatic habitats. Stressors are associated with human activities, climate change, and spread of invasive species. Promoting a healthy watershed includes restoration of critical components of the ecosystem that have been physically changed. However, there are challenges associated with ecosystem restoration. While it is always better and more cost effective to protect aquatic habitats and their buffers from alteration, restoration can have an important role in watershed management because of the valuable functions that can be returned. Current management activities and recommended actions are included for each of the stressors below.

A) Wetland Disturbance

Prior to regulation initiated in the 1970s, many wetlands were filled, ditched or drained. In Rhode Island, it has been estimated that 37% or more of freshwater wetlands have been historically lost to physical alteration (Dahl, 1990, cited in RI DOA, 2016), and it is estimated that 53% of previously existing salt marsh acreage in RI has been lost (Bromberg et al 2005, cited in RI DOA, 2016). As discussed in Section II., wetlands and salt marshes provide many environmental and ecological benefits for us. When wetlands are altered, these services are diminished or lost.

Direct disturbance to wetlands includes activities such as cutting of vegetation, filling, illegal dumping, excavating, water diversion, or roads and crossings (see subsection Barriers to Stream Connectivity, below). Wetlands can also be directly altered by an influx of sediment transported in stormwater. The sources of sediment can come from open construction sites, winter road sand, eroding river and stream banks due to excess high velocity runoff (either from poorly managed stormwater runoff or increasing intensities of storms), and from other areas of loose soil, such as dirt roads and driveways or vacant lots.

Wetlands are not isolated systems. The ecosystem of each wetland has adapted to certain water saturation depths, inundation at certain times of the year, and frequency and duration of inundation throughout the year. Such changes to a wetland hydrologic condition may be due to the direct disturbances noted above, or factors outside the wetland including dams, building in floodplains, and increased or decreased water inputs due to increases in impervious surfaces or decreases in groundwater recharge. Hydrologic alterations can also be caused from manmade withdrawals of water (discussed further below) for watering lawns, irrigation, or drinking water, and have been identified as a concern in Rhode Island with respect to freshwater wetlands.

While direct impacts to wetlands are regulated by law, the contributing drainage area to a wetland is not protected by wetland regulations. This stresses the importance of watershed planning in order to protect wetlands, not as isolated systems, but as an interconnected water resource—one that performs important functions with cumulative effects within the watershed. Watershed planning for wetlands can integrate policies and regulations pertaining to land use planning, stormwater management, erosion controls, land conservation, public water supply demand management, and other techniques to avoid indirect impacts to wetlands. More programs for education and outreach on the importance of wetlands in performing functions that benefit us, and how to avoid indirect impacts to wetlands, is also needed. (CWP, 2005).

Threats to Wetlands

Threats and stressors to the viability and functioning of freshwater and coastal wetlands include the following:

- Loss of vegetated buffer adjacent to waterbody or wetland
- Degradation of freshwater wetlands due to physical and hydrologic alteration
- Degradation of saltwater marshes due to loss of and lack of sediment to replenish and build up the substrate due to watershed-wide hydrologic alteration.
- Degradation and loss of coastal wetlands/marshes due to sea level rise
- Degradation of coastal wetlands/marshes due to stormwater (freshwater) inundation
- Damage to coastal wetlands/marshes (and submerged aquatic vegetation, such as eelgrass) due to boating (propeller and wake damage)
- Barriers to migration for saltwater wetlands

Wetlands are regulated by the State. Development proposals which may directly alter a wetland are reviewed and permitted on a project specific basis. This current method of regulating wetlands on a site by site basis does not consider the cumulative function of wetlands on a watershed basis (CWP, 2006), nor does it consider the cumulative impacts to the wetland from the changes that may occur within its 'contributing drainage area,' such as to the flow of water into the wetland that created its unique hydrologic conditions. Addressing these vulnerabilities in wetland protection can only be addressed on the local level (and with a watershed perspective).

Approximately 734 acres of freshwater wetlands in the Narrow River watershed are protected by ownership or easements by conservation agencies and organizations. This represents approximately 7% of the watershed's land area, and approximately 3% of the state's protected freshwater wetlands. This protected land includes 54 acres of sensitive and rare freshwater wetlands. The John H. Chafee National Wildlife Refuge contains nearly 300 acres of freshwater and coastal wetlands.

What Needs to be Done?

Protection and Restoration

RI has a policy of 'no net loss' of wetlands. Since both fresh and coastal wetlands perform such valuable functions, it is worth looking at potential opportunities to restore degraded wetlands, where possible. However, because wetlands are complex systems, restoring them to perform their original function is very difficult. It is, therefore, very important (and more cost effective) to first and foremost preserve and protect wetlands and their buffers from negative impacts. Methods to protect wetlands include regulatory enforcement, open space conservation easements and purchases, Low Impact Development site planning, and Conservation Development Design zoning. Unfortunately, many wetlands have been historically altered. Where feasible, restoration of altered wetlands and riparian buffers (see next section) can help improve conditions in the watershed and provide multiple resource protection benefits. The NRCS wetland reserve program provides funding and technical assistance to help property owners protect important wetland habitats. See Implementation Tools section IX. A) 6) (b) for more information on wetland protection and restoration resources. See Aquatic Habitat section VI. B) for effects of climate change on wetlands and salt marsh restoration efforts in the watershed.

Monitoring and Assessment

Under the Clean Water Act, states are required to report on the condition of all waters of the United States, including wetlands. The RIDEM has been working in partnership with the Rhode Island Natural History Survey (RINHS) and the New England Interstate Water Pollution Control Commission (NEIWPCC) since 2006 to develop methods to characterize freshwater wetland condition in accordance with the Rhode Island Freshwater Wetland Monitoring and Assessment Plan (WMAP). With continued EPA grant funding, DEM has been working with the RINHS since 2007 to implement the plan and develop the program. Some of the freshwater wetlands in the Narrow River watershed have been assessed using these methods in order to test the effectiveness of the methods. In Rhode Island, the condition of 281 wetlands were assessed between 2006 and 2011 under this testing protocol. Also, salt marsh monitoring has recently been initiated by RI CRMC and RINHS in accordance with the Strategy for Developing a Salt Marsh Monitoring and Assessment Program for the State of Rhode Island. Piloting of these salt marsh monitoring methods has been ongoing in 2018 and 2019. As these monitoring programs are being developed, a complete assessment of the wetlands (and their buffers) in the Narrow River watershed has not yet been conducted.

Provide for Salt Marsh Migration

In 2012, a project was initiated in Rhode Island to analyze the potential impacts to coastal wetland ecosystems from sea level rise and the landward migration potential of coastal wetlands. As part of this project, the Sea Level Affecting Marshes Model (SLAMM) was developed. These SLAMM scenario maps identify areas of potential future salt marsh migration, which can assist in determining land conservation priorities and opportunities for marsh restoration. These areas should be preserved now so that the marshes can adapt in order to avoid future losses. Additionally, where possible, removing barriers that currently exist in these areas should also be considered. Recommendations from the RI SLAMM Project Summary Report (2015) have been incorporated into this watershed plan.

<u>Recommended Actions</u>:

- Support State efforts to enhance wetland regulatory protection.
- Target wetlands and ample buffers for open space protection strategies, including purchases, easements, and through alternative zoning techniques that require open space. Focus on assemblage of large areas of protected land in order to provide better protection for wetlands.
- Put a priority on protecting marsh migration areas on the Narrow River as identified by the RI SLAMM Project and, where possible, removing barriers to migration (such as parking lots, hardened shorelines, etc.).
- Develop or update local conservation development ordinances to shift new construction and development projects away from SLAMM projected potential salt marsh areas.
- Conduct a study to evaluate the feasibility of freshwater and coastal wetland restoration opportunities in the Narrow River Watershed.

- Encourage and help facilitate the restoration of wetlands and their buffers on public and private property.
- Continue to collaborate on addressing the vulnerability of salt marshes through pursuing restoration and adaptation strategies.
- Incorporate Low Impact Development techniques in local regulations to the maximum extent practicable.
- Consider requiring a smaller minimum threshold (than the State minimum) for project size to trigger stormwater management and soil erosion control requirements for new and redevelopment applications before the town.
- Complete and continue the freshwater wetland monitoring and assessment that has begun in the Narrow River watershed.
- Continue the salt marsh monitoring and assessment program for coastal wetlands in the Narrow River watershed.
- Study freshwater flooding of salt marsh areas and alter drainage work to prevent freshwater ponding on salt marsh habitats.
- Expand the ‘No Wake Zone’ in the Narrow River to protect salt marsh and eelgrass bed habitats from increased erosion caused by motor boat wake energy.

B) Loss of Vegetated Riparian Buffers

A vegetated riparian buffer is an area of natural trees, shrubs, and other vegetation located adjacent to rivers, streams, lakes, ponds, and wetlands. These unique areas provide the important functions below:

- protects waterbodies from those nonpoint pollutant sources discussed above, and other stressors by performing natural functions
- filters and slows down runoff and allows it to soak into the ground to recharge groundwater
- traps sediment before it can reach the waterbody
- treats nutrients in stormwater by uptake in vegetation or trapping in the soils
- transforms nitrate in the groundwater, thereby reducing the amount of nitrogen entering the waterbody (via denitrification as flow passes through water-saturated, organic rich riparian soils)
- stabilizes and protects stream banks from erosion
- moderates temperature and provides shading around the waterbody, helping to maintain conditions for the aquatic habitat
- provides areas for flooding, protecting downstream properties
- provides organic debris, woody materials, and insects essential to healthy river and stream habitats
- provides important habitat for connecting wildlife to the waterbody corridor system and is also often a special transition area hosting a diversity of wildlife between the aquatic and the adjacent upland habitats

Riparian buffers are lost when land is cleared for development, yards and lawn areas, agricultural use, or views to the waterbody. In Rhode Island, significant physical alteration of the upland buffers to both coastal and freshwater wetlands has occurred. Approximately 30% of Narragansett Bay's marshes have inadequate or non-existent buffer zones. A riparian buffer plan, discussed below, could identify the extent of inadequate riparian buffer in the Narrow River Watershed.

Because buffers perform so many important functions, it is just as important to restore buffers as it is to protect them from being removed or degraded. However, like wetlands, it is much more difficult to restore riparian buffers, which makes it all the more imperative to proactively protect existing vegetated buffers. Restoration efforts should be targeted to those areas most likely to greatly improve water quality and/or aquatic habitat. It also must be stated that pollution source reduction adjacent to waterbodies and their buffers is also needed for protection and more effective and comprehensive watershed management (

For more information and resources on riparian buffers, see the Rhode Island "Low Impact Development Site Planning and Design Guidance Manual."

What Needs to be Done?

Restoration of naturally vegetated buffers around wetlands and along rivers, streams, and ponds provides multiple resource protection benefits, including resiliency from flooding and a changing climate, in addition to water quality protection and wildlife habitat. It is a State policy to facilitate restoration of the quality and quantity of wetlands and their adjacent buffers.

There is now an accepted methodology for calculating pollutant reductions for buffers, which can also be used for applying pollution reduction credits in implementing TMDLs under an MS4 program for buffer restoration projects. For more information, see Section IX. B, Technical Resources.

Example of missing buffer in the watershed to the Crooked Brook on private property. Google Imagery, 2019. (location: referred to as, 'horse farm property' in TMDL.)

Opportunities to restore and protect buffers can be explored through the development of a Riparian Buffer Plan. Such a plan would identify and prioritize areas for restoration and may assess the feasibility and potential benefits of buffer restoration for a given site. Challenges include coordinating with often multiple private landowners. Planning for riparian buffer restoration could be performed in conjunction with hazard mitigation planning for flood prevention and mitigation projects. Extent and condition of riparian buffers has not been evaluated for the waterbodies in the Narrow River Watershed, which would be the first step. (A cursory look of buffer conditions observed off aerial photos is provided in Appendix 8 for each waterbody.)

<u>Recommended Actions</u>:

- Evaluate the extent and condition of riparian buffers in the watershed (including invasive species).
- Work with landowners to promote buffer protection and restoration where possible.
- Develop a watershed wide Buffer Protection and Restoration Plan
- Address horse farm per Crooked Brook TMDL. (Lack of buffer on this property, also potential agriculture use, see aerial photo in Appendix 8.)

C) Aquatic Invasive Species

When plants or animals are released in areas outside of their native range without their natural predators, they can grow and reproduce out of control. They become “invasive” species. Invasive species out-compete native species and significantly degrade wildlife habitat.

This plan focuses on aquatic invasive species (AIS, or non-native aquatic plants), but includes discussion of upland invasive plants. AIS create dense vegetative growth that interferes with recreational activities such as swimming, boating, and fishing, and have been documented by researchers to reduce lakeside property values. AIS can be difficult and expensive to treat. AIS can live in freshwater lakes and ponds, or on the shorelines of waterbodies and in freshwater and marine wetlands. Excess nutrients exacerbate the AIS problem.

Aquatic invasive species are a widespread and significant management concern in RI freshwaters. RIDEM conducts seasonal surveys of lakes and ponds and program partners collaborate with RIDEM by sharing reports of suspected problems and other information. In 2007, the Rhode Island Aquatic Invasive Species Management Plan, which outlines actions to prevent, control, and mitigate the impacts of AIS in Rhode Island waters, was approved. Unfortunately, the plan is not fully implemented, and RI continues to struggle with the significant and growing threat of aquatic invasive species and the lack of capacity and resources to carry out management needs.
[The plan can be accessed here: http://www.crmc.ri.gov/invasives/RIAIS_Plan.pdf
(also here: http://www.dem.ri.gov/programs/benviron/water/quality/pdf/aisplan.pdf)]

As noted in Section III, some of the freshwater ponds in the watershed have the invasive aquatic species Fanwort and Variable Milfoil. Both of these species spread by fragments, and can easily be cut up by boats or during mechanical removal, and transported downstream or to other ponds by small fragments stuck on boats or other water recreation gear or equipment. These waterbodies are listed on the State’s 303 (d) list as impaired for ‘not supporting fish and wildlife habitat due to the presence of non-native aquatic plants.’ However, since non-native aquatic plants are not a ‘pollutant,’ a TMDL is not required. A different approach is needed to address this problem. Public education and awareness for boaters of how to stop the spread of AIS is a key strategy. Efforts to prevent, control, and mitigate the spread of AIS need local involvement.

Fanwort observed in Silver Spring Lake.
(RIDEM August 16, 2017 Field Report)

Both freshwater and estuarine wetlands are highly vulnerable to the spread of invasive species that take advantage of situations where these habitats have been disturbed through clearing, filling, dredging, increased sedimentation, and flood or tide control operations. Presence of invasive species in a wetland or riparian buffer is often an indicator of such disturbances.

Invasive species can also negatively affect riparian buffers. Upland invasive plants can crowd out and replace native species, affecting the value and functioning of the habitat, temperature regulation, hydrology, and flood storage and infiltration capacity of the buffer. Methods of controlling or removing invasive plants can affect soil stability and increase stream bank erosion. The invasive Japanese Knotweed in particular, which is present in the watershed, tends to invade travel corridors such as road shoulders and streambanks, and is often spread by small fragments carried downstream in floodwaters where it takes over both areas of new sediment deposits and newly disturbed eroded areas. Japanese Knotweed can also pose roadway and stormwater drainage maintenance issues. Other invasive species known to invade riparian areas and wetlands in our region include: Norway Maple, Japanese Barberry, Yellow Flag Iris, Purple Loosestrife, Common Reed (Phragmites australis), Lesser Celandine, and Multiflora Rose (RIRC, 2005). Phragmites is present and has been spreading in the Narrow River watershed, affecting locations such as Little Neck Pond and Canonchet Pond. Some other terrestrial invasive species known to be present in the Narrow River Watershed include Japanese Stiltgrass, Black Swallowwort, Oriental Bittersweet, European Honeysuckle, and Porcelain Berry.

Aside from the freshwater lakes that have been surveyed for AIS by RIDEM, the presence of or extent of aquatic invasive species along the estuary, its tributary streams, and coastal and freshwater wetlands in the Narrow River Watershed is unknown. The presence and extent of terrestrial invasive species in the riparian buffers of the watershed is also unknown.

Managing the problem of invasive species in freshwater lakes and freshwater and coastal wetlands involves efforts to prevent the introduction of new species, rapidly respond to new infestations, and undertake the long-term management techniques to control existing infestations. Given the technical challenges and expense involved in managing infestations of aquatic invasive species, the RI Aquatic Invasive 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 wetlands, it is evident that active management of existing AIS is also a necessity and challenge.

In freshwaters, effective control of AIS is best accomplished using integrated pest management strategies detailed in a written lake management plan. The lake management plan should also address stormwater pollution control activities to limit nutrients exacerbating the problem with AIS. It is important to address these nonpoint sources of pollution, in particular phosphorus, that can promote plant growth in freshwater systems.

(In addition to invasive species, Lake Management Plans can address a number of localized issues pertaining to water quality and aquatic habitat, and are discussed further in Section VII. I), below.)

The Friends of Canonchet Farm has been a local leader in tackling the problem of upland invasive species, focusing their efforts around the farm and coastal ponds on the property. They offer training and organize volunteer groups to remove invasive species, and to re-plant native species as habitat restoration projects within the Canonchet Farm property, which extends from the farm to the cove. They have obtained a permit to treat phragmites in Lake Canonchet, which will be treated with herbicide over the next few years.

The RIDEM had State-owned Silver Spring Lake treated with herbicide to control AIS in the Summer of 2018.

(This watershed plan does not address marine invasive species.)

What Needs to be Done?

Recommended Actions:

- Institute a targeted public education and awareness program for AIS, such as the RIDEM GREAT Boater Volunteer Program, or another marketing campaign to raise awareness and encourage boat hygiene practices. http://www.dem.ri.gov/programs/water/quality/surface-water/aisresp.php#GREAT (partner with RI Save the Lakes)
- Install effective educational signs at boat ramps.

- Design and create designated areas at boat ramps specifically for cleaning off boats and consider providing water or a boat washing/cleaning station for washing boats at ramps.
- Develop Lake Management Plans for Silver Spring Lake, Carr Pond, Silver Lake, and Lake Canonchet/Little Neck Pond.
- Survey the watershed for the presence and extent of invasive species, with a focus on AIS in lakes and ponds; wetland areas; and riparian buffers and stream banks.
- As opportunities arise, take actions to control invasive species in the watershed.
- Promote or require the use of native species for landscaping and erosion control seed mixes (especially near wetlands) in all development and redevelopment projects.
- Promote the use of native and sustainable plants to homeowners and provide public education on the harms of invasive species.

D) Water Withdrawals

Hydrologic alterations in a watershed can also be caused from manmade withdrawals of water for watering lawns, irrigation, or drinking water, and have been identified as a concern in Rhode Island with respect to freshwater wetlands, including vernal pools, and fish supporting streams. Resulting impacts to the aquatic habitat occur due to loss of riverbed area covered by water, receding wetlands, loss of vernal pools, and inadequate baseflow of streams for a healthy, reproducing natural fish population. Fortunately, there are no known impacts due to water withdrawal from the Pettaquamscutt Aquifer on stream flows.

Another issue of water balance in a watershed involves out of basin transfers of water. Many areas in the watershed that utilized OWTS's have been sewered over the past 25 years. It was previously noted that the wastewater treatment plant for these sewered areas discharges its treated water outside of the watershed. This 'out of basin transfer' of water can be a concern because that water is not available to be recharged into the groundwater, such as through OWTSs systems, or otherwise have a longer retention time inside the watershed. Such a concern was expressed for the Narrow River watershed in the Atlantic Coastal Fish Habitat Partnership 2015 document "River Herring Habitat Restoration Needs." The concern in this report is that less water may be getting recharged now that the area is sewered and discharging out of the watershed, possibly causing reduced riverine baseflow, and the need to study the impact of this, which is currently unknown.

Out-of-basin transfer is a concern when the water supply derives from within the watershed, as is the case for water withdrawn by North Kingstown from the Pettaquamscutt Aquifer that is supplied to the sewered areas of Narragansett. However, much of the public water that is used in the watershed comes from supplies derived outside the watershed. Therefore, the water coming in from outside the watershed, that is also discharged outside the watershed, has little to no effect on the hydrological balance of water in the watershed. The overall mass balance of such inputs and outputs of water would need to be calculated in order to determine if a significant amount of water is no longer being retained in the watershed due to an out of basin transfer.

The Town of North Kingstown Water Department actively manages the drinking water program to respond to changing conditions, including the need for conservation measures. A sprinkler ordinance is in place to control lawn watering in summer. The Department's newsletter promotes the use of sustainable landscaping and Xeriscaping with informational articles.

What Needs to be Done?

Further Assessment Needs:

- Study of inter- and outer- basin utility transfer of water to calculate balance of water in the watershed.

E) Barriers to Stream Connectivity

Rivers and streams provide "highways" for aquatic species, allowing them access to a variety of food resources, places to lay eggs and rear their young, and hide from predators. For some species, such as American eel and River herring, the ability to move freely up and downstream in a river is a critical part of their life cycle.

Dams and other obstacles, such as road culverts, prevent the free passage of fish and wildlife, and therefore limit access to riverine habitat. If not properly designed and constructed, wetland crossings can fragment linear habitat corridors, disturb or block fish and wildlife passage, alter ecosystem processes and aquatic communities, flood roads and property, and compromise water quality. Much attention has been paid to fixing these barriers to stream connectivity in Rhode Island, by the physical removal of these barriers, the construction of fish ladders, and by the replacement of undersized or perched culverts with larger structures designed for wildlife passage.

The Narrow River system is an historically important habitat for American eel and river herring. Both of these species are counted annually by RIDEM at the Gilbert Stuart ladders during their migrations. According to a 2015 report on River Herring Habitat Restoration Needs by the Atlantic Coast Fish Habitat Partnership, one of the top threats to river herring are fish passage barriers. Other threats include water quality degradation, ocean bycatch, sedimentation, and loss of salt marsh from sea level rise due to climate change.

Dams

Since Rhode Island's earliest settlement, dams of varying size were constructed on all of its larger rivers and many of its smaller streams. There are very few natural lakes and ponds in Rhode Island, and many of these dams no longer have a useful function. No dams in the watershed are used for hydropower. However, some impounded lakes and ponds now serve an important public recreational use. Dam removal is the best way to restore river functions and aquatic habitat. This important goal needs to be balanced with the long-term costs and other public benefits that the impounded waterbody may provide. However, over time, it can be more expensive to maintain and repair a dam than it is to remove it (Save the Bay, 2010).

Since old dams can pose a safety hazard, they are given a hazard potential rating, and are visually inspected by engineers hired by RIDEM on a schedule determined by the hazard rating. A dam with a high hazard rating would be inspected more frequently than a low hazard dam.

The dams in the Narrow River watershed, their Hazard Potential, and condition (if known) are listed in **Table 7**, below. The Hazard potential is based on how much damage would occur if the dam failed, and is ***not*** related to the actual condition of the dam.

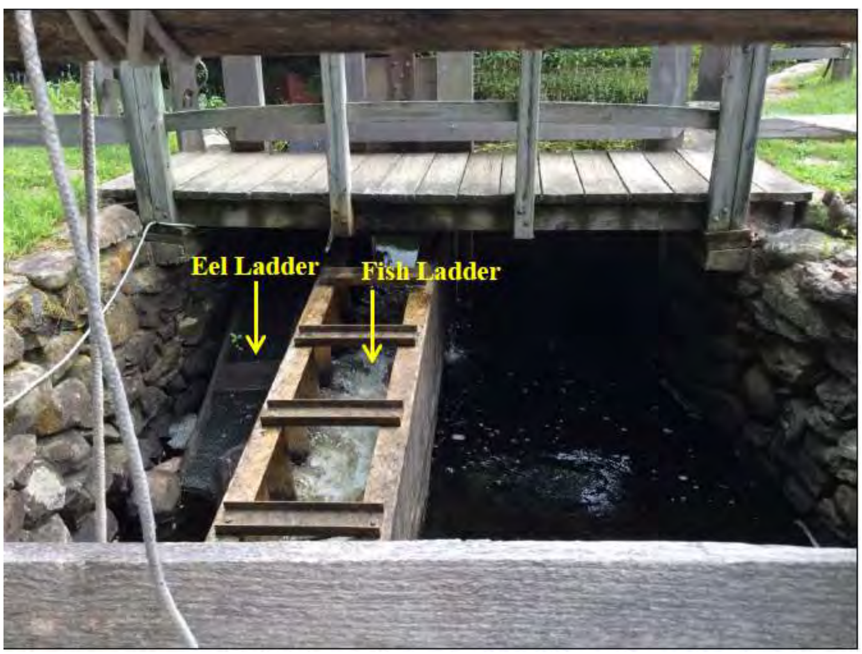
Table 7. Inventory of Classified Dams in the Narrow River Watershed

Town	Stream/River	Impounded Lake/Pond	Hazard Potential / Condition	Owner/ Caretaker
North Kingstown	Mattatuxet River	Silver Spring Lake	High / unsafe	RIDEM
North Kingstown	Tributary to Mattatuxet River (Pendar Brook?)	Pendar road pond	Low	
North Kingstown	Mattatuxet River Tributary	Bald Hill Nursery pond	Low	
North Kingstown	Mattatuxet River/ Gilbert Stuart Stream	Carr Pond/ Gilbert Stuart Pond	High	Gilbert Stuart Memorial, Inc./ Gilbert Stuart Birthplace & Museum
North Kingstown	Unnamed Tributary #2 to Narrow River	Mayo Farm Pond	Low	
Narragansett	Mumford Brook	Crying Bog	Low	
Narragansett	Sprague Brook	Sprague Pond Lower Dam (north of Kingstown Rd.)	Low	Town of Narr/ Parks and Rec
Narragansett	Sprague Brook	Sprague Pond (South of Kingstown Rd.)	Significant (but 2014 inspection report says High?)	Town of Narr/ Parks and Rec
Narragansett	Crooked Brook	Crooked Brook Pond	Low	

There are nine dams in the Narrow River watershed (see also, **Map 11**). If a dam cannot be removed, fish ladders or ramps may be installed to aid passage. There is a fish ladder and an eel ramp at the historic Gilbert Stuart site. However, a problem here is that the fish can be taken off-course, being attracted to the running water where the wheel for the mill operates, which jeopardizes their success. A temporary fence has been installed to prevent the fish from getting stranded in this location (personal comm. P. Edwards, 12/20/18). Silver Spring Lake dam has been evaluated for dam safety, and plans are being made to repair this dam (personal comm. E. Koo, 12/19/18), considering its importance as a popular state fishing area. There are no plans at this time for fish passage at the Silver Spring Lake dam, as there are other downstream barriers that would need to be evaluated first, such as the culverts at Route 138 and Route 1, and another obstruction recently discovered upstream of the Shady Lea dam.

Recent efforts taking place in the Narrow River watershed to restore the free movement of aquatic life up and down the river system includes a partnership among The Mill at Shady Lea, Save the Bay, RIDEM, and the Corporate Wetlands Restoration Partnership to remove the Shady Lea dam on the Mattatuxet River in North Kingstown. Save the Bay, Inc. secured multiple sources of funds to study and design the removal of the Shady Lea dam on the Mattatuxet River. This project will achieve multiple benefits of restoring the ecosystem function from a man-made pond to a natural stream bed habitat while improving flood resiliency. This dam was removed in July 2018.

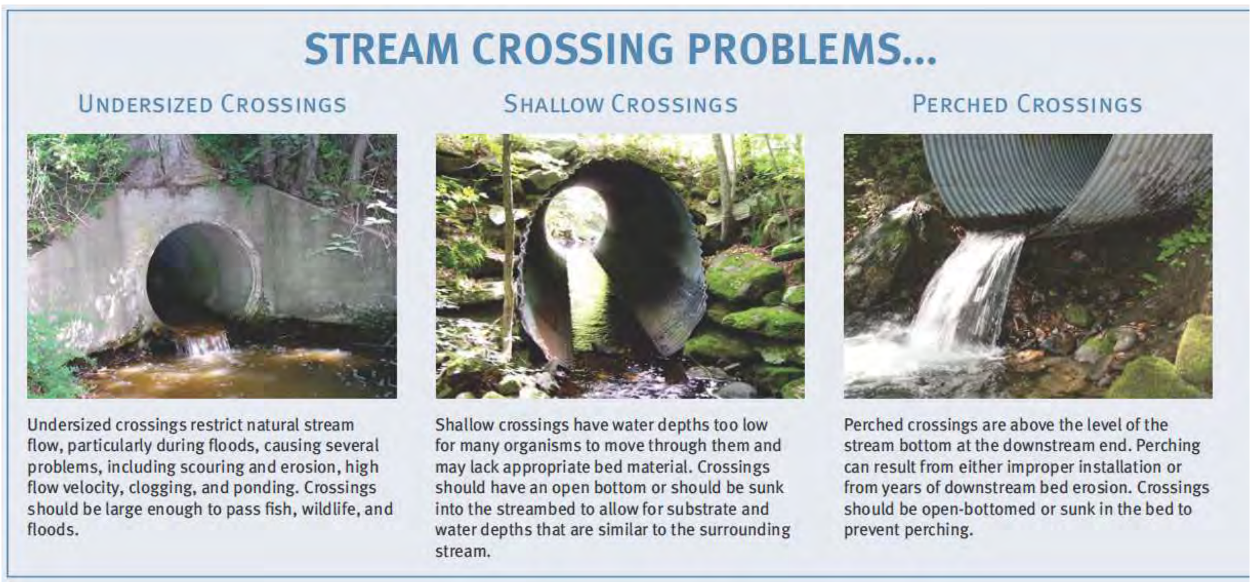
Another project was the Gilbert Stuart Fish Ladder and Eelway Adjustments project (awarded funds in 2011). The Gilbert Stuart Birthplace and Museum partnered with RIDEM to redesign and install a new fish ladder and modifications to the dam to improve access to Carr Pond for River herring and American eel.



Picture of fish passages at Gilbert Stuart Museum dam. Image taken from Carr Pond Dam Visual Inspection/ Evaluation Report by PARE Corporation, August 2014.

Substandard Culverts/ Other stream crossings

Not as dramatic as a dam, but as equally disruptive for some riverine species, are sub-standard stream crossings that are characterized by constricted or inadequate flow, culverts with sudden changes in elevation, blocked crossings, or crossings in disrepair. Culverts funnel a natural stream into an unnatural channel to accommodate vehicles, paths, or other structures on top of the stream, or to relocate the flow of the stream. They can often contribute to man-made flooding and stream erosion problems. Types of substandard culverts that prohibit or severely limit access and free passage for fish and wildlife are shown below.



Graphic from: Massachusetts Riverways Program. https://www.mass.gov/doc/massachusetts-stream-crossing-poster/download

There has not been a complete assessment of culverts or other road crossings in the watershed, though some crossings have previously been identified as a concern, and most of the crossings have been mapped. The North Atlantic Aquatic Connectivity Collaborative (NAACC) has completed a subwatershed prioritization to help identify subwatersheds in the region that may be higher priority for field survey. The crossings in the Narrow River Watershed have been mapped, and this watershed is ranked as a Tier 5 priority (out of 20). This map also includes an evaluation of restoration potential by location of non-bridge road stream crossings in the watershed. (To access this map, http://streamcontinuity.org/#collaboratives, and click on the TNC HUC12 Prioritization Tool to take you to the map viewer. You will need to zoom in to the Narrow River watershed and turn on the non-bridge road stream crossing layer.)
(See also, **Map 11**.)

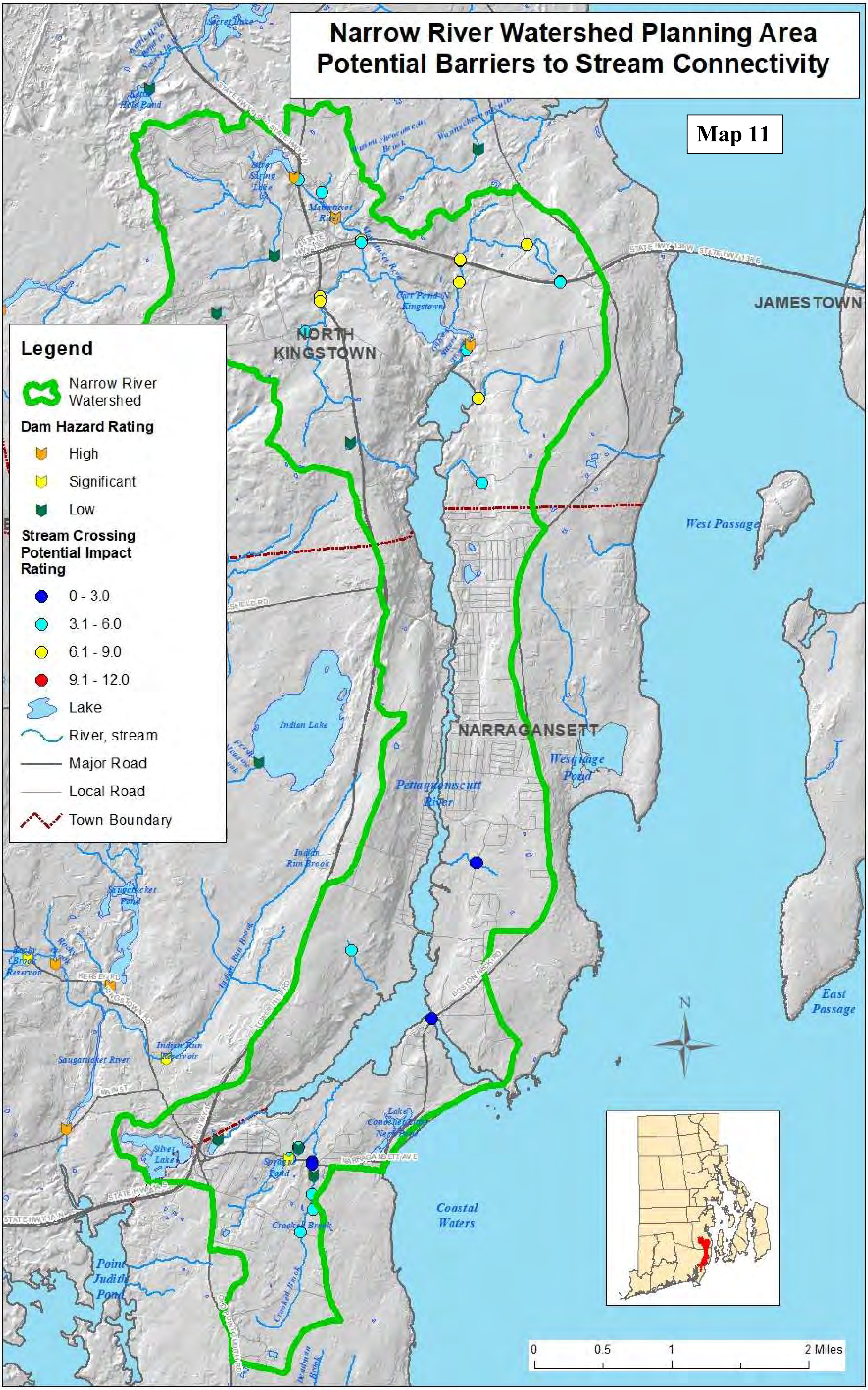
The crossings with greater restoration potential according to this inventory are:

- Culverts at crossing of wetland complex and unnamed stream with Route 138 (east and west bound lanes). Location is northeast of Carr Pond. (also a residential driveway with restoration potential downstream)
- Culverts at crossing of Mattatuxet River with Route 138 (east and west bound lanes)

- Perched culvert on TNC King Preserve in North Kingstown

Other areas of concern in the Narrow River Watershed as expressed by The Atlantic Coast Fish Habitat Partnership (2015) include evaluating:

- Culverts at crossing of Mattatuxet River with Route 1 (north bound lane and south bound lane)
- Mumford Brook road crossing at end of Pettaquamscutt Cove (Bowden, et. al, 2015)



Narrow River Watershed Planning Area
Potential Barriers to Stream Connectivity
Map 11
Legend
Narrow River Watershed
Dam Hazard Rating
High
Significant
Low
Stream Crossing Potential Impact Rating
0 - 3.0
3.1 - 6.0
6.1 - 9.0
9.1 - 12.0
Lake
River, stream
Major Road
Local Road
Town Boundary
NORTH KINGSTOWN
NARRAGANSETT
JAMESTOWN
West Passage
East Passage
Coastal Waters
Indian Lake
Pettaquamscutt River
Wesquage Pond
Indian Run Brook
Silver Lake
Point Judith Pond
Crooked Brook
Indian Run Reservoir
Saugatucket River
Silver Spring Lake
Carr Pond
N
0
0.5
1
2 Miles

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Stream Connectivity

The Narrow River system connects saltwater habitat from the Narragansett Bay to the fresh-water ponds and marshes in the upper reach of the watershed, which are important nursery and spawning habitats for anadromous fish, particularly River herring. River herring have been a historically important forage species for commercial fish. According to NOAA National Marine Fisheries Service, River Herring are listed as a 'species of concern' due to significant declines over most of their Atlantic range. Data on fish counts from RI DEM Fish and Wildlife indicates the number of these River herring has varied significantly over the years. As shown in **Table 8**., below, in the recent past there was a very high count in 2000 (290,814), but the numbers have dropped significantly since then, particularly between 2003 and 2009, and only rebounded to less than half. The cause for the decrease is not clear but may be related to water quality, lack of spawning habitat, climate change, predation, and by-catch.

Year	Herring Observed		Year	Herring Observed
1998	262,315		2009	34,835
1999	259,336		2010	110,287
2000	290,814		2011	64,500
2001	254,948		2012	107,901
2002	152,056		2013	91,240
2003	67,172		2014	102,408
2004	15,376		2015	11,135
2005	7,776		2016	74,304
2006	21,744		2017	72,664
2007	36,864		2018	86,520
2008	58,640		2019	35,832
			2020	125,196

Table 8: Annual Herring Counts for Narrow River at Gilbert Stuart (source: Data from RI Division of Fish and Wildlife, courtesy of Phil Edwards.)

In response to these declining numbers, Rhode Island has put in place a moratorium on the taking and possessing of River herring since 2006. The Atlantic States Marine Fisheries Commission has developed a River Herring Conservation Plan to increase public awareness of, and to help restore River herring. Maintaining and improving the Narrow River watershed as a spawning habitat for River herring is a goal for many stakeholders.

American eel, a catadromous species (spawn in saltwater and live in fresh and brackish water), are also monitored in the Narrow River. Eels mature in Carr Pond, where they can live for twenty years before leaving to spawn in the Sargasso Sea. Eel fry, called glass eels, are illegal to catch and are susceptible to poaching due to prices on the Asian market. Eel need a slower type of fish ladder to get over dams. An eel ramp is installed at the Gilbert Stuart dam.

What Needs to be Done?

For barriers such as undersized or perched culverts, an inventory would need to be conducted and any crossings determined to be substandard should be replaced with suitable crossings. A protocol for such an inventory is provided by the North Atlantic Aquatic Connectivity Collaborative. For information on design of suitable replacement crossings, refer to the Rhode Island Wetland BMP Manual. A complete assessment of crossings is an activity that could be combined with an assessment for storm and flood flow analysis for hazard mitigation purposes. Combining these goals broadens funding opportunities for restoration projects.

<u>Recommended Actions</u>:

- Municipalities work with and/or support RIDEM Fish and Wildlife to determine priority areas to investigate for potential barriers to fish passage.
- Coordinate with NRCS, RIDOT, and other organizations, including RI Emergency Management Agency and the local Hazard Mitigation Planning Committees to conduct an inventory and assessment of all stream crossings in the watershed.
- Conduct an inventory of substandard culverts for wildlife/fish passage and capacity for increased storm intensity. Use NAACC culvert assessment protocol.
- Coordinate with RIDEM and CRMC on updates for the following state plans: “Strategic Plan for the Restoration of Anadromous Fishes to Rhode Island Coastal Streams,” and “Rhode Island State Coastal and Estuarine Habitat Restoration Strategy.”
- Remove barriers and restore habitat for identified priorities.

F) Dredging and Dredge Material Management

There is no commercial boating or shipping in the Narrow River, which is a naturally very shallow estuary. The topic of dredging in the Narrow River has risen on numerous occasions for improving depth for recreational boating, as a source of sand for beach replenishment to the eroding Narragansett Beach, for improving flushing of the estuary to dilute the pollutant levels, and for creating relatively deeper areas for marine aquatic habitat ‘thermal refugia’ and areas with depths suitable for eelgrass habitat.

Should dredging be determined to be necessary in the Narrow River estuary, there are some important concerns to address. The potential long- or short-term benefits of dredging projects proposed for the Narrow River estuary must be weighed with the cumulative short- and long-term impacts. 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 actions of removal and redepositing the dredged sediment creates impacts to the aquatic environment that are similar at both steps, including:

- suspended sediment that is deposited can impact marine life, such as submerged aquatic vegetation and fish larvae;
- loss of marine life from the location of dredging;

- loss of bottom habitat in the area being dredged and at the place of disposal; and
- impacts of upland disposal of dredged material, primarily the infiltration to groundwater of contaminants from the sediment, including chlorides.

In addition to in-water and benthic ecological effects, there are other factors to consider when contemplating dredging. The Narrow River Special Area Management Plan discusses the myriad of potential short-term and long-term effects of dredging, and has specific policy and regulatory requirements pertaining to the topic of dredging in the Narrow River estuary. A recent report (by Swanson et al, 2016 for CRMC "Final Report: Impact of Dredging the Lower Narrow River on Circulation and Flushing in the Narrow River") indicates that dredging would alter the tidal attenuation, decreasing the suppression of the tide heights to the point where the change in inundation areas could negatively affect the salt marshes. This is an important consideration given the recent effort that has been undertaken to restore the salt marshes.

It has also been suggested that a jetty could be constructed to prevent the migration of sediment from the beach into the narrows in order to make it easier to retrieve the beach sand and also to help maintain flushing. This could reduce or eliminate the consideration of periodic dredging for this purpose. However, hard structures (such as jetties, groins, seawalls, etc.) placed in naturally dynamic coastal areas can alter hydrologic patterns resulting in a chain of potentially negative cascading effects (coastal erosion, sedimentation patterns, ecology, etc.). If this idea were to be explored, a thorough study would be needed to evaluate potential benefits and negative effects.]

What Needs to be Done?

Recommended Actions:

- Consider studying the feasibility and impacts of limited dredging for increasing flow/flushing; to retrieve beach sand; and/or for providing marine fish 'cool water refugia.'
- Consider a feasibility and impact study of a jetty structure at the mouth of the river to prevent and contain beach sand from entering the Narrows.

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VI. *Climate Change*

Climate change complicates many issues involving water quality, water quantity, and aquatic habitat, and exacerbates many of the threats identified in Sections IV. and V. Rhode Island is already facing the challenges of climate change, and these include sea level rise, increased storm frequency and intensity, changing patterns of precipitation and snowmelt, longer dry periods and droughts, increased evaporation, increased vulnerability to wildfires, and overall average warmer temperatures for air and water. While more rain is expected, it will not be evenly distributed throughout the year—flooding is likely to be worse in winter and spring, while droughts are likely to be worse than currently experienced in summer and fall.

A table of climate change issues provided in **Appendix 7** summarizes some of the anticipated effects associated with climate change, along with the environmental issues each effect can lead to, and some strategies to mitigate those impacts. Further discussion is below.

A) Stormwater, Drinking Water, and Wastewater Infrastructure

Climate change can affect the functioning of the storm water pollution infrastructure that we rely on to help keep our waters clean. Also, increased frequency of intense storms can overwhelm the existing storm flow drainage infrastructure (such as culverts, bridges, and catch basins), which may not have the capacity to freely pass the increased amounts of water, which can cause blow-outs or back-ups, thereby contributing to additional damage, erosion, and increased flooding risks to the public and the environment, and further decreasing the ability to treat the stormwater for water quality before it reaches our waterbodies.

Increased droughts and evaporation can affect the amount of drinking water supply available to serve our basic needs. Private wells near the coast can be affected by saltwater intrusion into the groundwater.

Warmer soil temperatures may decrease the effectiveness of OWTS to treat wastewater. Sea level rise can raise water tables along the coast which can impact septic systems and drinking water wells. Sea level rise, flooding, and storm surges can impact wastewater treatment plants, which tend to be located in low lying areas. Fortunately, according to CRMC's Stormtools Sea Level Rise mapping program, the South Kingstown wastewater treatment plant on Westmoreland Street in Narragansett is not in a flood zone or a sea level rise projection area.

B) Aquatic Habitat

Climate change is recognized as a threat to all aquatic habitats in the watershed, especially salt and brackish marshes, freshwater marshes, and vernal pools. Estuarine wetlands and other coastal habitats have the highest vulnerability to climate change impacts primarily due to the combined impacts of sea level rise and increases in storm frequency and intensity.

Freshwater wetlands are vulnerable due to changes 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 water regimes and temperatures can result in loss of wetlands and their valuable services to society; and can result in changes to species which can disrupt ecosystems in the short term, and alter them in the long term, resulting in loss of native habitat, while opening the door to invasive species. Warming air and water temperatures can affect fish habitat and water chemistry dynamics. Also, warmer water physically can't hold as much dissolved oxygen, and warmer water encourages the growth of algae, both situations exacerbating cultural eutrophication of lakes and ponds.

More extreme weather events of droughts and storms are expected due to climate change. Fires and hurricanes not only destroy habitat, but destroy the established vegetation and their stabilizing roots, resulting in increased erosion of fertile soils, erosion of river and stream banks, and sedimentation of stream beds. (Risk of wildfire during dry periods can also be enhanced due to deadwood from hurricane blowdown or from pestilence, such as gypsy moths.) Drought will affect base flow of streams, jeopardizing the survival ability of river species.

It is important to note that natural features such as coastal and freshwater wetlands and riparian buffers perform many important functions that self-regulate (or, counteract) and help mitigate climate change. It is therefore important to protect and not destroy these resources, otherwise the opposite effect can happen, accelerating climate change.

Of special concern in the Narrow River watershed are coastal wetlands. Due to their rarity and limited extent, brackish marsh communities are extremely vulnerable to the impacts of climate change, especially rising sea level. Application of SLAMM (Sea Level Affecting Marshes Model) modeling at several federal wildlife refuges in the Northeast has projected that the initial impact of sea level rise will be an increase in salt marsh (saline) habitats at the expense of brackish habitats (Manomet Center for Conservation Sciences and National Wildlife Federation 2012, as cited in RI Wildlife Action Plan by Terwilliger Consulting Inc., 2015). SLAMM modeling that has been applied to the Rhode Island coast (Boyd and Rubinoff 2014, as cited in Terwilliger, 2015) indicates similar impacts, with the degree of brackish marsh loss dependent on the accessibility of adjacent upland and/or freshwater wetland sites for inland marsh migration (Terwilliger, 2015, p. 2-29).

Another special concern in the Narrow River Watershed is the discovery of the inability of the salt marshes to keep up with rising sea level (and to a much lesser extent, land subsidence), and their degradation has been accelerating. The rate of sediment and detritus accretion in the salt marshes is less than the rate of the rising sea. A recent project at the John H. Chafee National Wildlife Refuge made an effort to stave off this 'drowning' of the salt marshes by restoring some areas with thin layers of sediment to build up the marsh elevation using a process called thin layer deposition. However, this is only a temporary solution and more sustainable solutions must be contemplated.

As sea level rises, new salt marsh habitat can naturally migrate inland as these areas are converted to the new tidal conditions, however, this can only happen if there are no physical barriers, such as hardened shorelines, parking lots, or buildings already occupying these potential migration areas. For more information on sea level rise and salt marsh migration, see the "Rhode Island Sea Level Affecting Marshes Model (SLAMM) Project Summary Report," March 2015, available here: http://www.crmc.ri.gov/maps/maps_slamm.html.

It is more important (and cost effective) to ensure, where practical, areas for these coastal wetlands to migrate to as sea level continues to rise than to attempt to address the issues by manually building up the existing marshes.

C) Flooding

As rain events are increasing both in frequency and intensity in the northeast due to climate change, the Narrow River Watershed will experience more flooding. Strategically analyzing the watershed for increased flood storage and retention capacity, and implementing strategies such as ensuring wetland protection or floodplain restoration projects, will help reduce this risk. Planning to avoid future development in projected floodplain areas and employing low impact development site planning techniques will also help reduce this risk. Such consideration should be included in local hazard mitigation planning. It is anticipated that flooding is likely to be worse during winter and spring, and droughts worse during summer and fall.

Areas of current flooding will experience more frequent flooding and/or a wider reach of flooding. As sea level rises, tidal flooding will affect new areas. There are already areas in the watershed with homes that flood during King tides in Narragansett and in the Middlebridge area of South Kingstown. As storms become more intense, surges from coastal storms will have a greater impact.

D) Managing Negative Effects from Climate Change and Sea Level Rise in the Watershed

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. Many of the topics discussed earlier, such as riparian buffers, wetlands, invasive species, wastewater, and stormwater, include how climate change interplays with that topic. This section covers items not already discussed earlier. The efforts already underway in the watershed to address the adverse effects of climate change and sea level rise include the following planning and management strategies:

Natural Hazard Mitigation Plans- a Hazard Mitigation Plan assesses the risks of natural disasters and a community's vulnerabilities to those risks, and includes plans for cost-effective strategies to mitigate those risks. Each of the three communities in the Narrow River Watershed has a Federal Emergency Management Agency (FEMA) approved Strategy to Reduce Risk from Natural Hazards, which includes a consideration of the impacts of a changing climate and sea level rise in the community.

Additionally, the towns of Narragansett and North Kingstown participate in FEMA's Community Rating System (CRS), which is a voluntary program that recognizes and encourages a community's efforts that exceed the National Flood Insurance Program's minimum requirements for floodplain management. By participating in the CRS program, communities can earn a 5-45% discount for flood insurance premiums based upon the activities that reduce the risk of flooding within the community. This program now includes discounts and incentives for protection and restoration of natural floodplain functions. See FEMA Fact Sheet: The Community Rating System Works to Protect Natural Floodplains, 2005.
https://www.fema.gov/media-library/assets/documents/115715

Comprehensive Plans- An amendment to the Rhode Island Comprehensive Planning and Land Use Act in 2011 requires that, by June 2016, local Comprehensive Plans seeking the benefits of State approval 'must include an identification of areas that could be vulnerable to the effects of sea-level rise, flooding, storm damage, drought, or other natural hazards. Goals, policies, and implementation techniques must be identified that would help to avoid or minimize the effects that natural hazards pose to lives, infrastructure, and property.' (RIGL 45-22.2-6)

Other Local Plans Addressing Sea Level Rise and/or Effects of Climate Change in the Watershed

- **North Kingstown**- "Adaptation to Natural Hazards and Climate Change in North Kingstown, Rhode Island" 2015 http://www.northkingstown.org/climate-change-adaptation

  This project evaluated impacts of sea level rise and storms on land use, bridges, culverts, stormwater systems, wastewater, drinking water, groundwater, wetlands, contaminated sites, and open space, among other sectors. The strategy options include recommendations of cost-benefit considerations in relation to the life-span of potential infrastructure investments.

  According to the study, approximately 54 linear feet of roadway in the Gilbert Stuart/ Walmsley Lane study area would be impacted by a 5-foot sea level rise scenario (above Mean High High Water), which is considerably less than other coastal areas that would be impacted in town. The area of town with the least amount of existing public assets at risk to sea level rise projections is in the Narrow River estuary.

- **South Kingstown**: "Building Capacity to Adapt to Climate Change Through Local Conservation Efforts: A South Kingstown Land Trust Pilot Project," URI CRC 2013 http://climatechange.lta.org/case-study/sklt_ri/

  This report provides guidance for conservation land owners on how to manage and monitor their properties for the impacts of climate change.

State/ Other Actions applicable in this Watershed:

Narrow River Estuary Resiliency Restoration Program

Led by the US Fish and Wildlife Service at the John H. Chafee National Wildlife Refuge, this restoration project was proposed to restore and enhance salt marsh and estuarine conditions, and to increase the ecological resiliency of the estuary in the face of sea level rise, climate change, increased coastal storms, and other natural and anthropogenic trends and impacts. This need was made apparent by the impact of Hurricane Sandy in October, 2012. The project was funded under the Disaster Relief Appropriations Act of 2013 (Public Law 113-2) and involved dredging areas at the cove and lower river to foster the growth of eelgrass; using the excavated sediment to build up the salt marsh in order to restore degraded and lost salt marsh areas; planting of salt grass plugs; and improving marsh surface drainage. The project environmental assessment report noted that while treatments to enhance elevation capital will help prevent catastrophic loss of salt marsh in the near term, sea level rise will continue to add stress on salt marsh and estuarine habitats.

STORMTOOLS

Sea Level and Storm Scenario Maps

STORMTOOLS is a very high resolution map viewer for stakeholders to evaluate sea level rise impacts on low-lying properties and public infrastructure in Rhode Island with simulations for 1, 2, 3, 5, 7, 10, and 12 feet of sea level rise. It also depicts projections of storm surge inundation extent and depth at any given point for nuisance floods (1,2,3,5, and 10 year recurrence intervals) and the 25, 50, 100, and 500 year storm scenarios. The storm surge scenarios may be shown combined with or without the sea level rise projections.
Sea Level Rise projections alone may be viewed here:
https://edc.maps.arcgis.com/home/webmap/viewer.html?webmap=f176a2def4714f2b986b8c0aece28cd2
Storm Surge projections (with or without SLR) may be viewed here:
http://www.beachsamp.org/stormtools/

Sea Level Affecting Marshes Model (SLAMM) Maps

The RI CRMC and its partners have developed Sea Level Affecting Marshes Model (SLAMM) Maps for the coastal wetlands of all 21 Rhode Island coastal communities. The purpose of these SLAMM maps is to show how coastal wetlands will likely transition and migrate onto adjacent upland areas under projected sea level rise scenarios of 1, 3 and 5 feet in the coming decades. These maps are intended to support state and local community planning efforts and to help decision makers prepare for and adapt to future coastal wetland conditions despite the inherent uncertainties associated with future rates of sea level rise. Maps and Report available here: http://www.crmc.ri.gov/maps/maps_slamm.html

RI CRMC Climate Change and Sea Level Rise Policy
Recognizing the potential impact sea level rise and climate change will have on the coastline of the state, the Rhode Island Coastal Resources Management Council (CRMC) adopted its Climate Change and Sea Level Rise policy as part of Section 1.1.10 (Formerly Section 145) of the R.I. Coastal Resources Management Plan (RICRMP). The findings in this section provide a discussion of the science and trends of sea level rise and the implications for planning and policy purposes. It can be accessed here: http://www.crmc.ri.gov/regulations/RICRMP.pdf

Education and Awareness for Municipal Boards and Commissions
In 2017, Rhode Island General Law 45-22-7 pertaining to powers and duties of local planning boards and commissions, was amended to add a requirement that each member of a planning board or commission must participate in two hours of training and education classes concerning the effects of development in a floodplain and the effects of sea-level rise once every two years. The RI Division of Statewide Planning issued a guidance memo including links to qualifying educational studies and training programs, which can be accessed here: http://www.planning.ri.gov/documents/about/PGM_Pl-Bd-Education_Final.pdf

Additional resources are available here: http://climatechange.ri.gov/cities-towns/toolkits-guidance.php

Providing Resilience Education for Planning in Rhode Island - (PREP-RI)
One of the resources currently available for local officials is an on-line training program prepared by URI Coastal Resources Center and the Narragansett Bay National Estuarine Research Reserve called PREP-RI (Providing Resilience Education for Planning in Rhode Island). This program consists of six modules covering the topics of Climate Change in RI, Flooding, Infrastructure, Stormwater, Mapping Tools, and Adaptation. It was designed for municipal officials but is informative and available for the general public and interested constituents, as well.
Website: http://prep-ri.seagrant.gso.uri.edu/

What Needs to be Done?
Addressing Watershed Resiliency: Flooding, Sea Level Rise, and Climate Change

Recommended Actions:

- Upon next update to Hazard Mitigation Plans, municipalities consider incorporating flood and storm surge protection projects involving habitat and wetland protection and restoration, including, but not limited to projects such as:
    - acquisition of marsh migration areas
    - conservation easements
    - culvert / stream crossing capacity upgrades that include stream continuity and wildlife passage
    - freshwater and coastal wetland and buffer restoration projects addressing such issues as fill, invasive species, clearing, hydrologic alteration, boat wake impacts, and other stressors, as applicable.
- Municipal Boards and commissions educate themselves on the impacts of flooding and sea level rise. Recommended for all Board members to complete the PREP-RI on-line module series, available here: http://prep-ri.seagrant.gso.uri.edu/
- Integrate/evaluate STORMTOOLS Sea Level Rise projections into planning infrastructure improvements and revisions to local land use ordinances
- Consider instituting a policy pertaining to prohibition of public investment in unsustainable measures that promote development or persistence of development in coastal areas at risk of rising sea levels. Pair such policy with conservation activities. (example, 'Blue Acres' program, coastal retreat)
- Incorporate SLAMM results and recommendations into community planning and municipal policies.

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VII. *Other Watershed Protection and Restoration Activities*

A) Narrow River Special Area Management Plan, CRMC, 1999, amended 2012

Originally adopted in 1986, the Narrow River Special Area Management Plan (SAMP) is a regional plan that recognizes that the watershed functions as an ecosystem. It "describes the present status of the river, characterizes its watershed, identifies sources of pollution, and recommends specific actions to restore, protect, and preserve this highly regarded natural resource." (CRMC, 2012)

This planning and management strategy document also encompasses the regulatory jurisdiction of the Rhode Island Coastal Resources Management Council (CRMC) over this coastal watershed. In addition to those activities captured under other CRMC management programs, certain activities which occur throughout the watershed are regulated. Authorized under the federal Coastal Zone Management Act of 1972 to develop and implement Special Area Management Plans to address specific regional issues, the CRMC coordinates with local municipalities, as well as government agencies and community organizations, to prepare the SAMPs and implement the management strategies.

In 2012, amendments to the Narrow River SAMP added density controls and other regulatory requirements to better manage nonpoint source pollution and cumulative development impacts.

For more information, refer to the Narrow River Special Area Management Plan. It can be found here: http://www.crmc.ri.gov/samp_nr.html

B) Comprehensive Planning

Rhode Island has a reciprocal system of land use planning whereby the State sets broad goals and policies through the State Guide Plan (including State Guide Plan Water Quality 2035) and municipalities express local desires and conditions through the development of community comprehensive plans. These local comprehensive plans serve as the basis for land use regulation and establish an implementation program for achieving each community's stated goals. An important part of a comprehensive plan is a Future Land Use Map, which depicts the location and densities of desired land uses and those areas identified for conservation. The Narrow River SAMP includes specific residential density policies for new development, as well as prohibitions of sewer and water line extensions in areas designated as "Lands of Critical Concern" and "Self-sustaining Lands" (except when certain criteria are met) which must be reflected on the local Future Land Use Maps.

C) Open Space Protection ("Conservation")

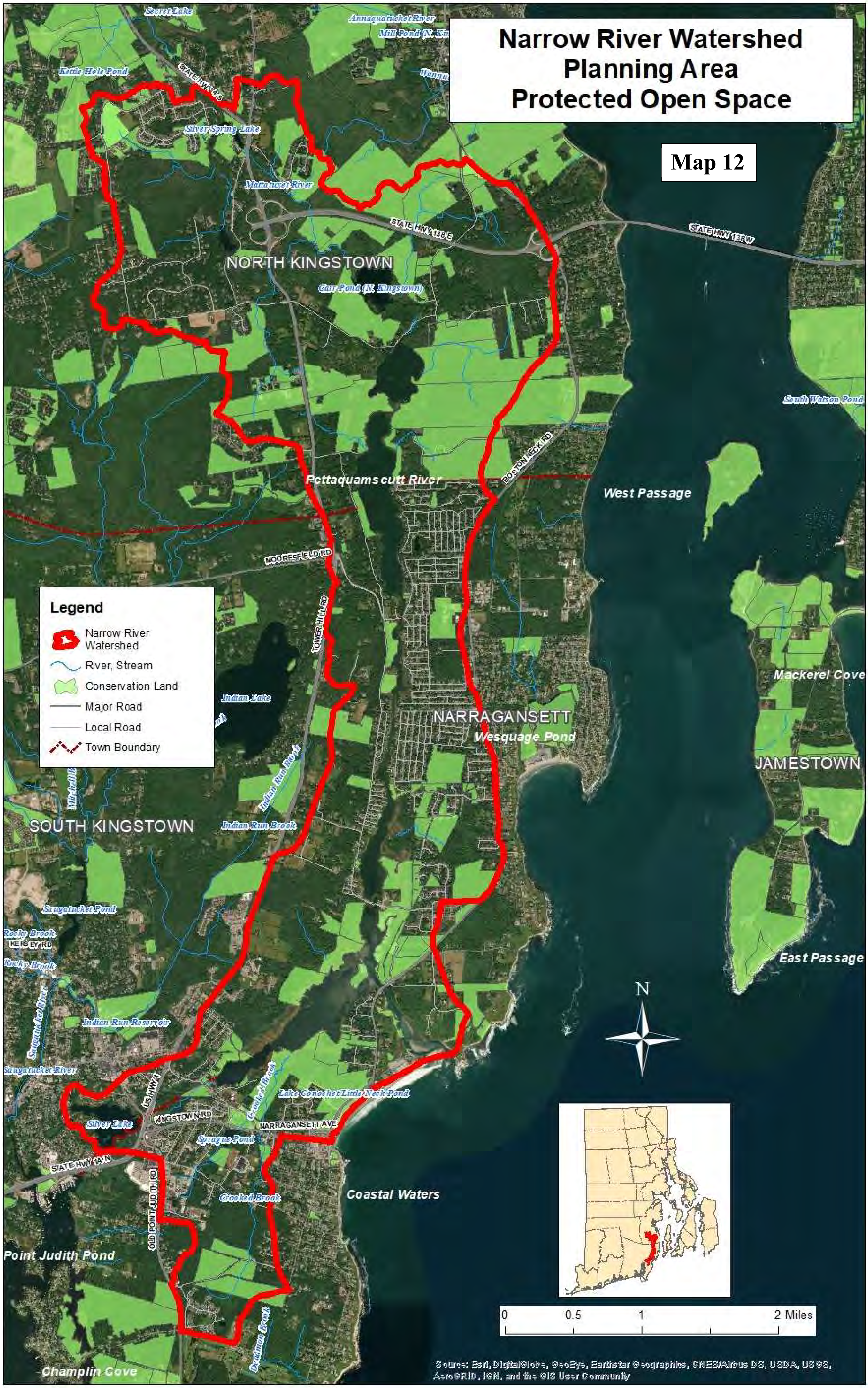
Preserving land in the watershed in its natural state is an important tool in protecting water quality and aquatic habitat. Natural landscapes remove pollutants through natural processes such as the infiltration of stormwater into the soil and the uptake of water and nutrients by plants. Protecting areas along the shoreline of a waterbody is particularly important as these natural riparian buffers reduce the amount of pollutants that enter the waterbody and provide important wildlife habitat for the many wetland dependent species.

In addition to the ways in which open space improves water quality, it also provides improved overall environmental quality, quality of life amenities, and economic benefits. It provides valuable wildlife habitat and migratory corridors; natural areas for groundwater recharge; recreational opportunities for hiking, biking, swimming, hunting, and fishing; pleasing scenic vistas; and often contains other historic and cultural values such as stonewalls.

In Rhode Island, natural landscapes are protected through conservation easements on private lands, purchases in fee simple, and conservation development (or 'cluster') zoning provisions. Conservation easements, which permanently limit the use of the land in order to protect its conservation value, are the most common tool for conserving private lands, and for adding an additional layer of legal protection to open space land. Conservation of land is undertaken by all levels of government (local, state, federal) and non-governmental entities, including land trusts and conservation organizations. Many homeowner's associations own conservation land as part of their conservation or cluster development neighborhood.

Active land stewards and land preservation groups in the watershed include:

- The Narrow River Land Trust (private)
- State of Rhode Island Department of Environmental Management
- U.S. Fish and Wildlife Services (federal)
- The Nature Conservancy
- The Land Conservancy of North Kingstown (private)
- Narragansett Land Conservancy (municipal)
- South Kingstown Land Trust (private)
- Audubon Society of Rhode Island
- US Department of Agriculture, Natural Resources Conservation Service
- Town of South Kingstown
- Town of Narragansett
- Town of North Kingstown
- Historic New England



Narrow River Watershed
Planning Area
Protected Open Space
Map 12
NORTH KINGSTOWN
NARRAGANSETT
SOUTH KINGSTOWN
JAMESTOWN
Pettaquamscutt River
West Passage
East Passage
Mackerel Cove
Wesquage Pond
Coastal Waters
Point Judith Pond
Champlin Cove
Silver Spring Lake
Carr Pond (N. Kingstown)
Indian Lake
Indian Run Brook
Saugatucket Pond
Indian Run Reservoir
Saugatucket River
Silver Lake
Sprague Pond
Crooked Brook
Lake Canochet/Little Neck Pond
South Watson Pond
Kettle Hole Pond
Secret Lake
Annaquatucket River
STATE HWY 138 E
STATE HWY 138 W
MOORESFIELD RD
TOWER HILL RD
BOSTON NECK RD
KINGSTOWN RD
NARRAGANSETT AVE
OLD POINT JUDITH RD
STATE HWY 1A N
Legend
Narrow River Watershed
River, Stream
Conservation Land
Major Road
Local Road
Town Boundary
N
0
0.5
1
2 Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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In the Narrow River watershed, over 33% (2,887 acres) of the watershed is currently protected as open space for conservation purposes (See **Map 12**). Much of this conservation land is strategically concentrated around Pettaquamscutt Cove, Crooked Brook, and the lower river, with some stretches protected immediately adjacent to the upper river on the South Kingstown side, and around Lower and Upper Ponds in North Kingstown. The headwaters to some small streams—such as Crooked Brook, some headwaters to the Mattatuxet and around the Silver Spring Lake, and an unnamed stream leading into the southeast end of the Carr Pond in North Kingstown—are also protected. There is also a fair amount of protected land in the uplands to the river. Note that some land that is protected from development may remain in agricultural use, and therefore, it can still be a source of pollution.

The Narrow River Land Trust is one of the largest open space holders in the watershed and is the only organization dedicated to serving the whole watershed. From their website, "Narrow River Land Trust preserves land in the watershed to protect water and agricultural resources, wildlife habitat, and open space for recreation. We work cooperatively with private owners and local communities to ensure that these areas are protected now and for future generations."

What Needs to be Done?

Limited resources requires that entities target areas for open space preservation based on the organization's goals, funding source program goals, and an evaluation of the resource value of a piece of property (water supply, habitat value, etc.).

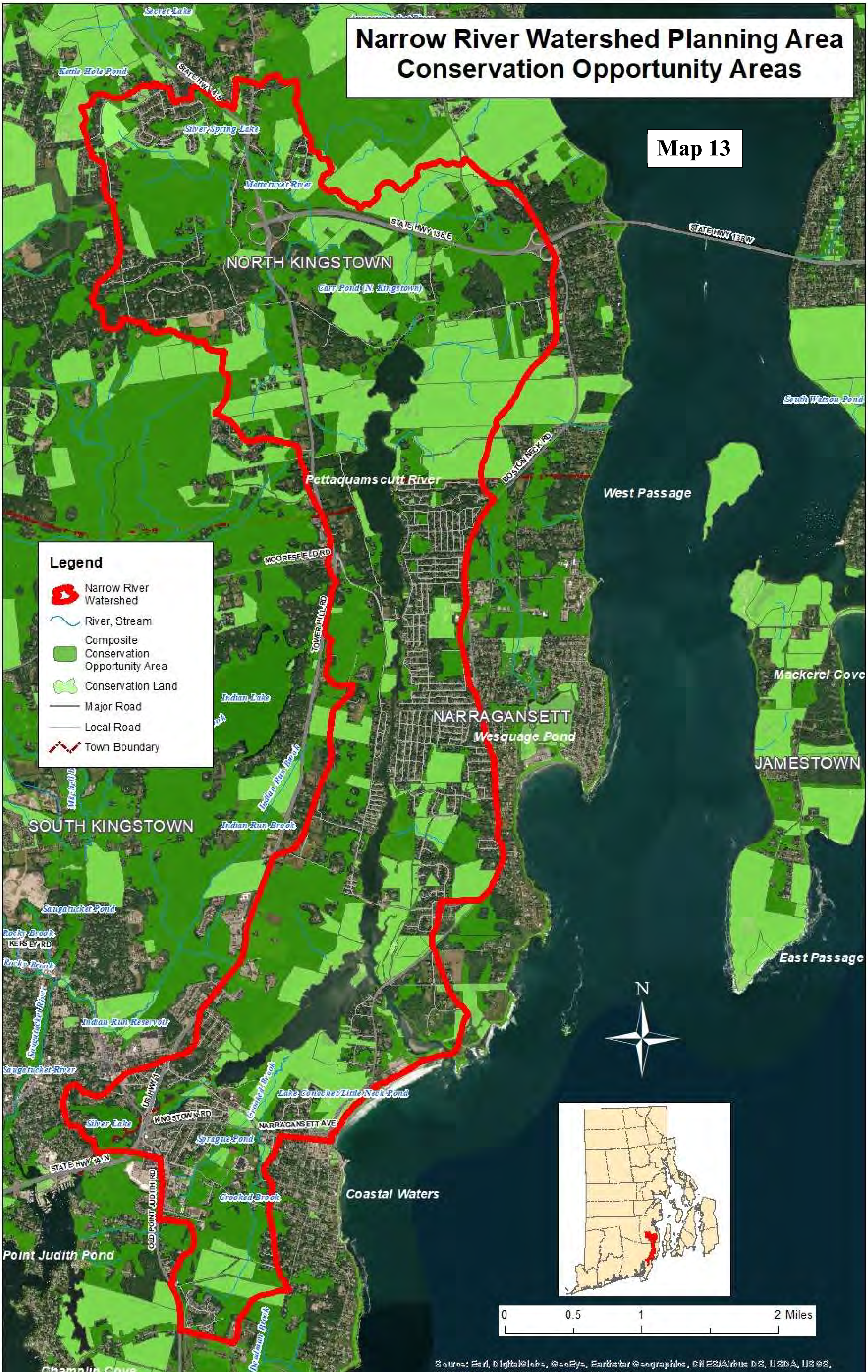
Targeting the preservation of intact wetlands and buffers along shorelines of streams and ponds is particularly important from both a water quality protection and aquatic habitat perspective. Open space conservation efforts can also focus on preserving reserve areas where coastal marshes can migrate to in the future as sea level rises (aka, 'marsh migration areas'), and the 'Conservation Opportunity Areas' (COA's) identified in the RI State Wildlife Action Plan.

The Conservation Opportunity Areas are mapped areas where a multitude of important conservation and ecosystem features overlap, including areas of large unfragmented forest, habitats of high biodiversity and high vulnerability, Ecological Land Units (ELU's) of diverse physical features, marine and estuarine systems, coastal habitats, natural corridors, and areas that are important to the species in Rhode Island with the greatest conservation need. COA's are priority areas that offer the best opportunities for conserving RI's species of greatest conservation need. The ELU's are landscapes that support ecological diversity and build in an element of resiliency, as these areas are likely to support diverse communities of plants and animals as the climate changes.

Map 13 shows composite COA's (which encompass many ELUs) in relation to the already protected lands. This map shows where there are gaps in protection of priority lands.

Other opportunities for open space protection are those areas noted in the Land Use Section II. B), above, that are shown on the maps in Figure 3. from the Narrow River SAMP as "Lands of

Critical Concern." These areas are planned for restricted low density residential development as a protection mechanism, however, their more sensitive nature also lends these areas for conservation protection, particularly when coinciding with the Conservation Opportunities areas discussed above.



Narrow River Watershed Planning Area
Conservation Opportunity Areas
Map 13
NORTH KINGSTOWN
NARRAGANSETT
SOUTH KINGSTOWN
JAMESTOWN
Pettaquamscutt River
West Passage
East Passage
Mackerel Cove
Wesquage Pond
Coastal Waters
Point Judith Pond
Champlin Cove
Legend
Narrow River Watershed
River, Stream
Composite Conservation Opportunity Area
Conservation Land
Major Road
Local Road
Town Boundary
N
0
0.5
1
2 Miles

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Organizations involved in protecting open space can also have a role in restoring important buffers and wetlands, whether on property that they control, or by working with land owners to promote and facilitate buffer and wetland restoration on private property. In addition to targeting healthy land for protection, land with restoration opportunities—such as altered wetlands or buffer areas in poor condition—can also be targeted for acquisition or easements, as these lands have the potential to contribute to improving conditions upon restoration. Riparian buffer areas that have been degraded or destroyed are much easier to restore once they are in control of a conservation organization.

Recommended Actions:

- Continue to pursue open space conservation, with a priority on areas that contribute to the protection and restoration of water quality and aquatic habitats, including wetlands and buffers, coastal marshes and salt marsh migration areas, groundwater reservoirs and recharge areas, and Conservation Opportunity Areas. Also focus on the connectivity of these areas.
- Consider amendments to local development regulations to strengthen the use of cluster zoning and conservation zoning for the purposes of protection of water resources by conserving ample forested riparian buffers and maximizing the use of LID.
- Establish criteria for preservation of open space, including creation of "green corridors" that connect conserved parcels.
- Support federal, state, and local agencies as well as non-governmental organizations in protecting natural resources. Establish partnerships with Narragansett Land Conservancy Trust, Friends of Canonchet, Narrow River Preservation Association, Audubon Society of Rhode Island, and The Nature Conservancy, among others working in the region. (under 'Plan Implementation' in Implementation Table)

D) Individual Actions

Be a Part of Protecting and Improving Water Resources

Each of us can make a difference improving water quality and protecting wetlands by being aware of our water resources and our actions, and taking steps to protect and restore these resources. Individual actions in our own backyards may not seem to have 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!

Watershed protection and restoration can only be successful when those that live and work in the watershed realize that they are a crucial part of their watershed.

Residents play an important role in protecting water resources in the Narrow River watershed.

Education and outreach to the public is crucial in reducing residential sources of water pollution. See **Appendix 5** for a brochure of actions that individuals can take to help protect and improve water quality in their watershed. Many of these actions are described in greater detail at the Rhode Island Stormwater Solutions webpage (link in Appendix 5).

E) Support Watershed Organizations

The best way to inform and engage the public is by means of an active local watershed organization. The **Narrow River Preservation Association** (NRPA), formed in 1970, works to preserve, protect, and restore the natural environment and the quality of life for all communities within the Narrow River (Pettaquamscutt Estuary) and Watershed.

The NRPA's work includes:

- An extensive river monitoring program, in which volunteers test water at 14 sites on the river and its freshwater inputs. The program, part of URI Watershed Watch, completed its 27th year in October 2018.
- A robust annual schedule of educational programs and recreational events that build awareness of the watershed and the need to protect its environment.
- Support of other non-profit environmental and cultural groups in the three watershed towns and a willingness to cosponsor new programs.
- Consistent and sustained public outreach through publications, speakers, a newsletter, a website, Facebook and Twitter.
- Watchful eyes on the health of the river for all communities of life in the watershed.
- The NRPA has also funded the Active Watershed Education Program (AWEsome) in south county schools since 1996.

NRPA is the RI Rivers Council (RIRC) designated watershed organization for the Narrow River. With this designation (pursuant to RIGL 46-28), NRPA is able to:

- receive notice of state and local projects in their watershed,
- testify before local and state hearings on issues affecting their watershed, and
- be eligible for small state grants through the RI Rivers Council (http://www.ririvers.org/).

The Narrow River Preservation Association is a key partner to promote and implement this watershed plan and to advocate for watershed action into the future.
Visit the NRPA's website here: http://narrowriver.org/.

F) Public Outreach

Public education and awareness is a key part of this watershed plan because everyone in the Narrow River watershed poses a risk to surface water, groundwater, and aquatic habitats. Though many actions to improve water quality are the responsibility of government agencies, other actions taken by residents and non-governmental groups have the potential to make a large difference in local water quality. Most homeowners will work to protect their local water resources if they know how to minimize contamination risks. 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.

Outreach to Narrow River watershed residents for pollution prevention has been on-going and will continue to be formally coordinated and/or reported through the individual municipal MS4 Phase II Programs and their partnerships. Such outreach activities are documented in their Annual MS4 reports.

Storm drain in Narrow River Watershed with informative message.

Some of the most important areas to focus on for pollution prevention are pet waste responsibility; lawn care; vegetated buffers; waterfowl; septic system maintenance; information for private well owners; proper disposal of household hazardous wastes, trash, and recycling; and ways to reduce stormwater. Other pollution prevention outreach should include addressing the potential threats from aboveground and underground storage tanks.

Outreach to the public should also include education on the values and importance of wetlands, riparian corridors, vegetated buffers to waterbodies, open space protection, and green infrastructure.

Local Land Trusts, Conservation Commissions, and Groundwater or Stormwater Committees can cover such topics in their programs also.

Opportunities to reach the public on these issues include local Earth Day events, environmental fairs, and special programs. Media outlets include municipal newsletters, pamphlets, stormwater webpages, and social media engagement. Pamphlets and/or posters can be provided to local businesses that directly engage the public on related water quality topics. For example: educational materials can be provided at water-based recreation businesses such as Narrow River Kayaks; at local pet service businesses to address pet waste; etc.

One way to create and increase public awareness of the importance of the watershed is with watershed road signs to indicate entering or leaving the Narrow River Watershed. These signs can also promote a sense of stewardship for the watershed with a message, such as to 'help keep it clean.'

Examples of outreach materials are included in Appendix 5. Other materials are available from the following organizations:

RI DOH: http://www.health.ri.gov/water/about/yourwater/
RI DEM: http://www.dem.ri.gov/programs/water/quality/
RI NEMO: http://web.uri.edu/nemo/
(see also: https://web.uri.edu/riss/stormwater-managers/educational-materials/
EPA: https://www.epa.gov/ground-water-and-drinking-water and https://cfpub.epa.gov/watertrain/
RI USDA/NRCS: https://www.nrcs.usda.gov/wps/portal/nrcs/main/ri/home/
Southern RI Conservation District: http://sricd.org/

Recommended Actions:

- Promote actions that can be taken by homeowners or individuals to keep water clean.
- Promote support of watershed organizations.
- Continue to implement the stormwater pollution prevention education and outreach, and public participation efforts of the local MS4 programs, and include the following pollution topics and how they relate to concerns in the Narrow River Watershed: pet waste responsibility; lawn care; waterfowl; vegetated buffers; septic system maintenance; information for private well owners; proper disposal of household hazardous wastes, trash, and recycling; above- and below-ground storage tanks; and ways to reduce stormwater. (under Stormwater Actions in Implementation Table)
- Incorporate public education on the importance of wetlands, riparian corridors, vegetated buffers to waterbodies, open space protection, and green infrastructure in outreach media and activities. (under Wetland Actions in Implementation Table)
- NRPA and/or the towns can install 'Entering/Leaving the Narrow River Watershed' signs to create awareness. (As a resource, see Creek Sign Guide https://oaec.org/wp-content/uploads/2014/12/creek-sign-guide.pdf)
- Update and re-issue the the "Narrow River Handbook." This document developed by NRPA has been distributed to all property owners in the past on what to do to protect/improve Narrow River water quality.This document was first issued in 1998, and reissued in 2002 and 2008. Alternatively, use Save the Bay's 'Bay Friendly Living'

booklet, available here: https://www.savebay.org/wp-content/uploads/Bay-Friendly-Living.pdf

G) Recreation: Potential Effects on Water Quality and Aquatic Habitats

A concern expressed by the stakeholders during development of this watershed plan is the potential impact of recreation on the environment. There is no question that recreation is an important resource that the watershed provides. However, there are two areas of possible negative impacts which should be further studied to determine how much, if any, impact recreation has on the environment in the watershed, and if so, to determine the appropriate response and management to mitigate those effects.

One question is the intensity of use in the lower river, the flats, and at the Narrows (mouth) of people bathing and congregating with food and dogs, where there are also no sanitation facilities or trash facilities; and how these factors may possibly contribute to bacteria and nutrient loading from human waste, pet waste, and the attracting of wildlife and waterfowl to the food scraps and trash.

The other question for study is the potential impact of jet skiing and motor boating on the aquatic habitats, particularly eelgrass beds and the salt marshes. As noted in the Narrow River Special Area Management Plan, the propellers can cut up the shallow eelgrass and the salt marsh edges if they come in direct contact with these areas, and the boat wakes can inundate and cause erosion and collapse of the salt marshes if motorized watercraft drive fast enough to increase wave action.

Recommended Action**:**

- Assess the impact of recreation on the water quality and aquatic habitat of the Narrow River. Develop a Recreation Management Plan, if necessary.

H) 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. 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 specific threats to water quality and habitat conditions that affect the beneficial uses (such as recreation and wildlife habitat) of the lake, and the actions needed to prevent degradation, restore the uses, and manage existing conditions. Actions commonly reflected in a plan include, but are not limited to, strategies to control invasive plants, reduce phosphorus and other pollutant loadings (promote proper maintenance of OWTSs, upgrades of cesspools, fertilizer practices, stormwater BMPs), protect lake shoreline vegetation (riparian areas), and to manage hydrology (dam operations). Resources for developing a Lake Management Plan are provided in Section IX. B) 7).

<u>Recommended Actions:</u>
Prepare Lake Management Plans for the following lakes:

- Silver Spring Lake- to address phosphorus and non-native aquatic species
- Carr Pond- to address non-native aquatic species (see if Gilbert Stuart Museum is interested)
- Silver Lake- to address phosphorus and low dissolved oxygen; and the prevention of non-native aquatic species

I) Groundwater Protection

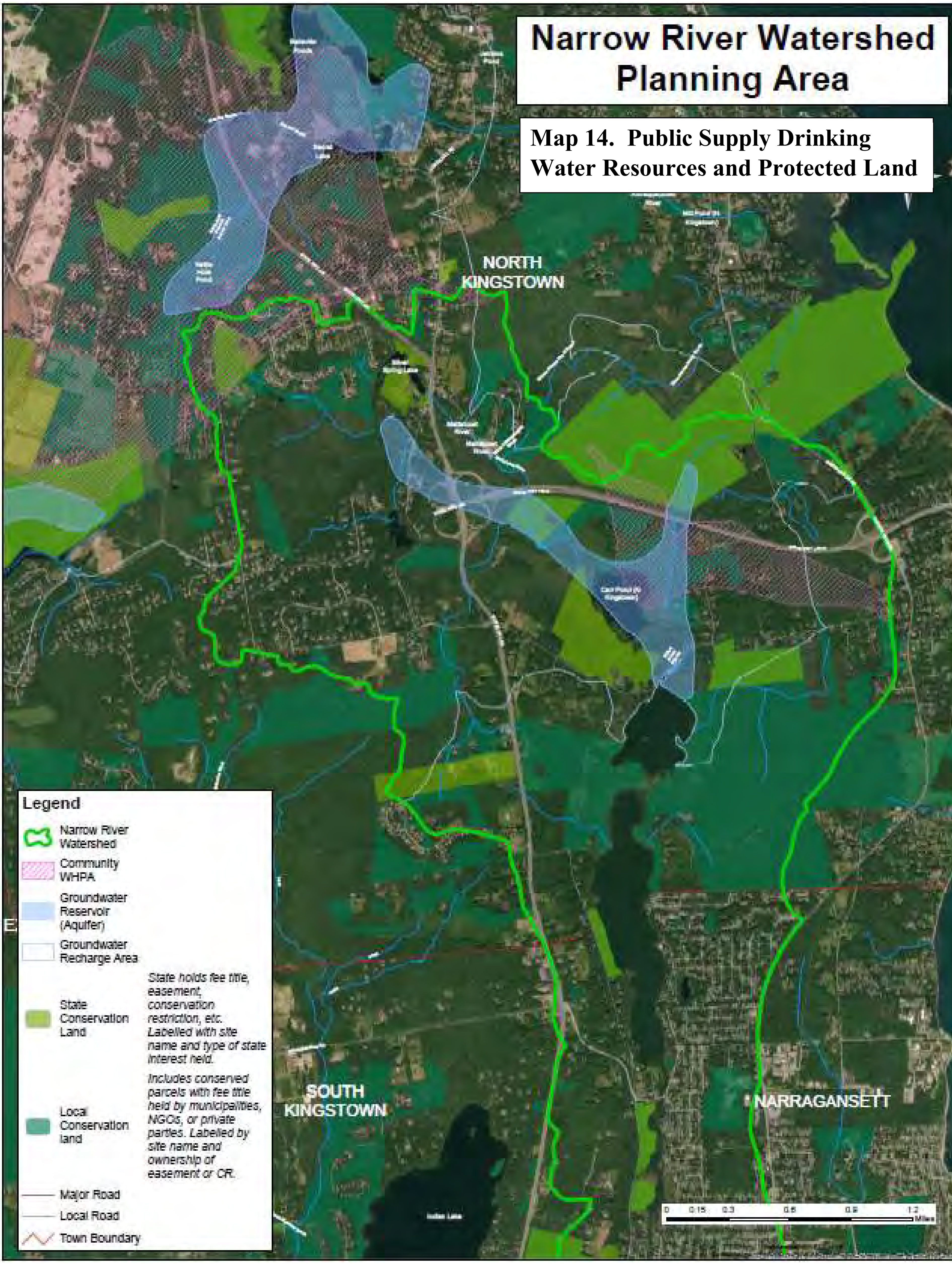
Public Water Supply Protection Management Activities

The area within the aquifer and its recharge areas that are protected from future development is shown on **Map 14**. The rest of the groundwater aquifer and recharge areas are zoned for Rural Residential and Very Low Density Residential land uses, and are further protected by the Groundwater Overlay districts. The Town of North Kingstown also has an On-site Wastewater Management Plan and associated wastewater management district to protect groundwater. See Section IV. A) 2) for further information on this program. Additionally, the North Kingstown Water Department has installed signs on roadways at the aquifer boundary so residents and visitors are aware that their actions impact a public water supply.

According to the 2008 North Kingstown Wellhead Protection Area Report (Source Water Assessment), the wellhead protection area for the public wells in the Narrow River Watershed has a moderate pollution risk and notes that ‘protection efforts are important to assure continued water quality.’ (URI NEMO website)

Recommended Actions:

- All existing and new development within groundwater protection areas to conform the Groundwater Protection Ordinance, and site plan and stormwater management design criteria for groundwater districts.
- Continue to acquire land and development rights, and to encourage land conservation in groundwater protection areas.
- Apply components of the State Water Supply System Management Planning Act to achieve effective and efficient conservation, development, utilization and protection of the water system’s resources in ways that satisfy the present and future needs of the Town.
- Continue to implement conservation techniques for the wise use of drinking water supplies.
- Integrate groundwater issues into public education programs: water conservation, household hazardous waste, septic systems, underground storage tanks (home heating fuel), pesticides, and other groundwater information.
- Continue to maintain signs on roadways at the watershed / aquifer recharge boundary so residents and visitors are aware that their actions impact a public water supply.



Narrow River Watershed Planning Area
Map 14. Public Supply Drinking Water Resources and Protected Land
NORTH KINGSTOWN
SOUTH KINGSTOWN
NARRAGANSETT
Legend
Narrow River Watershed
Community WHPA
Groundwater Reservoir (Aquifer)
Groundwater Recharge Area
State Conservation Land
State holds fee title, easement, conservation restriction, etc. Labelled with site name and type of state interest held.
Local Conservation land
Includes conserved parcels with fee title held by municipalities, NGOs, or private parties. Labelled by site name and ownership of easement or CR.
Major Road
Local Road
Town Boundary
0 0.15 0.3 0.6 0.9 1.2 Miles

VIII. *Implementation Table*

Table 9 identifies the actions for addressing the goals noted at the beginning of this watershed plan. The action items are derived from the discussions in the plan, and also include actions derived or modified from implementation of TMDL's, local, state, and regional plans, stakeholder comments, and other best management practices. Each action item is prioritized to reflect items of high importance that should be addressed first. Some items are requirements and are not given a priority, as they must be done. Implementation action items were prioritized based on the goal priorities, professional judgement of the direct applicability of the action to address the concern, relative ease of implementing the measure, and the input from the stakeholders during meetings and the workshop exercises.

The Implementation Table is divided by management topic, and includes the following information:

1) Action Item
2) Responsible Party: primary responsible parties listed include municipality, state agency, non-governmental organizations, private companies, landowners, etc. Supporting parties are indicated in parentheses.
3) Timeframe: on-going, 1-2 years, 3-5 years, 5-10 years. When target completion dates are known, these are included.
4) Cost Estimate: Relative indication of estimated cost as follows:
   $ = <$25,000; $$ = $25,000 -- $100,000; and $$$ = >$100,000
5) Priority, as follows:
   Required
   H – High
   M – Medium
   L – Low

Responsible Party Abbreviations:

Narr = Town of Narragansett
NK = Town of North Kingstown
SK = Town of South Kingstown
NRPA= Narrow River Preservation Association
RIDEM= RI Department of Environmental Management
RIEMA=RI Emergency Management Agency
RIDOT= RI Department of Transportation
CRMC= RI Coastal Resources Management Council
USFWS= US Fish and Wildlife Service
SRICD= Southern RI Conservation District
NRCS= RI Natural Resources Conservation Service
WRB= RI Water Resources Board
HMC=Hazard Mitigation Committee (local)
NGO's= Non-governmental organization, as applicable

Table 9. Narrow River Watershed Plan Implementation Action Items

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Stormwater Management				
Eliminate illicit sanitary and gray-water connections to storm sewers. (Priority areas include Mettatuxet and Rio Vista neighborhoods, and Middlebridge.)	Narr, NK, SK	1-2	$$$	H
Install stormwater BMPs per the Narrow River TMDL as resources allow.	Narr	On-going	$$$	H
Finish implementation of the recommendations from the Tri-town stormwater report and put in BMPs at Pettaquamscutt Lake Shore and Indian Trail Neighborhood.	Narr	3-5	$$$	H
Continue to install stormwater BMPs per stormwater study to implement the Narrow River TMDL.	SK	1-2	$$$	H
Conduct feasibility and prioritization study for mitigation actions/ BMPs identified in the Crooked Brook TMDL.	Narr	1-2	$$	H
Implement stormwater mitigation to treat runoff from outfalls identified in the Crooked Brook TMDL as prioritized by feasibility study.	Narr	3-5	$$$	H
Consider adopting local stormwater requirements, including soil erosion control, for development projects smaller than one acre (smaller than the state minimum requirement) for new and redevelopment applications.	Narr, NK, SK	1-2	$	H
Review existing planning and development ordinances to evaluate what LID techniques are included, decide what LID techniques would be appropriate for the community to incorporate, and adopt the use of the selected LID techniques into local development regulations for use in proposed development and redevelopment projects. See section IV. B) 4) for steps to take.	Narr, NK, SK	1-2	$	H

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Ensure ordinances pertaining to Post Construction Stormwater Runoff Control are applied to all zoning districts; and also address the legal enforcement of operation and maintenance requirements, particularly for stormwater BMPs on private property. Prioritize requiring nature-based stormwater management solutions.	Narr, NK, SK	1-2	$	H
Ensure adequate resources to properly maintain BMPs.	Narr, NK, SK, RIDOT	On-going	$$$	H
Provide public education on 'good housekeeping' efforts that residents (and business owners) in the Narrow River Watershed can do to reduce pollutants in stormwater runoff: connecting to the municipal sewers if available, restoring vegetated buffers around the river and tributary streams, discouraging the prolonged residence of waterfowl, regularly inspecting and pumping septic systems, properly disposing of pet wastes away from the river and storm sewer systems, minimizing the use of fertilizers, ways of reducing stormwater runoff, proper disposal of household hazardous wastes, and prevention of illegal dumping.	Narr, NK, SK, NRPA	On-going	$	H
Increase and improve performance of street sweeping of entire watershed. Per the Crooked Brook TMDL, perform more frequent street sweeping of South Pier Road (to prevent sediment load observed in Sprague Brook at CB-14).	Narr, NK, SK, RIDOT	On-going	$$$	H
Conduct a stormwater utility feasibility study. Investigate the feasibility of establishing a stormwater utility district as a stable source of funding for stormwater management needs.	Narr, NK, SK	3-5	$$	M
Reduce stormwater runoff by encouraging construction of rain gardens, other landscapes, and dry wells which facilitate groundwater infiltration on private and public properties.	Narr, NK, SK	1-2	$	M

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Require erosion and sediment control training for contractors to work in Town.	Narr, NK, SK	1-2	$	M
Implement the RIPDES Phase II MS4 Stormwater Water Management Program Plan (SWMPP) and program, and enforce existing requirements. Review and update as necessary.	Narr, SK, NK, RIDOT	On-going	$$$	Required
Ensure proper maintenance of stormwater BMPs on private property.	Narr, NK, SK	On-going	$$	Required
Work with RIDOT to develop Stormwater Control Plan for priority discharges to impaired waterbodies in the watershed, as applicable under the Consent Decree with EPA	Narr, SK, NK, RIDOT	3-5 (2021 start)	$$$	Required
Ensure Construction Site Runoff Control ordinances address the requirements of the MS4 permit for other sources of pollutants associated with construction sites, such as concrete washouts, fueling stations, litter, etc.	Narr, NK, SK	1-2	$	L
Consider ordinances to require all new development to reuse stormwater runoff as a method for reducing the need for watering landscaped areas with potable water	NK, Narr, SK	1-2	$	L
Promote the installation of cisterns to collect rainwater for non-potable uses such as landscape watering and car washing.	Narr, NK, SK	1-2	$	L
Encourage use of native species for landscaping.	Narr, NK, SK	1-2	$	L
Install stormwater BMP retrofits throughout the watershed as opportunities and needs arise.	Narr, NK, SK	On-going	$$$	L

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Wastewater Management				
Continue to implement and enforce local OWTS wastewater management plans, ordinances, and programs.	Narr, NK, SK	on-going	$$	H
Strengthen the town's role in identifying and addressing failed OWTSs.	Narr, NK, SK	1-2	$	H
Identify locations of failed septic systems and cesspools, and enforce repairs, upgrades (nitrogen removal), or connections to sewer. Priority areas include near Mumford Road, Mettatuxet Brook, and Middlebridge.	Narr, NK, SK	1-2 (then on-going)	$$	H
Require homes or businesses in the sewered areas that are not connected to the sewer to connect. (Enforce existing connection requirements.)	Narr, SK	1-2	$ (and $$$ to connect)	H
Continue to implement the Community Septic System Loan Program in areas where sewers will not be extended. Consider Community Development Block Grant program for OWTS repairs/ replacements/ upgrades for income eligible residents.	Narr, NK, SK	on-going	$	M
Develop or enhance a local educational program for OWTS maintenance.	Narr, NK, SK	1-2	$	L
Update wastewater facility plans to consider extending sewer lines into critical priority areas in existing neighborhoods as needed.	Narr, SK	1-2	$$	L
Expedite upgrading of OWTS for Nitrogen removal due to coastal resource concerns.	Narr, NK, SK, RIDEM	1-2	$	L
Identify inflow/infiltration projects that will reduce flow to the Westmoreland Treatment Plant.	Narr, SK	On-going	$	L

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Pet Waste Management				
Towns enforce local ordinances and improve strategies requiring owners to pick up after their pets on all property.	Narr, NK, SK	on-going	$$	H
Implement Crooked Brook TMDL recommendations to enforce existing town pet ordinances at: • stream channel running through Sprague Park • Kingstown Road outfall to Sprague Pond	Narr	1-2	$	H
Educate the public about the impact of pet waste on water quality.	Narr, NK, SK	On-going	$	M
Control pet waste at Dog Island and around the Narrows.	Narr (NRPA)	1-2	$	H
Install pet waste stations at known heavily used locations (such as dog parks, areas identified in TMDL's, etc.). Include signage citing local ordinances. Maintain stations.	Narr, NK, SK	1-2	$	L

Action Item **(Listed by Management Topic)**	**Responsible Party** (support)	**Timeframe**	**Cost Estimate**	**Priority**
Wildlife/Waterfowl Waste				
Provide public education on the negative impacts of feeding waterfowl.	Narr, NK, SK, NRPA, RIDEM (SRICD)	1-2 (then on-going)	$	H
Identify a local group to devise a sustainable strategy to address waterfowl/wildlife management in the watershed. Perform a study of wildlife locations and concentrations in the watershed and their impact to water quality of the freshwater stream input to the Narrow River (bacteria and nitrogen). Target areas identified in the TMDLs between Bridgetown Bridge and Middlebridge Bridge, and at the southern end of Pettaquamscutt Cove to control waterfowl populations, and in the Crooked Brook subwatershed.	Narr, NK, SK (SRICD)	1-2	$	H
Encourage residents to allow tall, coarse vegetation to grow along the banks of the river segments frequented by waterfowl or install commercially available fencing to restrict waterfowl access to the water. (Consider a demonstration project to educate and spur interest.)	Narr, NK, SK	3-5	$	H
Implement and enforce effective ordinances and signage to prevent the public from feeding waterfowl.	Narr, NK, SK, NRPA, RIDOT	1-2 (on-going)	$	M
Consider extending Goose Hunting Season at the National Wildlife Refuge to abate non-migratory Canada Geese	USFWS	3-5	$	L

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Storage Tanks				
Prohibit new heating oil USTs, particularly in areas dependent on private wells and in wellhead protection areas.	Narr, NK, SK	3-5	$	L
Educate homeowners on the threat to water quality from existing above-ground and underground home heating oil tanks and the potential financial consequences.	Narr, NK, SK	1-2	$	L
Lawn and Turf				
Educate residents why and how to limit application of fertilizers and pesticides to gardens and lawns to recommended doses and avoid application prior to rain events. Consider offering 'free' assessments and/or demonstrations.	Narr, NK, SK, NRPA	1-2 (then on-going)	$	H
Adopt requirements for LID landscaping (native landscaping, xeriscaping, minimum undisturbed areas, etc. for both residential and commercial development projects.)	Narr, NK, SK	1-2	$	M
Adopt limits on residential lawn areas in new developments to minimize this source of pollution. (This is a Low Impact Development strategy.)	Narr, NK, SK	1-2	$	M
Implement a local voluntary program for landscapers to commit to pollution prevention, such as the Town of Charlestown's Recommended Landscaper Process.	Narr, NK, SK	3-5	$	L
Consider participating in RIDEM's Green Certification / Sustainable Turf Management for Landscaping Certification program.	Narr, NK	3-5	$	L

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Utilize low maintenance, low fertilizer grasses and plantings in all public facilities to minimize non-point source pollution and maintenance costs.	Narr, NK, SK	1-2	$	L
Agriculture				
Contact NRCS to target outreach to farmers (including the very small part-time farmers) on best management practices to protect water quality.	SK, NK NRCS	3-5	$	M
Encourage farmers to apply for funding from NRCS to install BMPs on their properties to prevent adverse impacts to water quality.	SK, NK NRCS	3-5	$	M
Adopt municipal ordinances with BMPs for backyard livestock owners to properly control animal wastes.	Narr, NK, SK	3-5	$	L
Farmers install BMPs.	Farmers (NRCS/ SRICD)	6-10	$$	L
Road Salt and Sand				
Ensure private stockpiles of road salt are covered.	Narr, NK, SK, contractors	1-2	$$	M
Upgrade equipment for more efficient application of road salt and sand.	Narr, NK, SK	6-10	$$$	M
Promptly remove winter sand (street sweeping).	Narr, NK, SK, RIDOT	1-2	$$$	M

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Consider increasing frequency of street sweeping between winter storms.	Narr, NK, SK, RIDOT	3-5	$$	L
Marine and Riverine Debris				
Implement recommendations from Crooked Brook TMDL: Litter maintenance and policing of path connecting Kingstown Road to high school to minimize amount of trash dumping. (abundance of litter observed from station CB-04 thru CB-07).	Narr	1-2 (then on-going)	$$	M
Implement and enhance litter control programs.	Narr, NK, SK	1-2	$$	L
Educate the public on the importance of reducing the use of disposable products, to properly dispose of and recycle them, and to prevent them from getting loose in the environment.	Narr, NK, SK, NRPA	1-2 (then on-going)	$	L
Make sure there are adequate waste receptacles at public recreation areas and public water access locations in the watershed, and ensure that they are well maintained.	Narr, NK, SK, RIDEM, RIDOT	1-2	$	L
Promote public participation in coastal and river clean-ups.	Narr, NK, SK, NRPA	On-going	$	L

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Wetland Protection and Restoration				
Target wetlands and ample buffers for open space protection strategies, including purchases, easements, and through alternative zoning techniques that require open space. Focus on assemblage of large areas of protected land in order to provide better protection for wetlands.	Narr, NK, SK, Land Trusts	on-going	$$$	H
Protect salt marsh migration areas on the Narrow River (such as identified by the RI SLAMM Project) through land acquisition and conservation easements, and where possible, remove barriers to salt marsh migration (such as parking lots, hardened shorelines, etc.).	Narr, SK, Land Trusts	on-going	$$$	H
Incorporate Low Impact Development techniques in local regulations to the maximum extent practicable.	Narr, NK, SK	1-2	$	H
Develop or update local conservation development ordinances to shift new construction and development projects away from SLAMM projected potential salt marsh areas.	Narr, SK, NK	1-2	$	H
Expand the ‘No Wake Zone’ in the Narrow River to protect salt marsh and eelgrass bed habitats from increased erosion caused by motor boat wake energy.	Narr, SK (CRMC)	3-5	$	H
Support State efforts to enhance wetland protection.	Narr, NK, SK, NRPA, citizens	On-going	0	M
Study freshwater flooding of salt marsh areas and alter drainage work to prevent freshwater ponding on salt marsh habitats.	Narr, NK, SK, CRMC?	1-2	$$$	M

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Incorporate public education on the importance of wetlands, riparian corridors, vegetated buffers to waterbodies, open space protection, and green infrastructure in outreach media and activities.	Narr, NK, SK	1-2 (then on-going)	$	M
Complete and continue a wetland monitoring and assessment program for the Narrow River watershed.	RIDEM	3-5	$$$	M
Continue the salt marsh monitoring and assessment program for coastal wetlands in the Narrow River watershed.	CRMC, RINHS	On-going	$$	M
Conduct a study to evaluate the feasibility of freshwater and coastal wetland restoration opportunities in the Narrow River Watershed.	Narr, NK, SK	3-5	$$	L
Encourage and help facilitate the restoration of wetlands and their buffers on public and private property.	Narr, NK, SK	3-5	$$	L
Buffer Protection				
Develop a watershed wide Buffer Protection and Restoration Plan	Narr, NK, SK	3-5	$$	H
Work with landowners to promote buffer protection and restoration where possible.	Narr, NK, SK	3-5	$$	H
Address former 'horse farm' property per Crooked Brook TMDL. (Lack of buffer on this property, also potential agriculture use.)	Narr, Landowner (NRCS)	1-2	$$	H
Evaluate the extent and condition of riparian buffers in the watershed (including invasive species).	Narr, NK, SK	3-5	$$	M

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Aquatic Invasive Species (AIS and wetland)				
As opportunities arise, take actions to control and manage aquatic and wetland invasive species in the watershed.	Narr, SK, NK	On-going	$$	H
Survey the ponds in the watershed for the presence of Aquatic Invasive Species.	Narr, SK, NK, RIDEM	3-5	$$	M
Consider developing a regular monitoring program for AIS in the watershed.	Narr, SK, NK, RIDEM	3-5	$$	M
Survey the watershed for the presence and extent of terrestrial and wetland invasive species, with a focus on wetland areas, riparian buffers, and stream banks. (routinely monitor)	Narr, SK, NK, NGO's	3-5 (then on-going)	$$	M
Institute a targeted public education and awareness program for AIS, such as: • the RIDEM GREAT Boater Volunteer Program; • install effective educational signs at boat ramps; or another marketing campaign to raise awareness and encourage boat hygiene practices.	Narr, NK, SK, RIDEM	3-5	$	M
Design and create designated areas at boat ramps specifically for cleaning off boats and consider providing water or a boat washing/cleaning station for washing boats at ramps.	Narr, SK, NK, RIDEM	6-10	$$	L
Promote or require the use of native species for landscaping and erosion control seed mixes (especially near wetlands) in all development and redevelopment projects.	Narr, SK, NK, RIDEM, CRMC	1-2	$	L

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Promote the use of native and sustainable plants to homeowners and provide public education on the harms of invasive species.	Narr, NK, SK, NGO's	3-5	$$	L
Water Withdrawals				
Consider conducting a study of inter- and outer- basin utility transfer of water to calculate balance of water in the watershed.	RIDEM, WRB	3-5	$	L
Stream Habitat Connectivity				
Conduct an inventory and assessment of stream crossings in the watershed for wildlife/fish passage and capacity for increased storm intensity. Coordinate with partners.	Narr, NK, SK, RIDOT, NRCS, RIEMA, local HMC's, NGO's	3-5	$$	M
Determine priorities for removing dams or improving fish passage. (Work with partners and stakeholders.)	Narr, NK, SK, RIDEM	3-5	$	M
Remove barriers and restore habitat for identified priorities.	Narr, NK, SK, RIDEM, NGO's (?)	6-10	$$$	L
Update the following state plans: "Strategic Plan for the Restoration of Anadromous Fishes to Rhode Island Coastal Streams," and "Rhode Island State Coastal and Estuarine Habitat Restoration Strategy."	RIDEM, CRMC (Narr, NK, SK)	As applicable	$	L

Action Item **(Listed by Management Topic)**	**Responsible Party** (support)	**Timeframe**	**Cost Estimate**	**Priority**
Dredging				
Consider conducting a feasibility and impact study of a jetty structure at the mouth of the river to prevent beach sand from entering the Narrows.	Narr,	6-10	$$	L
Consider studying the feasibility and impacts of limited dredging for increasing flow/flushing; to retrieve beach sand; and/or for providing marine fish 'cool water refugia.'	Narr, SK, CRMC	6-10	$$	L
Climate Change Resiliency (see also Wetland Protection and Restoration)				
Municipal Boards and commissions educate themselves on the impacts of flooding and sea level rise. Recommended for all Board members to complete the PREP-RI on-line module series.	Narr, NK, SK	1-2 (then on-going)	$	H
Upon next update to Hazard Mitigation Plans, municipalities consider incorporating flood and storm surge protection projects involving habitat and wetland protection and restoration.	Narr, NK, SK	1-2	$	M
Integrate/evaluate STORMTOOLS Sea Level Rise projections into planning infrastructure improvements and revisions to local land use ordinances	Narr, NK, SK	1-2 (then on-going)	$$	M
Institute a policy pertaining to prohibition of public investment in unsustainable measures that promote development or persistence of development in coastal areas at risk of rising sea levels. Pair such policy with conservation activities.	Narr, NK, SK	1-2	$	M
Incorporate SLAMM results into community planning and municipal policies. Recommendations from the SLAMM report include:				

Action Item **(Listed by Management Topic)**	**Responsible Party** (support)	**Timeframe**	**Cost Estimate**	**Priority**
• Incorporate SLAMM results including community specific maps and other information into new updated natural hazards section of municipal comprehensive plans consistent with requirements of R.I.G.L. § 45-22.2-6.	Narr, SK	1-2	$	M
• Review SLAMM maps in the local planning and review of local redevelopment projects in areas adjacent to salt marshes.	Narr, SK	On-going	$	M
• Include SLAMM results into other local long-range plans for waterfront development, natural resource and land conservation, and water resource planning efforts.	Narr, SK	On-going	$	M
• Use SLAMM maps to guide local wetland restoration projects.	Narr, SK	On-going	$	M
Open Space/ Conservation				
Continue to pursue open space conservation, with a priority on areas that contribute to the protection and restoration of water quality and aquatic habitats, including wetlands and buffers, coastal marshes and salt marsh migration areas, groundwater reservoirs and recharge areas, and Conservation Opportunity Areas. Also focus on the connectivity of these areas.	Narr, NK, SK, land trusts	On-going	$$$	H
Continue to restrict development in Areas of Critical Concern identified in CRMC's Narrow River SAMP to low density residential use or acquire land as open space. Consider economic incentives for owners not to develop in these areas.	Narr, NK, SK	On-going	$$$	H

Action Item **(Listed by Management Topic)**	**Responsible Party** (support)	**Timeframe**	**Cost Estimate**	**Priority**
Consider amendments to local development regulations to strengthen the use of cluster zoning and conservation zoning for the purposes of protection of water resources by conserving ample forested riparian buffers and maximizing the use of LID.	Narr, NK, SK	1-2	$	H
Establish criteria for preservation of open space, including creation of "green corridors" that connect conserved parcels.	Narr, NK, SK, land trusts	1-2	$	M
Lakes and Ponds Management				
Prepare Lake Management Plans (to address such issues as AIS, phosphorus, etc.) for the following lakes: • Silver Spring Lake • Carr Pond • Silver Lake • Lake Canonchet	RIDEM, NK, SK, Narr	6-10	$$	M
Groundwater/Drinking Water Protection				
All existing and new development within groundwater protection areas to conform the Groundwater Protection Ordinance, and site plan and stormwater management design criteria for groundwater districts.	NK	On-going		Required
Continue to acquire land and development rights, and to encourage land conservation in groundwater protection areas.	NK	On-going	$$$	H

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Apply components of the State Water Supply System Management Planning Act to achieve effective and efficient conservation, development, utilization and protection of the water system's resources in ways that satisfy the present and future needs of the Town.	NK	3-5	$$	M
Continue to implement conservation techniques for the wise use of drinking water supplies.	Narr, NK, SK	On-going	$	M
Integrate groundwater issues into public education programs: water conservation, household hazardous waste, septic systems, underground storage tanks (home heating fuel), pesticides, and other groundwater information.	Narr, NK, SK	On-going	$	M
Continue to maintain signs on roadways at the watershed / aquifer recharge boundary so residents and visitors are aware that their actions impact a public water supply.	NK	On-going	$	L
Monitoring and Evaluation				
Continue monitoring to identify potential areas that can meet the water quality standard safe for shellfish consumption.	RIDEM	On-going	$$	H
Monitor bacteria in the Crooked Brook subwatershed in accordance with the Crooked Brook Bacteria TMDL.	Narr, NRPA	1-2 (then on-going)	$	H
Monitor bacteria in Pettaquamscutt Cove in accordance with the Narrow River TMDL.	Narr, NRPA	3-5 (then on-going)	$	H

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Continue to support programs such as Watershed Watch that provide a coordinated system of Town, State, federal and volunteer resources and personnel to test and monitor waters.	NK, Narr, SK, NRPA	On-going	$	M
Public Education (see also specific topics for additional education needs)				
Promote actions that can be taken by homeowners or individuals to keep water clean.	Narr, NK, SK	On-going	$	H
Promote support of watershed organizations.	Narr, NK, SK	On-going	$	H
Update and re-issue the NRPA document from the early 1990's that was distributed to all property owner on what to do to protect/improve Narrow River water quality- the "Narrow River Handbook." Alternatively, use Save the Bay's 'Bay Friendly Living' booklet.	NRPA	1-2 (3-5?)	$	M
Install 'Entering/Leaving the Narrow River Watershed' signs to create awareness.	Narr, NK, SK, NRPA	1-2	$	L
Provide educational opportunities for Town Staff, Board and Commission members, and citizens regarding the importance of utilizing a watershed-based approach within land conservation planning.	Narr, NK, SK	On-going	$	L
Further Study Needs/ Gaps in Information				
Re-evaluate bacteria loadings to the Narrow River to determine the amount of progress made towards the TMDL required load reductions.	RIDEM	1-2	$$	H
Study, model, and evaluate sources of nitrogen to the river (and its freshwater tributaries).	RIDEM	5-10	$$	M

Action Item (Listed by Management Topic)	Responsible Party (support)	Timeframe	Cost Estimate	Priority
Develop Phosphorus TMDLs for Silver Spring Lake and Silver Lake	RIDEM	3-5 (2023)	$$$	Required
Assess the impact of recreation on the water quality and aquatic habitat of the Narrow River.	Narr, SK, NK, (CRMC)	3-5	$$	M
Evaluate the need for sanitary facilities at recreation areas	RIDEM, Narr, SK, NK, RIDOT	3-5	$	L
Plan Implementation, Coordination, and Follow-up				
Initiate regular meetings of all 3 community representatives and NRPA to discuss successes, coordinate plan implementation, and identify plan revisions.	Narr, NK, SK, NRPA	1-2 (then on-going)	$	H
Support and work cooperatively with federal, state, and local agencies as well as non-governmental organizations in protecting natural resources. Establish partnerships with local land trusts, Friends of Canonchet, Narrow River Preservation Association, Audubon Society of Rhode Island, and The Nature Conservancy, among others working in the watershed. Encourage joint meetings among neighboring towns.	Narr, NK, SK, land trusts, NGO's	On-going	$	M
Continue to support implementation of the CRMC Narrow River Special Area Management Plan.	SK, NK, and Narr	On-going	$	M

IX. *Implementation Tools*

Tools to help implement the actions recommended in this plan include sources of financial support, technical and educational resources, and the key partners who can help with implementation.

A) Financial Support

Funding assistance for water quality and aquatic habitat protection and restoration actions is available from various government and private sources. This section provides an overview and contact information for financial assistance programs that may be used to implement some of the actions in this plan.

1) *DEM Nonpoint Source Grant Program using federal Clean Water Act Section 319 funds*

Section 319 Grants are available for projects to protect and restore water quality through reducing and managing nonpoint source pollution and for projects restoring aquatic habitat. Projects must be consistent with the goals and actions in the USEPA approved RI Nonpoint Source Management Program Plan. These grants are made possible by federal funds provided to RIDEM by the USEPA under Section 319 of the Clean Water Act.
Eligible applicants: Projects must be in watershed with a watershed plan; municipal, state, or regional governments, quasi-state agencies, public schools and universities, and non-profit watershed, environmental, or conservation organizations.
Contact: RIDEM's Office of Water Resources, 235 Promenade St., Providence, RI 02908. (401) 222- 4700

2) *Clean Water State Revolving Fund Loans*

The Clean Water State Revolving Fund is a federal/state partnership designed to finance the cost of infrastructure needed to achieve compliance with the Clean Water Act. The program is available to fund a wide variety of water quality projects including: 1) Traditional municipal wastewater treatment projects; 2) contaminated runoff from urban and agricultural areas; 3) wetlands restoration; 4) groundwater protection; 5) Brownfields remediation; and 6) estuary management. Through this program, Rhode Island maintains revolving loan funds to provide low-cost financing for a wide range of water quality infrastructure projects. Funds to establish or capitalize these programs are provided through federal government grants and state matching funds (equal to 20% of federal government grants). The interest rate charged to the Clean Water State Revolving Fund is one-third off the borrower's market rate.
Eligible applicants: Statewide, including municipal, state, or regional governments, quasi-state agencies. Funds are awarded to projects based on ranking of environmental benefits of the project, readiness to proceed, and availability of funds.

Contact: RIDEM Office of Water Resources, 235 Promenade St., Providence, RI 02908. (401) 222-4700; Rhode Island Infrastructure Bank (formerly known as RI Clean Water Finance Agency), 235 Promenade St., Suite 119, Providence, RI 02908. (401) 453-4430 info@riib.org
Program website: http://www.dem.ri.gov/programs/water/finance/state-revolving-fund.php

(a) Community Septic System Loan Program

The Community Septic System Loan Program allows homeowners in participating communities to obtain low interest loans to repair or replace failed, failing, or substandard onsite wastewater treatment systems. These individual loans are funded from a Clean Water State Revolving Fund loan to a community and are administered locally by Rhode Island Housing. Loans to homeowners are offered at 2% interest rate with a 10-year term.
Eligible applicants: Statewide. Municipal participation requires RIDEM approval of an onsite wastewater management plan. Funds are awarded to communities based on ranking of environmental benefits of the project, readiness to proceed, and availability of funds.
Contact: RIDEM Office of Water Resources, 235 Promenade St., Providence, RI 02908. (401) 222-4700; Rhode Island Infrastructure Bank, 235 Promenade St., Suite 119, Providence, RI 02908. (401) 222-4430

(b) Sewer Tie-In Loan Fund

Modeled after the Community Septic System Loan Program, the Sewer Tie-In Loan Fund allows homeowners to access funds to connect to the local sewer system. Individual loans are funded from a Clean Water State Revolving Fund loan to a sewer system owner and are administered locally by Rhode Island Housing. Loans to homeowners up to $10,000 are offered at a 2% interest rate for up to a five-year term.
Eligible applicants: Statewide. Funds are awarded to communities based on ranking of environmental benefits of the project, readiness to proceed, and availability of funds.
Contact: RIDEM Office of Water Resources, 235 Promenade St., Providence, RI 02908. (401) 222-4700; Rhode Island Infrastructure Bank, 235 Promenade St., Suite 119, Providence, RI 02908. (401) 222-4430

3) *Narragansett Bay and Watershed Restoration Bond Fund (BWRF Grants)*

State funds approved by RI voters are periodically available from this Bond Fund to restore and protect the water quality, and enhance the economic viability, environmental sustainability and resiliency of Narragansett Bay and the state's watersheds. The Fund is meant to provide funding assistance for the feasibility analysis, design, and construction of means to control nonpoint sources of pollution, stormwater pollution control projects, riparian buffer and aquatic habitat restoration projects.
Eligible applicants: Statewide; municipal, state, or regional governments; quasi-state agencies, public schools, and universities; non-profit watershed, environmental, or conservation organizations; and non-governmental for-profit businesses and private schools.

BWRF Contact: RIDEM's Office of Water Resources, 235 Promenade St., Providence, RI 02908. (401) 222- 4700
Program webpage: http://www.dem.ri.gov/programs/water/finance/

4) *EPA Southeast New England Program (SNEP)*

The US EPA Southeast New England Program for Coastal Watershed Restoration brings together partnerships to protect and restore coastal watersheds of southeast New England from Westerly to Cape Cod. The Program seeks projects and partnerships that leverage multiple resources to generate collaboration to implement innovations and efficiencies in ecosystem management.
Eligible applicants: Municipalities, non-profit organizations, and research/educational institutions.
Contact: Narragansett Bay Estuary Program, 235 Promenade St. Providence, RI 02908. (401) 633-0552.
Program webpage: https://www.epa.gov/snecwrp

5) *Coastal and Estuarine Habitat Restoration Program and Trust Fund*

The Coastal and Estuarine Habitat Restoration Program and Trust Fund is administered by CRMC. Funds come from the state's Oil Spill Prevention Administration and Response Act (OSPAR). The program allocates about $225,000 per year to support a range of habitat restoration projects throughout the State. The program's investment of about $2 million has help leveraged over $20 million in investment in restoration from federal and other state and partner sources. Proposed projects should seek to restore or enhance ecological conditions that have been degraded by human impacts in coastal or estuarine habitats such as coastal wetlands, submerged aquatic vegetation beds, shellfish beds, vegetated coastal upland, and anadromous fish runs. For 2018, priority will be placed on those projects that seek to enhance coastal habitats' resiliency to climate change and sea level rise; for example, projects that remove barriers to future wetland migration with sea level rise or that enhance shoreline vegetation where habitat is threatened by increased coastal erosion.
Eligible applicants: Municipalities, nonprofit organizations, civic groups, educational institutions, and state agencies are eligible to apply. Proposed projects must be located within Rhode Island.
Contact: R.I. Coastal Resources Management Council, Stedman Government Center, Suite 116, 4808 Tower Hill Road, Wakefield, RI 02879. Phone 401-783-3370
Program webpage: http://www.crmc.ri.gov/habitatrestoration.html

6) *Natural Resources Conservation Service (NRCS) Grants (U.S. Department of Agriculture)*

(a) *Environmental Quality Incentives Program (EQIP)*

This is a voluntary conservation grant program designed to promote and stimulate innovative approaches to environmental enhancement and protection, while improving agricultural production. Through EQIP, farmers and forestland managers may receive financial and technical help to install or implement structural and management conservation practices on eligible agricultural and forest land. Examples of eligible EQIP activities include practices for farm waste storage, nutrient management, riparian buffers and stream bank improvements, wetland restrictions, and groundwater and surface water conservation activities. EQIP payment rates may cover up to 75 percent of the costs of installing certain conservation practices.
Eligible applicants: Any person engaged in livestock, agricultural production, aquaculture, shellfishing, or forestry on eligible land.
Contact: USDA NRCS – RI State Office/Service Center, 60 Quaker Lane, Suite 46, Warwick, RI 02886, (401) 828-1300.
Program webpage:
https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

(b) *Easement Programs*

NRCS offers various easement programs to landowners who want to maintain or enhance their land in a way beneficial to agriculture and/or the environment. All NRCS easement programs are voluntary. Local landowners and organizations are needed to make NRCS easement programs successful. NRCS provides technical help and financial assistance to protect private lands through a variety of programs. These programs include:

- The **Agricultural Conservation Easement Program** (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits.
  - Under the **Agricultural Land Easements component**, NRCS helps Indian tribes, state and local governments and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land.
  - Under the **Wetlands Reserve Easements component**, NRCS helps to restore, protect and enhance enrolled wetlands.
- The **Healthy Forests Reserve Program** (HFRP) helps landowners restore, enhance and protect forestland resources on private lands through easements and financial assistance. Through HRFP, landowners promote the recovery of endangered or threatened species, improve plant and animal biodiversity and enhance carbon sequestration.

Eligible applicants: Private landowners.
Contact: USDA NRCS – RI State Office/Service Center, 60 Quaker Lane, Suite 46, Warwick, RI 02886, (401) 828-1300.
Program Webpage:
https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/

7) *Community Development Block Grants*

Title 1 of the Housing and Community Development Act of 1974 authorized the Community Development Block Grant (CDBG) program. The program is sponsored by the US Department of Housing and Urban Development, and the Rhode Island program is administered through the State of Rhode Island Office of Housing and Community Development. There are income eligibility requirements for qualifying areas, businesses, or residents. These grants include water and sewer system improvements, and private well and OWTS repair or replacements.
Eligible applicants: Municipalities
Contact: Division of Planning, Office of Housing and Community Development, 1 Capitol Hill, 3rd Floor, Providence, RI 02908, (401) 222-7901
Program website: http://ohcd.ri.gov/community-development/cdbg/

8) *Community Development Block Grant Disaster Recovery (CDBG-DR)*

In response to Presidentially declared disasters, Congress *may* appropriate additional funding for the Community Development Block Grant (CDBG) Program as Disaster Recovery (CDBG-DR) grants to rebuild the affected areas and provide crucial seed money to start the recovery process. This is an appropriation, not a program, that when available, may include a resiliency component that may help address areas that were directly or indirectly affected by the disaster. In the past, Rhode Island received disaster recovery funds for the March 2010 floods, and Hurricane Sandy (allocation included impacts from Hurricane Irene and Winter Storm Nemo). Projects ranged from stormwater infrastructure repairs and improvements, to property acquisitions and clearance in floodplains, and flood mitigation planning studies. Green Infrastructure projects were encouraged. The RI CRMC received CDBG-DR funds to build coastal resiliency in the Narrow River Estuary at the US Fish and Wildlife John H. Chafee National Wildlife Refuge. The RIDEM received funds to prepare a plan to integrate climate change considerations into wastewater system planning and current facilities operations.
CDBG-DR funds are administered through the RI Office of Housing and Community Development. http://ohcd.ri.gov/community-development/cdbg-dr/

9) *State Open Space Grants*

RIDEM administers grant programs to facilitate land conservation relying on State bond funding and Federal program funds. Local Open Space Grants provide up to 50% matching funds to preserve valuable open space through ownership or easements.
Eligible Applicants: Municipalities, land trusts, watershed councils, and non-profit organizations.
Contact: RIDEM Office of Planning and Development, 235 Promenade St., Providence, RI 02908. (401) 222-4700
Program webpage: http://www.dem.ri.gov/programs/planning/grants/

10) *Healthy Watersheds Consortium Grant Program*

The Healthy Watersheds Consortium (HWC) was launched in summer 2015 and is a partnership between the U.S. Endowment for Forestry and Communities, the U.S. Environmental Protection Agency, and the USDA Natural Resources Conservation Service. The goal of the HWC Grant Program is to accelerate strategic protection of healthy, freshwater ecosystems and their watersheds, with a primary focus on prevention of land deterioration in the watershed by:

- Developing funding mechanisms, plans, or other strategies to implement large-scale watershed protection, source water protection, green infrastructure, or related landscape conservation objectives;
- Building the sustainable organizational infrastructure, social support, and long-term funding commitments necessary to implement large-scale protection of healthy watersheds; and
- Supporting innovative or catalytic projects that may accelerate funding for or implementation of watershed protection efforts, or broadly advance this field of practice.

Eligible Applicants: Not-for-profit 501(c)(3) organizations, for-profit companies, tribes, intertribal consortia, interstates, state, and local government agencies including water utilities and wastewater facilities, and colleges and universities.
Contact: U.S. Endowment for Forestry & Communities, Inc., 908 E. North Street, Greenville, SC 29601 Phone: 864.233.7646 Fax: 864.235.3842
Program webpage: https://www.epa.gov/hwp/healthy-watersheds-consortium-grant
Consortium webpage: http://www.usendowment.org/healthywatersheds.html

11) *Municipal Stormwater Utility*

A stormwater utility is a public utility established to provide stormwater management services. It is to stormwater what a sewer utility is to sewage, and a water utility is to drinking water. Stormwater utilities generate revenue through user fees that are based upon the amount of stormwater generated on a property. An important distinction between stormwater utility fees and real estate taxes is that they are user-based and are tied to stormwater management services provided by the utility, whereas taxes are not tied to specific services. Stormwater utilities provide a dedicated, stable and predictable source of revenue to finance local stormwater management services. More specifically, this stable funding source can be used to ensure ongoing maintenance of stormwater infrastructure, conduct long-term strategic planning, incentivize water quality protection among landowners, and facilitate compliance with the State RIPDES Phase II (MS4) Stormwater Program.

The Rhode Island Stormwater Management and Utility District Act of 2002 (http://webserver.rilin.state.ri.us/Statutes/TITLE45/45-61/INDEX.HTM) authorizes municipalities to create stormwater management districts, and empowers them to charge fees, provided that the fee system shall be reasonable and equitable so that each contributor of runoff to the system shall pay to the extent to which runoff is contributed. Stormwater utilities have focused on a variety of needs, including flood management, erosion control, stormwater treatment for water quantity and quality, and infrastructure maintenance.

In Rhode Island, some of the communities that are looking into this funding mechanism and have conducted feasibility studies include Bristol, Middletown, West Warwick, and the City of Providence. In 2017, the State BWRF grant round included projects that support development of a dedicated sustainable funding mechanism for stormwater management in its list of eligible applications. See Technical Resources section, below for more information.

B) Technical Resources

1) *Low Impact Development Regulations*
    - LID Manual Appendix A 'Ordinance Checklist for LID,' available here: (http://www.dem.ri.gov/programs/bpoladm/suswshed/pdfs/lidplan.pdf).
    - The Code & Ordinance Worksheet: A Tool for Evaluating the Development Rules in Your Community,' by the Center for Watershed Protection (CWP), 2017, available here: https://www.cwp.org/updated-code-ordinance-worksheet-improving-local-development-regulations/ .)
    - [placeholder for new RIDEM / NEMO Self-Assessment Checklist w/ primer]

2) *Lawn/Turf Management*
    - RIDEM's voluntary 'Sustainable Turf Management for Landscaping Certification' program
      Contact: Ann Battersby, Senior Environmental Scientist
      RIDEM Office of Customer and Technical Assistance
      Phone: (401) 222-6822 ext. 7284
    - Town of Charlestown Recommended Landscaper Process
      https://www.charlestownri.org/index.asp?SEC=57BE787A-1F23-406A-906B-4FBC5BCACF34&DE=5CA3025C-C8D4-4182-BABE-9B19B7A55024

3) *Wetland Resources*

For more information on Wetland Restoration see RIDEM's webpage, "Freshwater Wetland Restoration Kit for Landowners," available here: http://www.dem.ri.gov/programs/water/wetlands/restkit.php

For more information on wetlands, see the Center for Watershed Protection, Article series on 'Wetlands & Watersheds,' available here: https://owl.cwp.org/mdocs-posts/wetland-and-watershed-article-series_-article-1/

4) *Buffer Resources*

For calculating estimated pollutant removal rates for constructed buffers:

- Pollutant Removal Credits for Restored or Constructed Buffers in MS4 Permits: Technical Memorandum, June 2019 available here: See 'Credit for Going Green' on UNH's Stormwater Center website. https://www.unh.edu/unhsc/news/credit-going-green

5) *Invasive Species Resources*

A Lake Management Plan designed specifically to target an invasive plant should be developed by a certified lake manager or licensed herbicide applicator who is knowledgeable about the species. For more information, see http://www.dem.ri.gov/programs/water/quality/surface-water/aisplant.php

For information on Aquatic Invasive Plants, see RIDEM's webpage on AIS here: http://www.dem.ri.gov/programs/water/quality/surface-water/aisplant.php

RI Save the Lakes
For creation of a lake association and educational opportunities, see RI Save the Lakes http://stlri.org/

The RI Aquatic Invasive Species Management Plan, 2007
http://www.crmc.ri.gov/invasives/RIAIS_Plan.pdf

CRMC's Invasive plants website: http://www.crmc.ri.gov/invasives.html

RI Natural History Survey
The RINHS keeps track of the terrestrial (only?) invasive species that are widespread and those that are emerging in locations throughout Rhode Island. They also hold workshops on invasive species for the general public. For more about their programs: http://rinhs.org/invasive-species-portal/invasive-species-lists/

For resources to create a Lake Management Plan:
The Practical Guide to Lake Management in Massachusetts
https://www.mass.gov/files/documents/2016/08/te/practical-guide.pdf

RIDEM GREAT Boaters Program:
http://www.dem.ri.gov/programs/water/quality/surface-water/aisresp.php

6) *Stream Connectivity Resources*

North Atlantic Aquatic Connectivity Collaborative

The University of Massachusetts Extension hosts the North Atlantic Aquatic Connectivity Collaborative, which is a participatory network of practitioners united in their efforts to enhance aquatic connectivity. The NAACC has developed unified protocols for road-stream crossing assessments that can help identify bridges and culverts that are problematic from an aquatic connectivity perspective. Their website includes resources such as field forms, training webinars, an on-line database, and local contact persons. For more information, their website is here: https://streamcontinuity.org/index.htm

RI Wetland BMP Manual
http://www.dem.ri.gov/programs/benviron/water/permits/fresh/pdfs/wetbmp.pdf

7) *Open Space Conservation Resources*

For more information on Ecological Land Units and their role in climate change resiliency, see URI's website on "Biodiversity, Land Protection, and Climate Change," available here: http://www.edc.uri.edu/elu/default.html

Maps: Conservation Opportunity Areas - 2015 State Wildlife Action Plan, can be accessed here: http://www.dem.ri.gov/maps/ (click on app 'RI Conservation Opportunities').

8) *Creating a Lake Management Plan*

- Website for the North American Lake Management Society: https://www.nalms.org/home/lake-management-planning/
- Practical Guide to Lake Management in Massachusetts: https://www.mass.gov/files/documents/2016/08/uk/practical-guide-no-pics.pdf

9) *Creating a Stormwater Utility*

Some resources available to assist communities in developing a stormwater utility include:

USEPA Funding Stormwater Programs Fact Sheet
This document includes information on various stormwater funding mechanisms and types of stormwater utilities. It also describes how to create a stormwater utility and provides a list of resources.
Online at: http://www3.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

New Hampshire Department of Environmental Services Stormwater Utilities Webpage
This webpage provides information about creating stormwater utilities, provides examples, and a list of resources.
Online at: http://des.nh.gov/organization/divisions/water/stormwater/utilities.htm

C) Potential Watershed Partners

Land Trusts

Land trusts seek to preserve open spaces, natural areas, scenic character, watersheds, drinking water sources, farmland, forests, historic sites, and shorelines that uniquely define communities. Land can be held by a land trust in outright ownership or by means of a conservation easement that permanently limits the use of the land in order to protect its conservation value.
Contacts: (Available on organization websites)

- The Narrow River Land Trust http://narrowriverlandtrust.org/
- The Land Conservancy of North Kingstown http://lcnk.org/
- Narragansett Land Conservancy https://www.narragansettri.gov/228/Land-Conservancy-Trust
- South Kingstown Land Trust http://sklt.org/
- The Nature Conservancy https://www.nature.org/en-us/about-us/where-we-work/united-states/rhode-island/
- Audubon Society of Rhode Island https://asri.org/

Other Organizations

Other research-based and non-profit organizations whose focus is protecting the water resources in the watershed are either located within the watershed or work within the watershed. These groups contribute to the improvement and protection of the water quality of waterbodies in the watershed by continuing water quality monitoring, public education, stormwater abatement, and other water quality and habitat improvement projects. These organizations include:

Save the Bay
Founded in 1970, Save the Bay has been working to protect and restore the Narragansett Bay and its watershed for over 40 years. Save the Bay projects in the Narrow River watershed have included habitat restoration, such as the Shady Lee Mill dam removal. Save the Bay was also involved in developing a strategy for a salt marsh monitoring and assessment program for the State of RI.
Website: http://www.savebay.org

Narragansett Bay Estuary Program (NBEP)
Since 1987, the Narragansett Bay Estuary Program (NBEP) has strived to protect and preserve Narragansett Bay and its watershed through partnerships that conserve and restore natural resources, enhance water quality and promote community involvement. While funding and oversight comes largely from USEPA, support also comes from stakeholder commitment and the Association of National Estuary Programs (ANEP). NBEP is mandated by the U.S. Government to update the existing Comprehensive Conservation and Management Plan (CCMP), which will be renamed as the Narragansett Bay Region Plan. This plan is a multi-state consensus of goals and priority actions regarding the Narragansett Bay watershed, of which the Narrow River watershed is a part. The NBEP has worked on a number of habitat restoration and water quality monitoring programs throughout Rhode Island.
Website: http://www.nbep.org/

Narragansett Bay National Estuarine Research Reserve (NBNERR)
Coastal Training Program (CTP)
The NBNERR CTP provides coastal decision-makers with science-based trainings and tools to help them make informed decisions about how to best protect the health of their communities and Narragansett Bay. Training programs include, among others, Low Impact Development Site Planning and Design, Conservation Development, and Conservation Easements and Open Space Management.
Website: http://nbnerr.org/ctp/

University of Rhode Island Cooperative Extension
As a function of URI's Land Grant mission, URI's 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)- provides information, education, and assistance to local land use officials regarding how they can accommodate growth while protecting their water resources
- URI Home* A* Syst – provides information and training on pollution prevention for homeowners
- Watershed Watch Program– coordination of volunteer water quality monitoring

Website: https://web.uri.edu/coopext/water/

Southern Rhode Island Conservation District (SRICD)
The mission of the SRICD is to promote and achieve a healthy environment and sustainable use of natural resources for the people of Kent and Washington Counties and the State of Rhode Island, now and for the future, by coordinating partners to provide technical, educational, and financial resources. SRICD has been a partner with the municipalities in the Narrow River Watershed to implement their MS4 programs, including projects to install stormwater management best practices and to conduct education and outreach and public involvement activities. The SRICD developed the AWEsome curriculum with URI's Department of Natural Resources.
Website: http://www.sricd.org/

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X. *Evaluation: Monitoring and Measuring Progress*

A) Summary of Scheduled and Recommended Water Quality Monitoring Efforts

Many of the existing monitoring programs can be used to monitor the parameters and indicators applicable to the goals of this watershed plan.

- The North Kingstown Water Department will continue to test its drinking water supply.
- Bacteria will continue to be monitored by the RIDEM Shellfish Growing Area Monitoring Program for the Narrow River. However, if efforts are pursued to investigate areas for potential delisting for shellfish consumption impairment, there may be a need to expand this monitoring.
- RI Department of Health Bathing Beach Monitoring Program will continue to monitor bacteria at the public beach at Camp Grosvenor.
- The Narrow River Preservation Association will continue to monitor water quality of the Narrow River through the Watershed Watch program for bacteria, forms of nitrogen, and other parameters.
- Eelgrass beds are being monitored through aerial photography by the RI Environmental Data Center in partnership with RI CRMC.

Additional Monitoring Recommended

As resources allow, some areas for additional monitoring are recommend. Additional monitoring should be designed and implemented in order to track progress and evaluate the effectiveness of the implementation efforts.

- Bacteria needs to be monitored for the Crooked Brook in accordance with the Crooked Brook Bacteria TMDL. It has been suggested that NRPA add this to their Watershed Watch monitoring program.
- Bacteria needs additional monitoring in Pettaquamscutt Cove in accordance with the Narrow River TMDL to determine the effectiveness of remedial actions in the tributaries since waterfowl still contribute to cove bacteria loads despite tributary improvements.
- Aquatic Invasive Species are not routinely monitored in the Narrow River watershed. All of the ponds in the watershed should be surveyed and routinely monitored for the presence and extent of AIS.
- Complete and continue a wetland monitoring and assessment program for the Narrow River Watershed.

B) Measuring Progress

There are several indicators of progress that can be used to measure and document improvements in water quality and aquatic habitat protection and restoration in the watershed. The most direct and straightforward indicators are water quality measurements, such as concentrations of bacteria, nitrogen, and phosphorus; and dissolved oxygen. Water quality monitoring data for these parameters can be compared with the water quality criteria for the waterbody classification. Monitoring can extend to biological indicators, such as aquatic macroinvertebrates, eelgrass beds, and anadromous fish. Biological monitoring can look at species population levels, species composition, and/or contaminant levels in tissues.

For the Narrow River watershed, applicable indirect indicators of pollutant load reductions that can be used for communicating success include:

- Area/acreage of Narrow River meeting the water quality standard for shellfish consumption
  - Goal: Reduce bacteria sources from entering Narrow River
- Acreage of eelgrass beds
  - Goal: Reduce excess nitrogen in Narrow River
- Change in trophic status
  - Goal: Reduce excess phosphorus in freshwater lakes and ponds
- Number of algae blooms observed in Narrow River / freshwater lakes
  - Goal: Reduce excess nitrogen in Narrow River
  - Goal: Reduce excess phosphorus in freshwater lakes and ponds
- Number of beach days in season closed to swimming
  - Goal: protect and restore swimming opportunities in the Narrow River (at Camp Grosvenor)

Indicators to measure and communicate health of aquatic habitat include:

- Number of waterbodies without AIS
  - Goal: reduce AIS
- Total stream miles with improved stream connectivity due to removal of barriers
  - Goal: restore connectivity of aquatic habitat for fish and wildlife
- Acres of damaged wetlands and buffers restored
  - Goal: protect and restore wetlands and their buffers

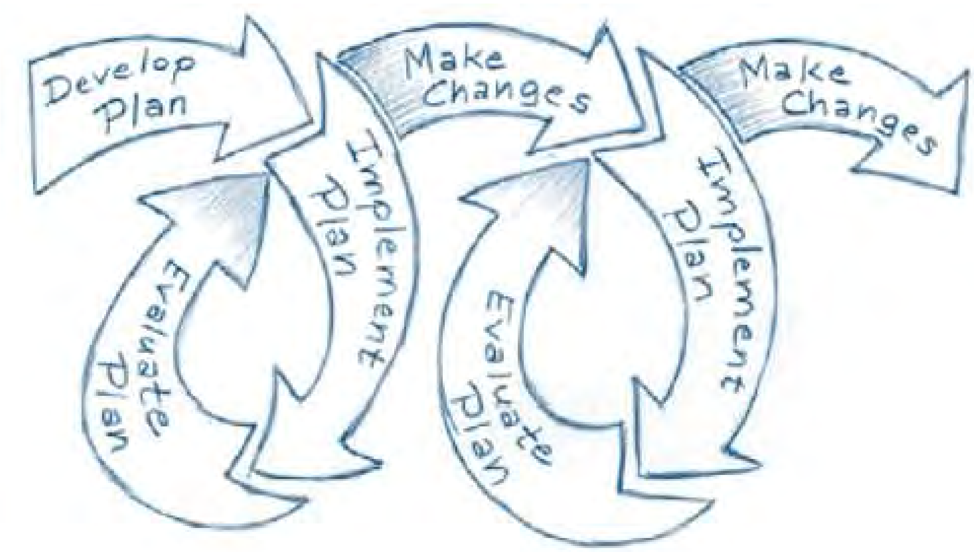
An additional way to measure progress is to systematically track the implementation of the actions in the Implementation **Table 9**. Taking this a step further, the programmatic performance indicators below may be used to measure plan implementation. Although these actions are not a measure of direct environmental improvements, they are assumed to contribute to water quality and aquatic habitat improvements.

Some potential performance indicators for water quality and aquatic habitat improvements include:

- Number of stormwater BMPs installed.

- Number of substandard/ failing septic systems upgraded or connected to sewer system.
- Number of illicit discharges discovered compared with percent that are corrected.
- Acreage of open space/ percent of watershed in conservation.
- Acreage of wetlands protected, and acreage/percent degraded that are restored.
- Number of watershed projects implemented to improve and protect wetlands.
- Acreage of buffers protected, and acreage/percent degraded that are restored.
- Number of watershed projects implemented to improve and protect riparian buffers.
- Number of stream connectivity projects implemented/ percent of substandard crossings improved for connectivity.
- Number/percent of lakes managed for AIS with a Lake Management Plan.
- Municipal progress in implementing strategies for improved OWTS, Stormwater, and LID programs.
- Increase in impervious area that is connected to stormwater treatment/ area that is disconnected.
- Number of contact hours of educational outreach attained.
- Awareness among residents and other targeted audiences as measured by surveys.

In addition to communicating success, measuring progress and assessing the information helps to figure out if the actions are working towards achieving the goals of the plan. If they are not, a more thorough assessment may be needed in order to figure out a more effective approach. Adjustments may be needed for any portion of this plan or in its implementation. For instance, there may be a need for new monitoring information, or in understanding the sources of pollutants. Evaluating implementation items may help determine whether installed management measures are functioning as intended, or if new action items are needed to most effectively address the problems. Be sure to ask the right questions before making any changes. Deliberate methods for monitoring and evaluating the implementation strategies in this plan are needed to assure success and make best use of limited resources. Watershed planning is iterative, and an adaptive management process is necessary.



The adaptive management process. Image source: EPA Handbook for Developing Watershed Plans to Restore and Protect Our Waters.

C) Plan Implementation

The Narrow River Preservation Association has agreed to steward the implementation of this watershed plan. Stewardship involves:

- Responsibility for revising and updating this plan.
- Reconvening the stakeholders, at a frequency to be determined.
- Keeping track of projects and implementation.
- Measuring and tracking progress and reporting milestones to the public, stakeholders, and other interested parties.
- Championing and fostering communication for implementation of this plan.

Implementation of this watershed plan involves many stakeholders, each with identified action items as noted in the Implementation Table. Some action items may involve coordination with other stakeholders. Coordination and communication across the municipalities, the State, the Narrow River Preservation Association, and other entities involved in protecting and restoring the water quality and aquatic habitats in the Narrow River Watershed is very important in order to achieve the goals of this plan.

This plan is being provided to the Towns of Narragansett, South Kingstown, and North Kingstown as a tool to use in the long-term protection and restoration of water quality and aquatic habitat in the Narrow River watershed. In partnership, the municipalities ideally should take ownership of this plan and lead efforts, in communication and coordination with NRPA, to implement strategies in the Plan and update the Plan as needed. The Plan should be considered the first step in an on-going effort. From here, developing annual work plans, implementing projects, applying for funding, assessing progress, communicating successes, and making adjustments as needed are all part of the watershed plan implementation process.

This watershed plan will satisfy the requirements for eligibility for USEPA Section 319 funds that are administered by RI DEM. Projects requesting Section 319 funds must be either identified in the Plan's implementation section or at minimum consistent with the intent of the Plan, in addition to meeting the criteria of the 319 funding program. The Plan will also be useful in showing support for applications to other sources of funding for implementation.

As more is learned about the watershed or as additional strategies for protection and restoration are identified, the Plan should be amended accordingly.

This Plan should be continually evaluated and updated in order to guide appropriate actions to protect and restore water quality and aquatic habitat in the Narrow River Watershed.

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Appendix 1. Outreach for Watershed Plan

Outreach Efforts for This Watershed Plan

Outreach efforts for this watershed plan are described below. Meeting materials (agenda and workshop handout with stakeholder comments) are included at the end of this Appendix.

Watershed Organization Meetings

The watershed plan coordinator attended two general meetings of the Narrow River Preservation Association's (NRPA) Board of Directors, and NRPA's annual meeting. The NRPA has been empowered by the Rhode Island Rivers Council as the designated watershed council for the Narrow River. The NRPA also conducts water quality monitoring for the Narrow River, in addition to a number of other outreach and stewardship activities.

The first meeting was on April 4, 2017 to introduce the development of the Narrow River Watershed Plan and to obtain input on the issues and concerns, and to find out about current activities. The second meeting was held on July 10, 2018 to discuss work to date on the watershed plan, planning for stakeholder input meetings, and planning for stewardship of the plan after it is complete.

The watershed plan coordinator gave a brief presentation on the watershed plan at the NRPA's annual meeting held on October 2, 2018, which was free and open to the public and attended by approximately 50 guests.

Municipal Meetings

Meetings with key staff in each municipality were held in May of 2018. The watershed coordinator held one meeting with available staff in each town. The purpose of these meetings was to introduce and discuss watershed planning and the approach for developing the Narrow River Watershed Plan; to obtain information on local concerns pertaining to water quality, aquatic habitats, and the watershed plan; and to learn about current municipal activities and relationships with other entities that would be relevant to the plan. Stakeholders included town managers, town planners, town engineers, public works directors, and water and wastewater managers.

Stakeholder Workshops

Two stakeholder workshops were held in August 2018. Both workshops had the same purpose and used the same presentation materials, but were scheduled to accommodate different dates and times of stakeholder availability in order to obtain more input. Written comments were also welcome before and after the workshops. Stakeholders represented municipalities and organizations who are involved in or interested in protecting and/or restoring the water resources and aquatic habitats in the watershed. The purpose of the workshop was to introduce the Narrow River watershed planning effort and to obtain stakeholder input on the priority issues and action items in the watershed for the protection and restoration of water quality and aquatic habitats.

The first workshop was held in the morning on Thursday, August 23, 2018 and was attended by 21 guests. The second workshop was held in the evening on Tuesday, August 28, 2018 and was attended by 10 guests. The watershed plan coordinator facilitated the workshops with support from RIDEM Nonpoint Source Pollution Program staff.

Narrow River Watershed Plan

Purpose: Planning for the Protection and Restoration of Water Quality and Aquatic Habitats in the Narrow River Watershed.

Ground Rules:
1. Stick to Time Limits (flexible)
2. Get to know your partners in the Watershed!

Today's Agenda:

Objectives:
- Introduce the Narrow River Watershed Planning Effort
- Stakeholder Input on the Priority Issues and Action Items in the Watershed

Schedule (flexible as needed):

9 a.m.- 9:10 a.m.	Welcome and Introductions
9:10 – 9:40 a.m.	Presentation on Narrow River Watershed Planning and Issues
9:40 – 9:50 a.m.	Q & A
9:50 - 10:00 a.m.	Exercise: Priority Issues and Goals Review
10:00 –10:45 a.m.	Exercise: Gaps in Action Items and Priority Action Items [and, if time: Potential Project Ideas]
10:45- 11:00 a.m.	Wrap Up and Next Steps

Activity Instructions:

a. Issues/Goals: Review Priority Issues/Goals and Comment, if needed
b. Action Items:
    i. Review Action Items and fill in gaps with your recommended Action Items- use sticky notes to write your actions and affix to appropriate issue sheet.

    ii. Prioritize Action Items- What should we focus our attention on in order to make progress? Put dots next to the action items that you think are 'Most Important to Focus on Next.'

c. [Time Permitting: Protection and Restoration Project Ideas Exercise: Use sticky notes to provide your input on potential aquatic habitat and riparian buffer restoration and/or protection projects.]

Time Permitting- Can also e-mail your ideas to Jenny any time after the workshop

Narrow River Watershed Plan- Issue Goals and Action Items:
<u>Comments Received at Stakeholder Workshops</u>

Comments/Actions are written in Times New Roman 12 point font.

Dates of workshops were:
Thursday morning, August 23, 2018 Priorities marked with ★
Tuesday evening, August 28, 2018 Priorities marked with ✶
Some people who could not make either workshop submitted written comments, incorporated below.

Potential Habitat Restoration Project Ideas

<u>Comments received at 8/23/2018 stakeholder workshop:</u>

- Look at/ study "Recreational Carrying Capacity" of the River- Responsibility: CRMC and the Towns. ★
- Expand 'No Wake Zone'
- Health: Each recreation area has port-a-johns

<u>Comments received at 8/28/2018 stakeholder workshop:</u>

(none)

Potential Habitat Protection Project Ideas

<u>Comments received at 8/23/2018 stakeholder workshop:</u>

- Look at freshwater flooding of salt marsh areas. Move drainage work to prevent ponding. (Contact Wenley at Save the Bay)
- Invasive control of Japanese Knotweed and Japanese Stiltgrass

<u>Comments received at 8/28/2018 stakeholder workshop:</u>

(none)

<u>Written Comments received:</u>

- <u>Maintain and improve forested habitat</u> in upland areas surrounding the estuary. This will improve and maintain connectivity, reduce erosion, sedimentation and non-point source pollution, while maintaining open space and providing essential habitat for species that utilize coastal edge, upland habitat and open water.

Goal: Improve Water Quality for Shellfishing and Swimming in the Narrow River, at areas closed due to Bacteria

Narrative: The entire Narrow River is permanently closed to shellfishing because it exceeds the water quality standard (for shellfish consumption) for bacteria (fecal coliform). Additionally, portions of the river occasionally experience high bacteria counts that exceed the safe swimming standard, resulting in beach closures. (There are also private beach areas that the State does not test).

Causes/Sources/Threats: ✶✶✶✶✶ ✶Reprioritize these sources? Are they the same as identified in the TMDL?

- wastewater
  - failing septic systems
  - illicit connections
  - cracked/ leaking sewer pipes
- stormwater
- pet waste
- wildlife/ waterfowl

Action Items from Existing Plans:

Reference	Action	Responsible Party	Comment
Narrow River TMDL	Implement the action items as noted in the Narrow River TMDL for Bacteria	Narr, SK, NK	✶✶✶
Crooked Brook TMDL	Implement the action items as noted in the Crooked Brook TMDL for Bacteria	Narr	
Narrow River TMDL (p.74)	Identify/repair failing septic system(s) near Mumford Road. (status?)	SK, DEM	★ ✶
Narrow River TMDL (p.75)	Connect to town sanitary sewers and eliminate illicit sanitary and gray-water connections to storm sewers.		★ May require (amendment?) to Tri-Party agreement
Narragansett Comprehensive Plan (p.12)	Identify inflow/infiltration projects that will reduce Narragansett's overall flow contribution to the Westmoreland Treatment Plant. Use earmarked funds from the new connection permit fee for implementation	Narr	★ Study is complete. Policy in place. Projects have been implemented. Not complete.
NK Comp. Plan (p.173)	Work to eliminate substandard wastewater treatment systems (cesspools and poorly functioning ISDS /OWTS).	NK	★ ✶✶✶✶
Narrow River TMDL (p.75)	Utilize combination of end-of-pipe structural BMPs, smaller-scale structural retention/ infiltration BMPs located up-gradient within the catchment areas, and	Narr, SK, NK	Narr and SK have stormwater

Reference	Action	Responsible Party	Comment
	implementation of nonstructural BMPs throughout the watershed. (refer to TMDL for specific locations)		abatement plans
Crooked Brook TMDL	Non-structural/structural stormwater BMP at stream channels running through Sprague Park, behind Pier Ice Plant, by high school, upstream of South Pier Road, at Kingstown Road outfall to Sprague Pond.	Narr	✶ Need guidance on appropriate design.
NR TMDL p.75 CB TMDL p.18	Police pet wastes. (enforce existing ordinances, esp. at areas identified in the TMDL's)	Narr, NK, SK	★ ✶
Crooked Brook TMDL (p.19)	Horse farm on upper Crooked Brook: (address each recommendation per TMDL) (status?)	Narr, Landowners	Please identify. Coordinate w/ SRICD
TNR-075	(as interpreted from discussion of what is needed): Encourage residents to allow tall, coarse vegetation to grow along the banks of the river segments frequented by waterfowl or install commercially available fencing to restrict waterfowl access to the water.		★ ✶ Please provide technical assistance.
TNR-075	Inform residents not to feed waterfowl.		★★★ ✶
TCB-018	Discourage waterfowl from residing in specific areas (Crooked Brook subwatershed)	Narr	★★★ Need help with appropriate techniques.

Will these Actions adequately Resolve this Issue?

What is Missing? Put your Recommended Actions Here:

Comments received at 8/23/2018 stakeholder workshop:

- Set up septic system replacement grant program as incentive to replace failed /failing/ substandard OWTS
- Conduct leak checks of municipal sewers esp. in Middlebridge area. ★
- Port-a-potty at parking areas. ★
- Suggest that NRPA consider monitoring Crooked Brook
- Provide sanitation facilities for recreational users
- Figure out enforcement of identified point sources of septic failure- for RIDEM to do- New Goal
- Identify hotspots and eliminate. (instead of eliminating/ analyzing EVERYTHING at once)
- Study "Recreational Carrying Capacity"- for CRMC and Towns
- Goose abatement (oiling, culling, no feeding, buffer) ★
- Additional sewer connections: May require assessment of Tri-party WWTF and revision to the Tri-party agreement.
- Watershed-wide Pet disposal system of collection. ★

- Provide education materials for Narrow River Kayak customers (not to feed waterfowl)

Comments received at 8/28/2018 stakeholder workshop:

- Need to identify "actual" location of septic systems and cesspools to determine whether they are failing and need to be repaired, or can be upgraded (Nitrogen removal), or connected to sewer. Does the OWTS database track OWTS that have been connected to sewer or upgraded?
- For bacteria, what is the contribution of bacteria loadings from the Westmoreland Treatment Plant? Are there any CSO's (combined sewer overflow w/stormwater)? This will determine the priority of this action.
- Research is needed to accurately pinpoint the effects of OWTS to high bacteria loading through groundwater to the estuary? Land use, riparian buffers are also important components to consider
- For bacteria, identify, quantify water quality improvement and effectiveness of BMPs designed to remove, retain bacteria loadings, before spending funds. What are the priority drainage areas to be intersected/treated by BMP?
- For horse farm, identify NRCS funding opportunities to work w/ landowner to implement conservation practices.
- Ban cesspools and get old systems upgraded.
- Should include dredging to restore flow-ACOE is interested—they will want to see it in the plan.
- Seriously study the impact of the Canada Geese on their impacting the water quality of the river.

Goal: Protect and Improve Water Quality for Fish and Wildlife Habitat in the Narrow River which is threatened by excess Nitrogen ✶

Narrative: Excess Nitrogen in coastal (salt) waters fuels algae growth. Nitrogen levels in the Narrow River estuary are high. Algae blooms are observed to be increasing in the Narrow River. Increased algae blooms are a threat to the aquatic ecosystem which can harm fish and other aquatic life.

Causes/Sources/Threats:

- wastewater
  - failing septic systems
  - illicit connections
  - cracked/ leaking sewer pipes
- groundwater flow (legacy from septic systems)
- fertilizer
- stormwater
- pet waste
- wildlife/ waterfowl
- combustion emissions

Action Items from Existing Plans:

Reference	Action	Responsible Party	Comment
Narr Comp. Plan (p.12)	Identify inflow/infiltration projects that will reduce Narragansett's overall flow contribution to the Westmoreland Treatment Plant. Use earmarked funds from the new connection permit fee for implementation.	Narr	★
SK Comp. Plan (p.46)	The Town will provide sewer service primarily to RM, R-10, selected R-20 zones, and other high and medium high-density residential areas.	SK	★ ✶
(local OWTS Plan)	Implement the ISDS Wastewater Management Plan for the Town of Narragansett (2002) (and enforce related ordinances); Review and update as necessary.	Narr	Update complete.
(local OWTS Plan)	Implement the Town of South Kingstown On-Site Wastewater Management Plan (1999) (and enforce related ordinances); Review and update as necessary.	SK	
(local OWTS Plan)	Implement the Town of North Kingstown Onsite Wastewater Management Plan (2000) (and enforce related ordinances); Review and update as necessary.	NK	✶✶
NK Comp. Plan (p.173)	Investigate ordinances requiring use of denitrification systems in environmentally vulnerable areas.	NK	★★ ✶✶
Narr Comp. Plan (p.3)	Incorporate low impact development techniques into the Subdivision and Land Development Regulations.	Narr	★✶ Comp Plan has as Med-term objective
SK Comp.Plan (p.13)	The Town shall promote 'green' housing development/ redevelopment throughout the community utilizing Low Impact Design (LID) techniques, energy	SK	✶

Reference	Action	Responsible Party	Comment
	conservation/efficiency and the use of innovative building technologies.		
NK Comp. Plan (p.136)	Consider adoption of Low Impact Design standards to improve long-term sustainability.	NK	
NK Comp. Plan (p.136)	Utilize low maintenance, low fertilizer grasses and plantings in all public facilities to minimize non-point source pollution and maintenance costs.	NK	✶
NR TMDL (p.75) & CB TMDL (p.18)	(as interpreted from discussion of what is needed): Educate residents to limit application of fertilizers and pesticides to gardens and lawns to recommended doses and avoid application prior to rain events.		★★ ✶✶✶✶✶ SRICD can help
NK Comp. Plan (p.175)	Educate landowners on proper use of pesticides and fertilizers to reduce nutrient loading and algal blooms on ponds, particularly around ponds used for recreation.	NK	★★ ✶✶✶

Will these Actions adequately Resolve this Issue?

What is Missing? Put your Recommended Actions Here:

<u>Comments received at 8/23/2018 stakeholder workshop:</u>

- Education programs on geese as nuisance population- NRPA for implementation
- Education program on use of fertilizers and pesticides- NRPA
- Talk to Representatives about stormwater assistance- (for Towns to do)
- Watershed wide program for pet waste disposal- NRPA
- Re-issue the NRPA document from the early 1990's that was distributed to all property owner on what to do to protect/improve Narrow River water quality- the "Narrow River Handbook" ★★
- Develop strategies for funding mechanisms to replace failing OWTS for residential properties trough partial grants via community
- High nitrogen level can reduce the stability of saltmarsh edges. Establish standards.
- Groundwater assessment to identify Nitrogen sources
- Planting to discourage geese. Demonstration project. Along slope of river.

<u>Comments received at 8/28/2018 stakeholder workshop:</u>

- Increase fertilizer education and offer "free" assessments and/or demonstrations
- Need to finish the recommendations from the Tri-Town Stormwater Report and put in BMPs at Pettaquamscutt Lake Shore and Indian Trail Neighborhood
- What is the Nitrogen loading from the Westmoreland Treatment Plant?
- Nitrogen removal- do the ordinances use coastal resource concern areas to promote upgrading OWTS?
- For Narrative- add that Nitrogen levels are high in the tributaries.
- Prioritize the sources of nitrogen. Via land use modeling. SWAT model was applied in Green Hill Pond and Ninigret Pond.

Goal: Improve Water Quality for Fish and Wildlife Habitat in the Freshwater Ponds of the Narrow River Watershed, which are impaired by excess Phosphorus ✶

Narrative: Two freshwater lakes in the watershed are listed as impaired for Fish and Wildlife Habitat due to excess Phosphorus. Excess Phosphorus can cause algae blooms which can lead to low oxygen conditions, posing a threat to fish and other aquatic life. (Additionally, some types of blue-green algae produce a toxin, which is harmful to humans and pets, which is of growing concern.)

Causes/Sources/Threats:

- Wastewater: failing septic systems, illicit connections (don't know if any exist around these ponds- need to investigate and confirm)
- Pet waste
- Waterfowl/wild animal and bird waste
- Fertilizer
- Eroding sediments (P binds to sediment and travels with it)
- Vehicle exhaust and combustion of fossil fuels
- Recirculation of excess phosphorus from lake bottom sediment

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Action Items from Existing Plans:

Reference	Action	Responsible Party	Comment
NK Comp. Plan (p.171)	Implement regulatory techniques that provide measures for soil erosion and sediment control.	NK	
NK Comp. Plan (p.175)	Educate landowners on proper use of pesticides and fertilizers to reduce nutrient loading and algal blooms on ponds, particularly around ponds used for recreation.	NK	★ ✶✶
(local OWTS Plan)	Implement the ISDS Wastewater Management Plan for the Town of Narragansett, Rhode Island (2002) (and enforce related ordinances); Review and update as necessary.	Narr	Possibly updated ★ ✶
(local OWTS Plan)	Implement the Town of South Kingstown On-Site Wastewater Management Plan (1999) (and enforce related ordinances); Review and update as necessary.	SK	★
(local OWTS Plan)	Implement the Town of North Kingstown Onsite Wastewater Management Plan (2000) (and enforce related ordinances); Review and update as necessary.	NK	✶
NK Comp. Plan (p.175)	Develop a plan and regulations to protect the town's river corridors, surface waters, wetlands, freshwater and saltwater features by establishing undisturbed setbacks.	NK	★★ ✶
SK Comp Plan-IMP-34	The Town shall develop a freshwater ponds and lakes management plan to address such issues as docks, public access and land use in the watershed.	SK	Address Phosphorus, too?
SK Comp Plan -IMP-33	The Town shall implement recommendations for best management practices included within the DEM	SK	✶

Reference	Action	Responsible Party	Comment
	Stormwater Design and Installation Standards Manual (2011), as amended.		
NK Comp. Plan p146	Require that improved stormwater systems meet current state and federal regulations when upgrading or reconstructing roads.	NK	★ ✶✶
NK Comp. Plan p174	Educate the public about preventing water contamination, especially activities such as dumping yard waste and other pollutants.	NK	★★ ✶

Will these Actions adequately Resolve this Issue?

What is Missing? Put your Recommended Actions Here:

<u>Comments received at 8/23/2018 stakeholder workshop:</u>

- <u>Require</u> erosion and sediment control training for contractors to work in Town. Training is available through RIDOT/URI NEMO.
- Install pet waste disposal bag dispensers. This has been quite successful in South Kingstown parks. ★
- Investigate the visibility of using constructed wetlands to restore water quality in freshwater ponds and rivers.
- Consider initiating regular meetings of all 3 community representatives to discuss successes and possibly coordinate community projects.
- Phosphorus control is not a priority for Narrow River watershed lakes and ponds. Nitrogen in freshwater lakes is a bigger priority.
- Some watersheds maps have Silver Lake in Saugatucket watershed.

<u>Comments received at 8/28/2018 stakeholder workshop:</u>

- Ban all cesspools—expand regulations to get rid of them.
- Should phosphorus sources be prioritized via a more specific study?

Goal: Improve and Protect Fish and Wildlife Habitat and Recreational Use in the Freshwater Ponds of the Narrow River Watershed, some of which are impaired by Aquatic Invasive Species (AIS), and others of which are threatened by AIS

Narrative: Aquatic invasive species (AIS) damage fish and wildlife habitat. AIS out-compete native plants, disrupt the ecosystem, and create a nuisance for recreation. Once established, AIS are difficult and expensive to control. Management of AIS is needed for the impaired waterbodies to improve habitat and prevent the further spread of invasives from these source locations. Prevention of AIS from spreading to the unimpaired waterbodies is an equally important goal. It is much easier to intervene and contain a small population than attempt to abate and control a widespread, well-established population of aquatic invasive species.

Current Status: Two freshwater lakes are impaired for recreational use and fish and wildlife habitat due to aquatic invasive species (AIS) (also called: 'non-native aquatic species').

- Silver Spring Lake in North Kingstown has invasive fanwort and variable milfoil
- Carr Pond in North Kingstown has invasive fanwort and variable milfoil
- Silver Lake in South Kingstown, no AIS observed during August 8, 2017 investigation
- Other waterbodies: not assessed

Causes/Sources/Threats:

- Increased traffic of boats with AIS fragments from other ponds
- lack of AIS awareness and boat hygiene
- Fragmentation of non-native species
- aquarium/water garden trade
- wildlife movement

Action Items from Existing Plans:

Reference	Action	Responsible Party	Comment
SK Comp. Plan (p.34)	The Town shall develop a freshwater ponds and lakes management plan to address such issues as docks, public access and land use in the watershed.	SK	Address AIS, too? ✶
	Ideas?		

Will these Actions adequately Resolve this Issue?

What is Missing? Put your Recommended Actions Here:

<u>Comments received at 8/23/2018 stakeholder workshop:</u>

- Provide water for washing boats at docks. ★
- BIG Education signs at boat docks
- Mechanical Removal
- Awareness and boat wash campaigns
- Survey other ponds/rivers for presence to control spread

<u>Comments received at 8/28/2018 stakeholder workshop:</u>

- AIS prevention education and ensure monitoring and prevention
- Boat monitoring of invasives

Goal: Restore Connectivity of Aquatic Habitat for Fish and Wildlife, impeded by dams and sub-standard culverts

Narrative: The Narrow River and its tributary streams and ponds provide habitat for aquatic life, including River Herring and American eel. Human made structures, including dams and road crossings (bridges and culverts) can obstruct the full functioning of this ecosystem. Barriers to stream connectivity prevent the free movement of aquatic life up and down a river system, resulting in a fragmented aquatic habitat, with potential impacts on water quality (and an increased potential for flooding).

Causes/Sources/Threats: Barriers to Stream Connectivity:

- Dams
- Sub-standard culverts
- Inadequate fish passages/ladders
-
- Sediment
- Trash

Locations to target:

- Shady Lea Mill dam (currently being removed)
- Culverts at road crossings, particularly at Route 1 and Route 138
- Silver Spring Lake dam (this is a popular fishing spot- need to evaluate options with further study)
- Passage at Gilbert Stuart to minimize distraction of fish from reaching the ladder
- Others?

Action Items from Existing Plans:

Reference	Action	Responsible Party	Comments
NK Comp. Plan (p.164)	Routinely inspect and classify all dams (based on FEMA Regulations) to determine their vulnerability to failure, and repair as needed.	NK	✶
NK Comp. Plan (p.177)	Consider removal of small private dams to promote and restore fish passage.	NK	★★★★ ✶

Will these Actions adequately Resolve this Issue?

What is Missing? Put your Recommended Actions Here:

<u>Comments received at 8/23/2018 stakeholder workshop:</u>

- Perched culvert on TNC King Preserve in North Kingstown
- NAACC culvert assessments (UMASS Amherst) for fish connectivity. ★★

<u>Comments received at 8/28/2018 stakeholder workshop:</u>

- Inventory of substandard culverts for passage and increased storm intensity
- Has this been documented or mapped?

Goal: Protect and Restore Wetlands, Aquatic Habitats, and their Buffers for Fish and Wildlife Habitat and as a Resiliency Strategy for Flooding, Sea Level Rise, and Climate Change

Narrative: Freshwater wetlands and coastal salt marshes, along with their protective buffers, provide significant and economically valuable contributions to clean water, flood and storm surge protection, recreation, scenic beauty, and wildlife habitat. They provide critical habitat for many of Rhode Island's rare and threatened wildlife species; and are among the most productive natural systems regionally and worldwide. In the coastal zone, high productivity supports the food chains that subsequently support the fish and shellfish industries. Wetlands also have a fairly significant role in storing excess carbon from the atmosphere.

Protection and Restoration of naturally vegetated buffers around wetlands and along rivers, streams, and ponds provides multiple resource protection benefits, including resiliency from flooding and a changing climate, in addition to water quality protection and wildlife habitat.

Causes/Sources/Threats: Stressors to Viability of Freshwater and Coastal Wetlands, Riparian Buffers, and Submerged Aquatic Vegetation (SAV):

- Loss of vegetated buffer adjacent to waterbody or wetland (called a 'riparian' buffer)
- Degradation of freshwater wetlands due to physical and hydrologic alteration
- Degradation of coastal wetlands/marshes due to sea level rise
- Degradation of coastal wetlands/marshes due to stormwater (freshwater) inundation
- Loss of coastal wetlands/marshes as sea level rises due to barriers to natural migration
- Damage to coastal wetlands/marshes and submerged aquatic vegetation, such as eelgrass, due to boating (propeller and wake damage)

Action Items from Existing Plans:

Reference	**Action**	**Responsible Party**	**Comment**
Narr Comp. Plan (p.3)	Establish priorities for acquisition of open space that creates the greenbelt network.	Narr	✶ LCT active project
SK Comp. Plan (p.61)	The Town shall consider the connectivity and accessibility of open space and greenway projects in its criteria for acquisition.	SK	✶
NK Comp. Plan (p.181)	Establish criteria for preservation of open space, including creation of "green corridors" that connect conserved parcels.	NK	✶✶
NK Comp. Plan (p.135)	Continue to utilize cluster techniques, PUDs, conservation easements and/or preferential tax assessment tools to preserve natural resources, unique landscapes, open space, historic structures and archaeological sites.	NK	✶✶
The RI Sea Level Affecting Marshes	Develop or update local conservation development ordinances to shift new construction and development projects away from SLAMM projected potential salt marsh areas.		★★ ✶

Reference	Action	Responsible Party	Comment
Model (SLAMM) Project: Summary Report p.20	Review SLAMM maps in the local planning and review of local redevelopment projects in areas adjacent to salt marshes.		★ ✶✶
	Use SLAMM maps to guide local wetland restoration projects.		
Narr Comp. Plan (p.29)	Encourage the acquisition or preservation of marshlands through easements.	Narr	★
SK Comp. Plan (p.60)	Policy 1.1 - The Town shall continue to preserve land which is primarily undeveloped and which consists of open, agricultural, or littoral property, ..	SK	
NK Comp. Plan (p.176)	Continue to protect wetlands through various means such as protected open space, setback requirements, easements, and direct purchase.	NK	★ ✶✶
Narr Comp. Plan (p.3)	Incorporate low impact development techniques into the Subdivision and Land Development Regulations.	Narr	
Narr Comp. Plan (p.2)	Review and update existing Zoning Ordinances and Subdivision and Land Development Regulations to ensure adequate protection of water quality and wildlife habitats.	Narr	★
SK Comp. Plan (p.5)	The Town shall support a Low Impact Development (LID) approach to development and redevelopment by revising its regulations to provide innovative standards for resource protection and site design	SK	
NK Comp. Plan (p.175)	Develop a plan and regulations to protect the town's river corridors, surface waters, wetlands, freshwater and saltwater features by establishing undisturbed setbacks.	NK	★ ✶
SK Comp. Plan (p.33)	Policy 2.1 - The Town will work toward protecting the integrity of the varied wetlands which serve many important ecological and economic functions. - The Town will pursue both regulatory and nonregulatory options for ensuring the protection of these resources.	SK	★ ✶✶
Narr Comp. Plan (p.2)	Continue to restrict development in Areas of Critical Concern identified in CRMC's Salt Pond and Narrow River SAMPs to low density residential use or acquire land as open space. Consider economic incentives for homeowners not to develop in these areas.	Narr	★★ ✶✶✶

Will these Actions adequately Resolve this Issue?
What is Missing? Put your Recommended Actions Here:

Comments received at 8/23/2018 stakeholder workshop:

- Emphasize invasive species control
- Prioritize land acquisition and conservation easement efforts on undeveloped land adjacent to coastal wetlands to preserve future coastal wetland migration to upland areas (SLAMM)

- Use limited dredging to provide “cool water refugia” for marine fish
- Integrate / Evaluate STORMTOOLS Sea Level Rise projections into planning infrastructure improvements and revisions to local land use ordinances.
- Apply information from existing TLD (thin layer deposition) projects on salt marshes to pursue
- Limit actions which will increase tide heights

Comments received at 8/28/2018 stakeholder workshop:

- Take a look at boat traffic

Written Comments received:

- Climate change and the impacts from it, flooding and sea level rise should be given center stage in developing the watershed plan. The plan is a long term management strategy to deal with past abuses, current issues and emerging problems. One aspect of this is the protection and restoration of wetlands as water levels rise and boat wakes become greater threats to marsh edge collapse. CRMC/DEM Development guidelines and requirements within the watershed must be revised and strengthened to address the coming coastal threats.
- Blues Acres – Coastal Retreat. I propose the watershed plan consider a program that is being developed in many other states facing flood and sea level rise challenges. With water levels rising, extreme tides and storms increasing in number and intensity, it makes sense to accept that some low-lying properties in the Pettaquamscutt watershed will become uninhabitable, unsustainable in the future without massive and costly engineering efforts to keep the sea out. Around the country and the globe, homeowners are beginning to retreat from low ground that is flooding regularly as the National Flood Insurance Program is discontinued. This is a delicate and difficult issue with many complex aspects, but reclaiming and restoring marsh and coastal edge should be priority activities with long term planning. With Narrow River Land Trust in place, there are several good examples of these types of programs that can serve as a model. At the least, an assessment of the numbers and locations of low-lying properties at risk should be made using a GIS analysis.

Goal: Maintain Good Quality Groundwater in the northern portion of the Watershed, which is a well-protected Drinking Water Source.

Narrative: The Pettaquamscutt Aquifer in North Kingstown supplies public drinking water to portions of the Towns of North Kingstown and Narragansett. The Pettaquamscutt Aquifer has been designated by the US EPA and grouped together with the Hunt-Annaquatucket-Pettaquamscutt Aquifer as a Sole Source Aquifer. This means that it is the only viable source of drinking water for the area. Drinking water is vital to the health of our citizens and in providing economic prosperity. Protecting the source of supply is far cheaper than treating the water to remove contaminants. As such, it is necessary that it continue to be well protected. This groundwater supply is of good quality and is safeguarded by the generally undeveloped nature of the well head areas, a groundwater protection overlay district, a large amount of protected open space, and the Town's on-site wastewater management program.

Causes/Sources/Threats: the groundwater source can be threatened by future development, which poses risks to groundwater quality from the additional lawns using fertilizers; more vehicles, pets, and septic systems in the area; and more stormwater runoff from roads, lawns, and other surfaces that collect pollutants associated with development.

Action Items from Existing Plans:

Reference	**Action**	**Responsible Party**	**Comment**
NK Comp. Plan (p.152)	Continue to ensure strict protection measures for development in groundwater protection zones and other sensitive natural areas.	NK	★★ ✶
NK Comp. Plan (p.172)	Continue to acquire land and development rights in groundwater protection areas.	NK	★ ✶✶✶
NK Comp. Plan (p.172)	Require all existing and new development within groundwater protection areas to conform to the Groundwater Protection Ordinance, and site plan and stormwater management design criteria for groundwater districts.	NK	✶
NK Comp. Plan (p.173)	Decrease impervious surface and encourage use of pervious surface wherever environmentally sound to encourage percolation of groundwater and reduce runoff and flooding potential, especially in groundwater recharge areas.	NK	✶✶

Will these Actions adequately Resolve this Issue?

What is Missing? Put your Recommended Actions Here:

<u>Comments received at 8/23/2018 stakeholder workshop:</u>

- Develop policing and enforcement standards for septic compliance
- Offer ordinance review and recommended language

<u>Comments received at 8/28/2018 stakeholder workshop:</u>

(none)

<u>Other Comments:</u>

- Consider initiating regular meetings of all 3 community representatives to discuss successes and possibly coordinate community projects.

<u>Written Comments received:</u>

- add " increase and maintain access to the river" as a priority statement
- <u>Evaluate the Narragansett Beach sand re-nourishment program</u> and its impact on sediment buildup in the lower mouth of the river. A cursory review of historical aerial photographs of the area shows the continual growth of the sand bar in the lower river, probably over the past 20-30 years. The south end of the beach naturally loses sand to the long shore current. Most is swept offshore, but the recent dredging study has shown that more sand captured in this current enters the river on a flood tide than exits on an ebb tide. This annual accumulation, along with ocean storms pushing beach sand inland, is filling the mouth, reducing flush and flow and forcing the ebbing river flow to cut severely into the back side of the dune, increasing the amount of sand in the mouth. This is a natural environmental response to an unnatural situation caused by human activities.
- Recreation Management Plan. The elephant in the room During the summer season and particularly on weekends, holidays and during sunny weather, the lower river, flats and mouth are a chaos of human activity. Boats and motors, kayaks, paddleboards, jet skis, floats, rafts, people and dogs are everywhere. This love of the river results in outboard pollution, re-sedimentation and bottom scarring from boat propellers, marsh edge collapse from battering wake waves and floating trash. Beach goers by the hundreds or even thousands urinate and yes, defecate directly into the bushes and in the water. Every harbor and every estuary in the modern day needs a management and use plan. The river can only accommodate so many users without causing significant degradation. The Pettaquamscutt needs more than a Harbormaster, it needs a recreational management plan to protect what has been described as the most important single natural area in the state.

Appendix 2. Water Quality Standards and Watershed Monitoring

Water Quality Standards

Both the United States government and the state of Rhode Island have adopted water quality goals and standards that act as important tools that help protect Rhode Island's abundant and valuable water resources from pollution. Each waterbody has a set of water quality standards applied to it, based on its intended use. For example, drinking water reservoirs must be much cleaner than waterbodies that are used for recreation. Both descriptive and numeric standards are used.

Scientists use information from water monitoring to indicate whether or not a waterbody is acceptable for its intended use (it "supports" its intended, or "**designated**," use). If monitoring indicates that water quality in a waterbody meets its standards ("good," water quality) then the waterbody can fully support its intended use(s). If, however, the monitoring results indicate that it does not meet its standards (a finding of "unacceptable," or "**impaired**") the waterbody cannot support one (or more) of its intended uses. When this happens, the intended uses (e.g., swimming, fishing, shellfishing, etc.) are restricted because the water quality is unsafe for those purposes. The Environmental Protection Agency requires that DEM prepare a report every 2 years documenting the waters that do not meet water quality standards and are therefore listed as impaired – have unacceptable water quality. This report is referred to as the "List of Impaired Waters" or the "303d List," referring to the section of the Clean Water Act which requires this reporting. To see which waters have been listed as "impaired," see **Map 8** and **Table 4** in Section III A.

Waterbodies are given a "classification," which is based on its intended use. These Classifications, as abbreviated from the State Water Quality Regulations, are as follows:

For Fresh Water:

Class AA - These waters are designated as a source of public drinking water supply, for primary and secondary contact recreational activities, and for fish and wildlife habitat. These waters shall have excellent aesthetic value.

Class A - These waters are designated for primary and secondary contact recreational activities and for fish and wildlife habitat. These waters shall have excellent aesthetic value.

Class B - These waters are designated for fish and wildlife habitat, and primary and secondary contact recreational activities. These waters shall have good aesthetic value.

Class B1 - These waters are designated for primary and secondary contact recreational activities and fish and wildlife habitat. These waters shall have good aesthetic value. Primary contact recreational activities may be impacted due to pathogens from approved wastewater discharges.

Class C - These waters are designated for secondary contact recreational activities and fish and wildlife habitat. These waters shall have good aesthetic value.

For Seawater:

Class SA - These waters are designated for shellfish harvesting for direct human consumption, primary and secondary contact recreational activities, and fish and wildlife habitat. These waters shall have good aesthetic value.

Class SB - These waters are designated for primary and secondary contact recreational activities; shellfish harvesting for controlled relay and depuration; and fish and wildlife habitat. These waters shall have good aesthetic value.

Class SB1 - These waters are designated for primary and secondary contact recreational activities and fish and wildlife habitat. These waters shall have good aesthetic value. Primary contact recreational activities may be impacted due to pathogens from approved wastewater discharges.

Class SC - These waters are designated for secondary contact recreational activities, and fish and wildlife habitat. These waters shall have good aesthetic value.

The Department may designate a 'Partial Use' for the above listed water use classifications. Partial Use denotes specific restrictions of use assigned to a waterbody or waterbody segment that may affect the application of criteria. Used here, the partial use classifications 'a.' and 'b.' are added to the main classifications and are for the following situations:

(a). CSO - These waters will likely be impacted by combined sewer overflows in accordance with approved CSO Facilities Plans and in compliance with rule 19.E.1 of these regulations and the Rhode Island CSO Policy. Therefore, primary contact recreational activities; shellfishing uses; and fish and wildlife habitat will likely be restricted.

(b). Concentration of Vessels - These waters are in the vicinity of marinas and/or mooring fields and therefore seasonal shellfishing closures will likely be required as listed in the most recent (revised annually) RIDEM document entitled Shellfish Closure Areas, however, all Class SA criteria must be attained.

There are numeric water quality standards or performance criteria for the following parameters:

Freshwater and Saltwater:

- Dissolved Oxygen
- Turbidity
- Fecal Coliform Bacteria (the standard is more stringent for shellfish consumption than contact recreation)
- Enterococci Bacteria (current preferred indicator for recreation uses)
- pH
- Temperature

Additional numeric water quality standards for freshwater:

- Phosphorus

There are no numeric water quality standards for nitrogen for either fresh or saltwater, but rather, the criteria is “none in such concentration that would impair any usages specifically assigned to said Class, or cause undesirable or nuisance aquatic species associated with cultural eutrophication.” Since nitrogen is a limiting nutrient in saltwater (marine water), excess nitrogen is more of a concern in saltwater than in freshwater.

Designated Uses

Table 10: Designated Uses- Definitions and Classifications

RI WATER QUALITY CLASSIFICATIONS

Designated Use	Applicable Classifications	Designated Use Definitions
Drinking Water Supply	AA	Supply safe drinking water with conventional treatment.
Primary Contact Recreation/Swimming	**All surface waters**	Swimming, water skiing, surfing or other recreational activities with prolonged and intimate contact by the human body with water.
Secondary Contact Recreation/Swimming	**All surface waters**	Boating, canoeing, fishing, kayaking or other recreational activities with minimal contact by the human body with the water and the probability of ingestion of the water is minimal.
Aquatic Life Support/ Fish, other Aquatic Life and Wildlife	**All surface waters**	Waters suitable for the protection, maintenance, and propagation of a viable community of aquatic life and wildlife.
Shellfishing/ Shellfish Consumption	SA, SA{b}	Supports a population of shellfish and is free from pathogens that could pose a human health risk to consumers.
Shellfish Controlled Relay and Depuration	SB	Suitable for the transplant of shellfish to Class SA waters for ambient depuration and controlled harvest.
Fish Consumption	**All surface waters**	Supports fish free from contamination that could pose a human health risk to consumers.

Shellfish Growing Area Water Quality Monitoring in the Narrow River

The RIDEM performs water quality testing specifically for shellfishing areas. The Shellfish Growing Area Monitoring program is part of the state of Rhode Island’s agreement with the United States Food and Drug Administration’s National Shellfish Sanitation Program (NSSP). The purpose of this program is to maintain national health standards by regulating the interstate shellfish industry. As part of this agreement, the State of Rhode Island is required to conduct continuous bacteriological monitoring of the shellfish harvesting waters of the state in order to maintain certification of these waters for shellfish harvesting for direct human consumption. Since the Pettaquamscutt Growing Area 7-2 is classified as prohibited, there is no minimum sampling requirement. The entire area has been closed to shellfish harvesting for direct human consumption since 1986 due to unpredictable and elevated fecal coliform levels. Areas closed are reflected on the map, below.

There are four locations where testing for shellfish consumption standards occurs—Sprague Bridge, Middlebridge Bridge, Mettatuxet Yacht Club area shore access, and Lacey Bridge (see Map 15, below). These sites were tested twice in 2015, and twelve times in 2016. The geometric mean results of this testing are reported in the RIDEM's annual Shellfish Program Classification Report. The report states that "Results of the statistical evaluation demonstrate that all stations exceed shellfish harvesting criteria during combined wet and dry weather. The dry weather only data also exceeds harvesting criteria."

The data presented in the 2016 report is in **Table 10**, below.

Table 11. 2016 Shellfish Program Classification Report- Geometric Mean Results for Pettaquamscutt Growing Area 7-2

Station Key:

Lacey Bridge (GA7-2-17S)

Mettatuxet docks (19S)

Middlebridge (21S)

Sprague Bridge (22S)

Most recent 15, all conditions, >9/11/2014, all 15 mtec

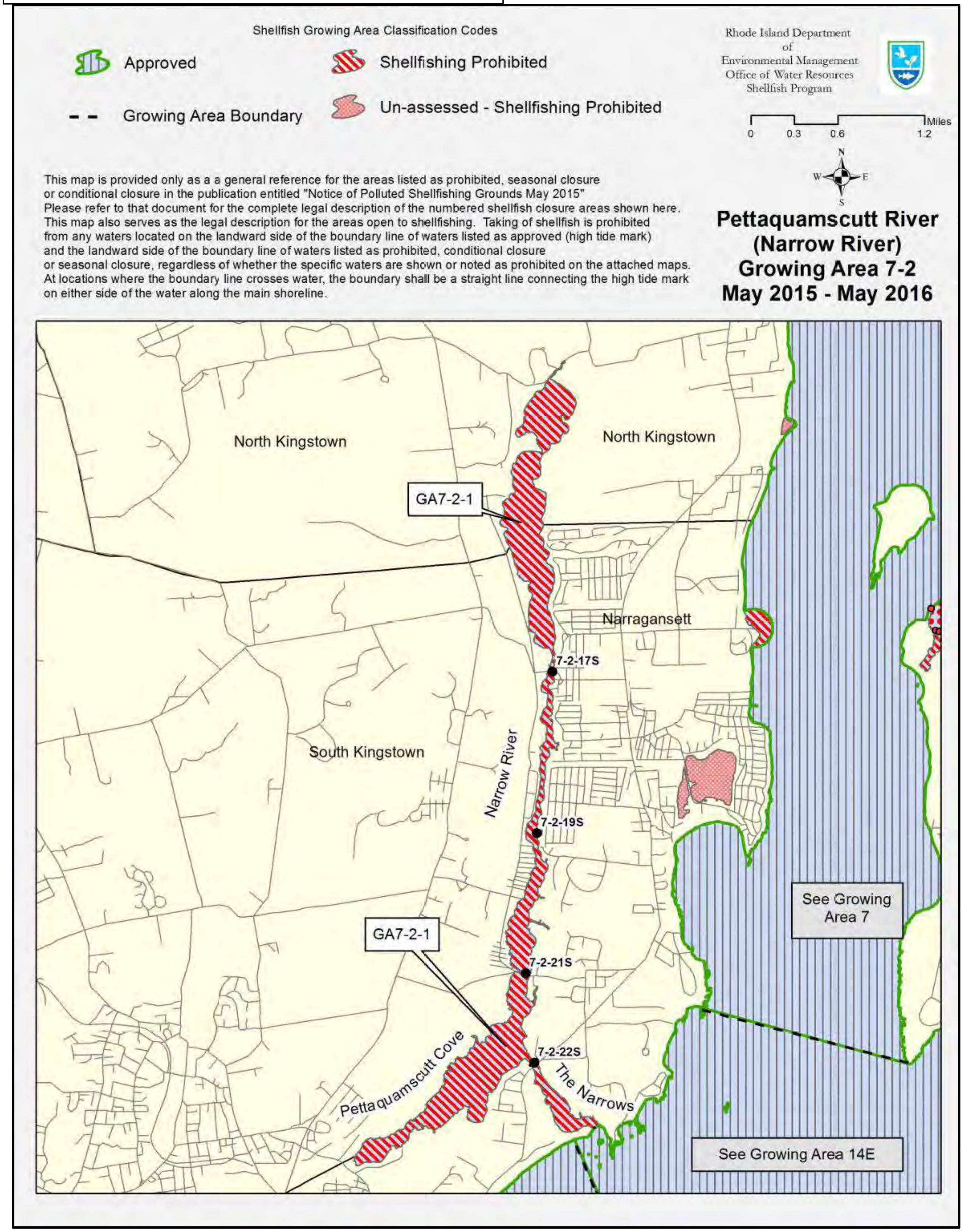
Station Name	*Status*	*N*	*FECAL-GEO MEAN*	<10 *%>CRITICAL 31*
GA7-2-17S	P	15	13.5	20.00
GA7-2-19S	P	15	34.9	40.00
GA7-2-21S	P	15	25.0	26.67
GA7-2-22S	P	15	15.1	13.33

RIDEM SHELLFISH GROWING AREA MONITORING

Most recent 15, Dry conditions only, >5/27/2010, 11 mtec, 4 mpn

Station Name	*Status*	*N*	*FECAL-GEO MEAN*	<10 *%>CRITICAL 49/31*
GA7-2-17S	P	15	19.5	33.33
GA7-2-19S	P	15	44.0	50.00
GA7-2-21S	P	15	22.5	46.67
GA7-2-22S	P	15	13.3	20.00

Map 15. Shellfish Monitoring



Source: 2015 Shellfish Program Classification Report, RIDEM

Beach Monitoring in the Narrow River Watershed

During the beach season (Memorial Day to Labor Day), the R.I. Department of Health's Beach Monitoring Program routinely tests water quality at all state operated beaches and a few private beaches. However, not all the locations in the state where the public regularly "goes to the beach" are monitored. (For up-to-date information about closed beaches, call (401) 222-2751 or visit SWIM at https://beaches.health.ri.gov/swim/ to use Health's interactive beach map.)

Beach closure rates, in general, are closely linked to rainfall as stormwater runoff is a significant source of bacteria to many beaches. Swimmers are advised not to swim in the river within 48 hours of a rain event. Watershed Watch monitoring shows bacteria levels in the Narrow River are sometimes exceeded for safe swimming following a storm event.

There is only one public beach—Camp Grosvenor in North Kingstown on the shore of Upper and Lower Ponds, owned and operated by the Boys and Girls Clubs of Newport County—that is tested by RI Department of Health in the watershed. The water is tested once or twice a month. Records from Dept. of Health indicate that this beach has been closed due to elevated bacteria levels for 26 beach days over the past 10 years, with 5 of those days during the swim season in 2018 (see **Table 11**). There are also private beaches and private swimming from waterfront homes, which are not tested by the State.

The source of bacteria leading to beach closures at Camp Grosvenor is unknown. While it is clear that rainfall leads to beach closures here, there are also some beach closures that are not strongly tied to a rainfall event. There are no stormwater outfalls in this location and the area is not classified as urban. The area is fairly wooded and steeply sloped. In 2007 and 2008, all of the cesspools and old septic systems have been upgraded to systems with leachate pumped uphill to a common leaching field that is outside the 400 foot public well radius on the property, and over 400 feet from the river. Further investigation would be needed to identify the source(s) of bacteria in order to determine the best method of addressing the high bacteria counts that lead to beach closures at this location.

Table 12. Beach Closure Days

Beach	City/Town	Closed On	Re-Opened	Number of Days Closed
Camp Grosvenor	North Kingstown	8/24/2018	Closed for season	1
Camp Grosvenor	North Kingstown	7/17/2018	7/19/2018	2
Camp Grosvenor	North Kingstown	7/12/2018	7/14/2018	2
Camp Grosvenor*	North Kingstown	8/13/2015	8/14/2015	1
Camp Grosvenor	North Kingstown	8/17/2012	8/18/2012	1
Camp Grosvenor	North Kingstown	8/2/2012	8/3/2012	1
Camp Grosvenor	North Kingstown	8/23/2011	8/25/2011	2
Camp Grosvenor	North Kingstown	6/14/2011	6/16/2011	2
Camp Grosvenor	North Kingstown	7/7/2010	7/9/2010	2

Camp Grosvenor	North Kingstown	7/1/2010	7/3/2010	2
Camp Grosvenor	North Kingstown	7/24/2009	7/28/2009	4
Camp Grosvenor	North Kingstown	7/22/2009	7/23/2009	1
Camp Grosvenor	North Kingstown	7/9/2009	7/14/2009	5
Camp Grosvenor	North Kingstown	8/20/2008	8/27/2008	7
Camp Grosvenor	North Kingstown	8/13/2008	8/15/2008	2
Camp Grosvenor	North Kingstown	7/9/2008	7/10/2008	1
Camp Grosvenor	North Kingstown	6/11/2008	6/26/2008	15
Camp Grosvenor	North Kingstown	7/11/2007	7/13/2007	2
Camp Grosvenor	North Kingstown	8/21/2006	8/24/2006	3
Camp Grosvenor	North Kingstown	8/17/2006	8/18/2006	1
Camp Grosvenor	North Kingstown	8/16/2005	8/19/2005	3
Camp Grosvenor	North Kingstown	7/27/2005	7/28/2005	1
Camp Grosvenor	North Kingstown	7/1/2004	7/8/2004	7
Camp Grosvenor	North Kingstown	7/24/2003	7/30/2003	6

Source: http://health.ri.gov/data/beaches/
*Data Source: 2015 Rhode Island Beach and Recreational Water Quality Report, by RIDOH, Beaches Environmental Assessment and Coastal Health Program, March 31, 2016
No closures in 2016 or 2017. (what about 2013 and 2014?)

Water Quality Monitoring in the Narrow River Watershed

URI Watershed Watch Volunteer Water Quality Monitoring Program

Narrow River and Tributaries

In addition to the RIDEM water quality monitoring and the RIDOH beach monitoring, there has been active and extensive volunteer monitoring in this watershed for over 25 years. The Narrow River Preservation Association coordinates and sponsors this monitoring, through the Watershed Watch volunteer water quality testing program at URI (URI WW). The URI WW works with local communities to assess water quality, identify sources of pollution in water, and provide information about water leading to more effective management of critical water resources. Led by trained scientists, URI Watershed Watch helps local governments, watershed, tribal and other organizations recruit and train volunteers to become citizen scientists gathering detailed, quality assured monitoring data. This comprehensive watershed-based program focuses on long-term environmental monitoring of RI's fresh and saltwater resources including lakes, ponds, streams and coastal waters. The program provides training, equipment, supplies and analytical services tailored to organizational needs, while meeting strict quality assurance and quality control guidelines in the field and in a state-certified water testing laboratory.

Monitoring in the Narrow River follows the "Revised Narrow River Monitoring Manual," updated March 2012, by Linda T. Green and Elizabeth M. Herron of the URI Cooperative Extension Water Quality Program. This revised manual incorporates standard operating procedures (SOP's) from Quality Assurance Project Plan, University of Rhode Island Watershed

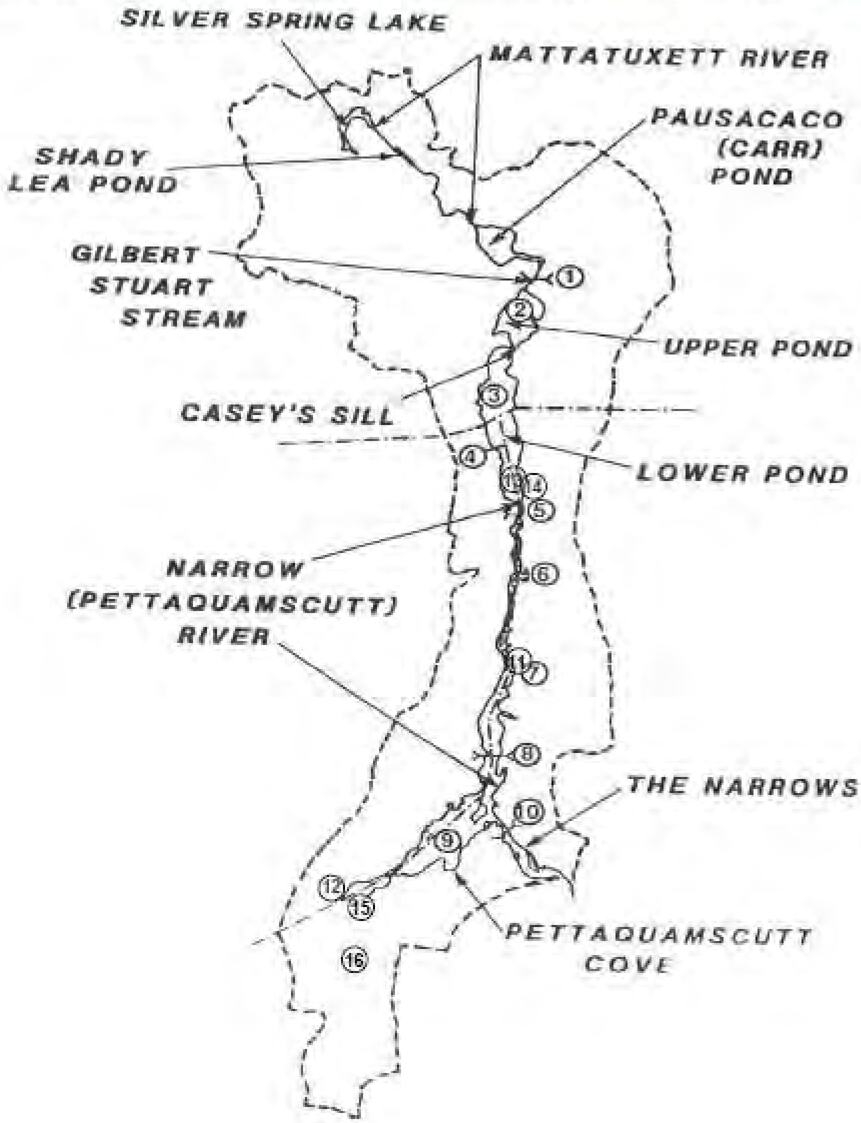
Watch Ambient and Marine Field Assays, prepared September 2005 for US EPA, New England region.

See **Map 16** for WW monitoring locations. When monitoring began here, there were 10 sites through 1995 (sites NR1 through NR10), after which a few more sites, including some freshwater locations, were added over the years. Since 2004, there have been 14 regular monitoring locations (including the addition of NR11 through NR14). (Note: NR15 and NR16 were for a special monitoring project, discussed below.)

Map 16.

NARROW RIVER MONITORING LOCATIONS

Location#	Site Name	Access	Location#	Site Name	Access
NR-1	Gilbert Stuart Strm	Shoreline	NR-9	Pettaquam. Cove	Boat
NR-2	Upper Pond	Boat	NR-10	Sprague Bridge	Shore
NR-3	Lower Pond A	Boat	NR-11	Mettatuxet Brook	Shore
NR-4	Lower Pond B	Boat	NR-12	Mumford Brook	Shore
NR-5	Lacey Bridge	Bridge/Shore	NR-13	Near Lakeside Dr	Shore
NR-6	End of Narrows	Boat	NR-14	Lakeside Outflow	Shore
NR-7	Mettatuxet	Boat	NR-15	Crooked @ Farm	Shore
NR-8	Middlebridge	Bridge/Shore	NR-16	Crooked@ School	Shore



Source: URI Watershed Watch Narrow River Monitoring Manual, March 2007, updated March 2012
(Note: NR 15 and NR 16 shown in this map were for a special project, discussed in the section below, and are not part of the on-going monitoring.)

The monitoring season runs from May through October. Parameters tested for are as follows:

Biweekly

- Temperature
- Dissolved Oxygen
- Chlorophyll (algal biomass)

Monthly

- pH
- Salinity
- Total Phosphorus
- Total Dissolved Phosphorus (since 2006)
- Total Nitrogen
- Nitrate + Nitrite (since 2006)
- Ammonium Nitrogen (since 2006)
- Bacteria- Fecal Coliform
- Bacteria- Enterococci (since 2007)

The data from 25 years has been aggregated and summarized in a 2017 report by members of NRPA entitled, "Narrow River Water Quality: Trends and Findings Spanning a Quarter Century!" (Berounsky and DeSilva, 2017) A split for comparison for most of the data (the salt-water sites) was made between the data from 1992 to 2003 and the data from 2004 to 2016. Since the freshwater monitoring sites were added later, the break in this data is presented with a break after 2006. Highlights from this report reveal the following potential trends:

- Average temperature is slightly higher in the recent years than in the earlier years
- Average dissolved oxygen levels are lower in the recent years than in the earlier years
- Geometric mean for fecal coliform exceeds the shellfishing standard for all saltwater sites south of Lacey Bridge.
- Geometric mean for fecal coliform for 3 of the 4 freshwater sites greatly exceed the shellfishing standard.
- Geometric mean for enterococci is below the safe swimming standard at all saltwater sites, and is also much lower in the recent years than in the earlier years, though there are individual data values that have been observed at all sites in the later years, except Lacey Bridge, which have exceeded the safe swimming value.
- Geometric mean for enterococci is lower in the recent years than in the earlier years for the freshwater sites, however, the geometric mean values greatly exceed the safe swimming standard at Mettatuxet Brook and Mumford Brook.
- Total Nitrogen is higher for the recent years than for the earlier years at all freshwater and saltwater sites, except Upper Pond.
- Ammonia averages at all saltwater and freshwater sites are lower in recent years than in the earlier years.

- Nitrate + Nitrite averages at all saltwater sites are lower in recent years than in the earlier years, and are considered low.
- Nitrate + Nitrite averages at the freshwater sites, except for the Gilbert Stuart site, are higher in recent years than in the earlier years and are considered very high.
- Chlorophyll averages at all saltwater and two freshwater sites are higher in recent years than in the earlier years, though low enough to not be considered eutrophic.

It is important to relate these trends spatially across the river and by tributary in order to understand potential pollutant sources, areas to target for restoration, and effectiveness of restoration strategies implemented over the years. The summary data from the NRPA report is presented in **Figures 4 through 15**, below, by monitoring site from north to south, and by salt-water sites and freshwater sites (tributaries). Some key conclusions of this report are that bacteria levels have improved north of Lacey Bridge; lower ammonia and nitrate values indicate sewering has improved the water quality; however, increases in Total Nitrogen indicate new sources of nitrogen have been introduced into the river.

Discussion on Nitrogen in the Narrow River (and tributaries)
The NRPA URI Watershed Watch data for nitrogen in the Narrow River indicate a shift in the source (or type) of nitrogen in the water. Total Nitrogen has been increasing, yet Ammonium and Nitrate have been decreasing, which means organic nitrogen has been increasing. Organic nitrogen can be broken down by bacteria into ammonium and nitrate.

This data also reveals a convergence of trends in the estuary towards conditions favoring increased algae blooms. These observations are average increasing temperature, average increasing total nitrogen (a limiting nutrient in saltwater), average increasing chlorophyll, and average decreasing dissolved oxygen (current levels are adequate). Algae blooms can cause an upset in the ecosystem and should be documented.

The following bar graphs are from "Narrow River Water Quality: Trends and Findings Spanning a Quarter Century! by Annette DeSilva and Veronica Berounsky.

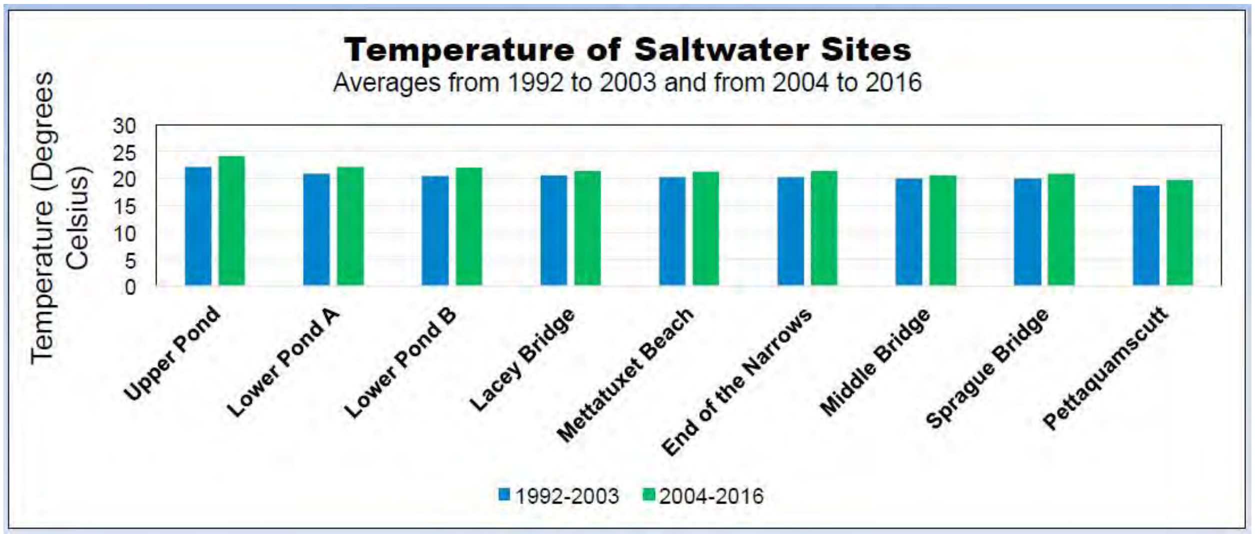


Figure 4

Figure 5

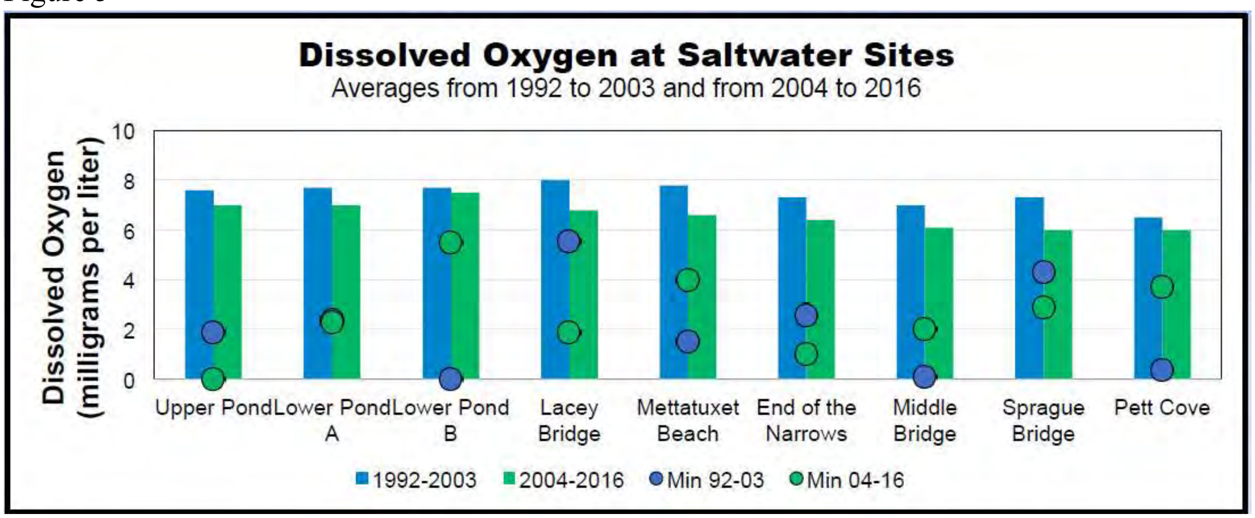


Figure 6

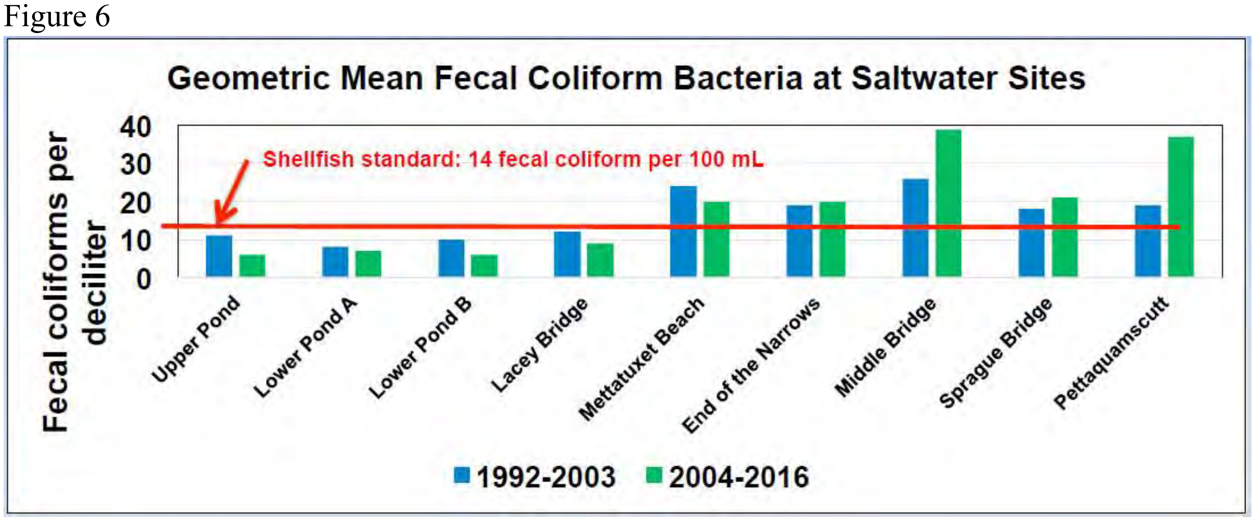


Figure 7

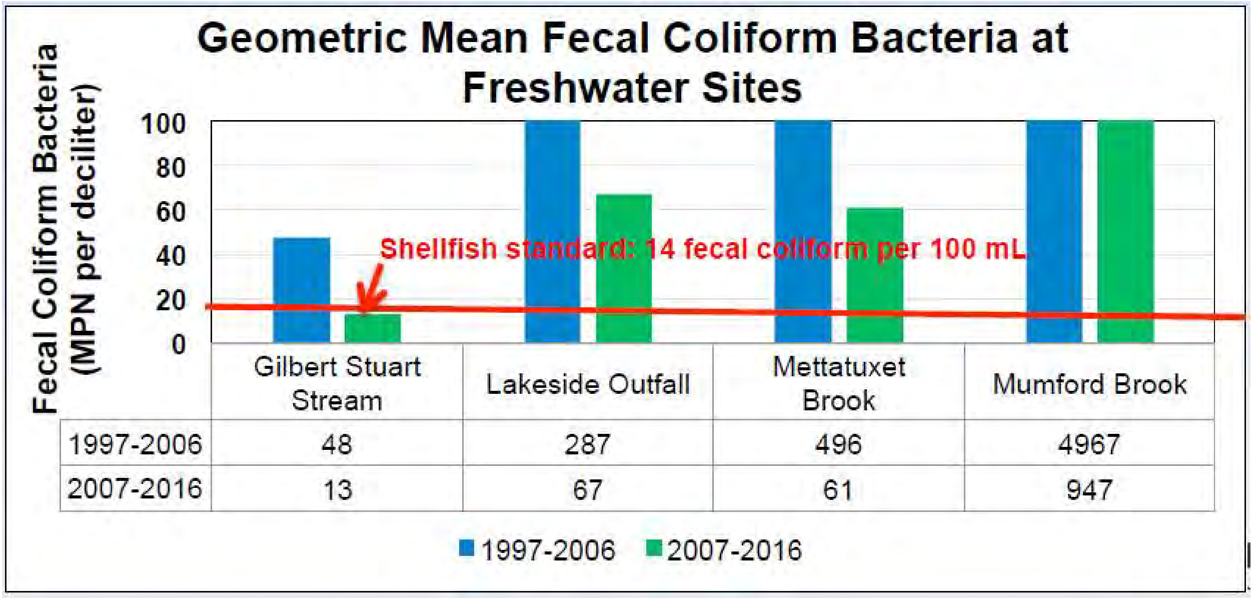
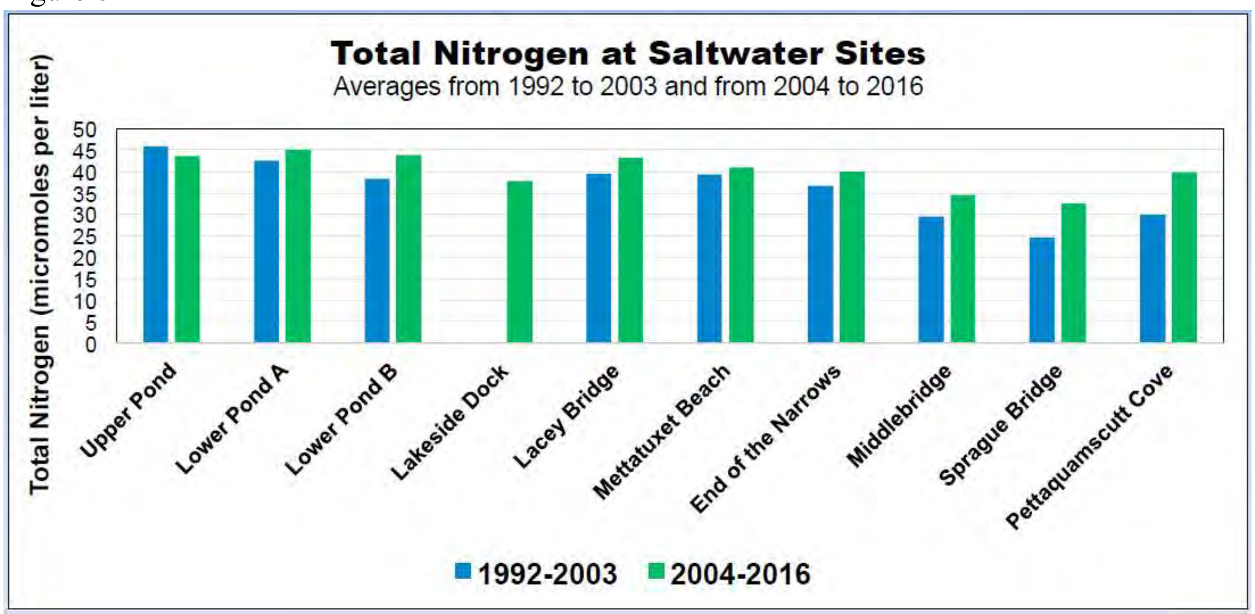


Figure 8



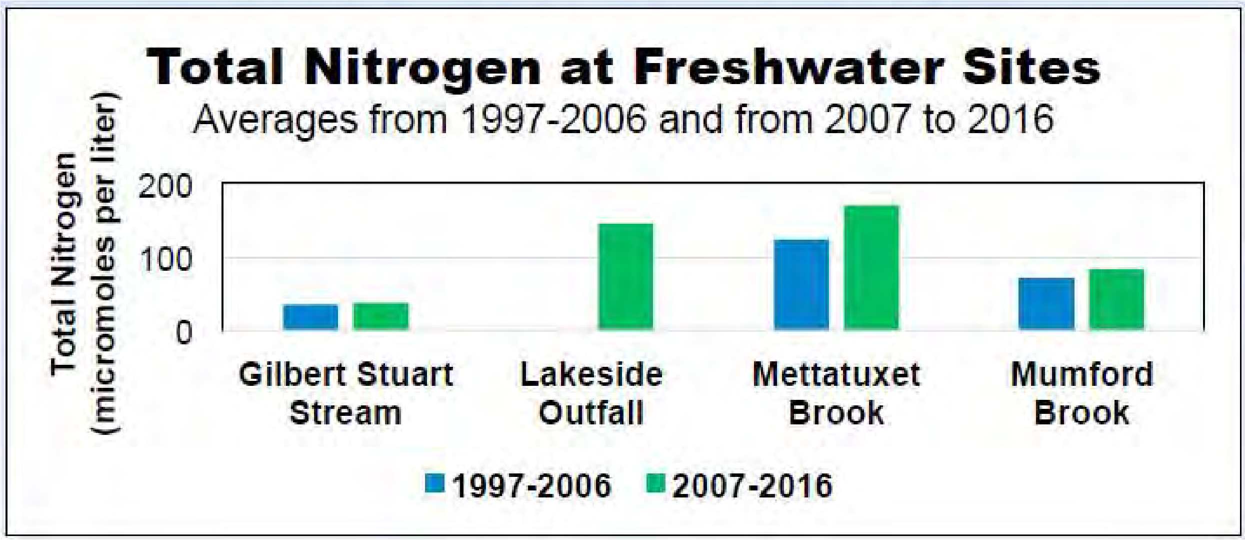


Figure 9

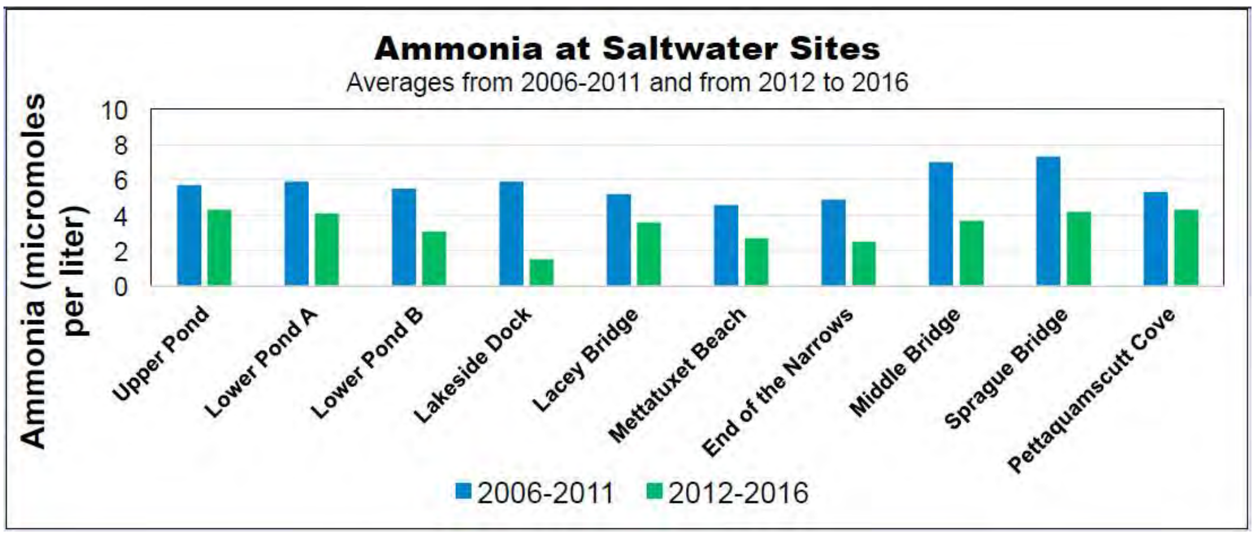


Figure 10

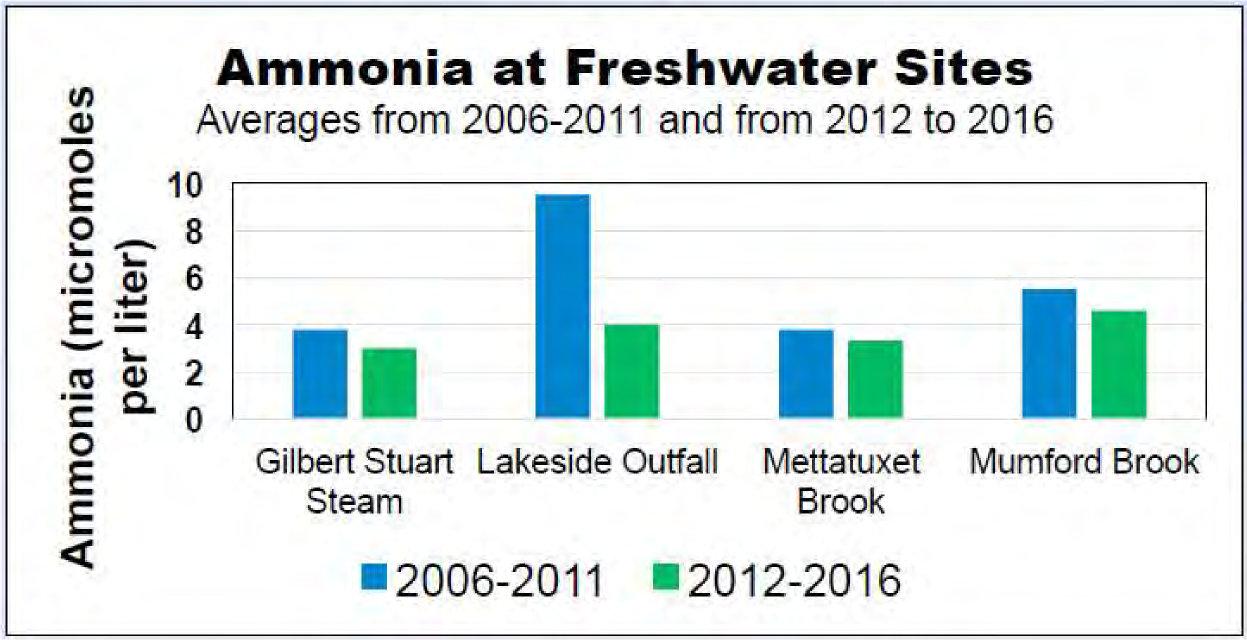


Figure 11

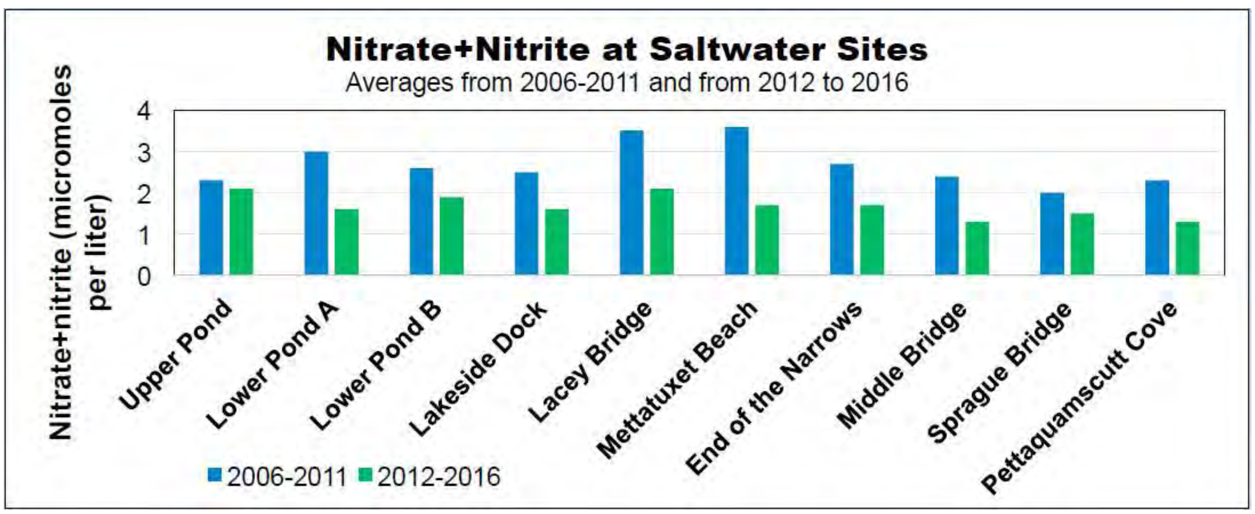


Figure 12

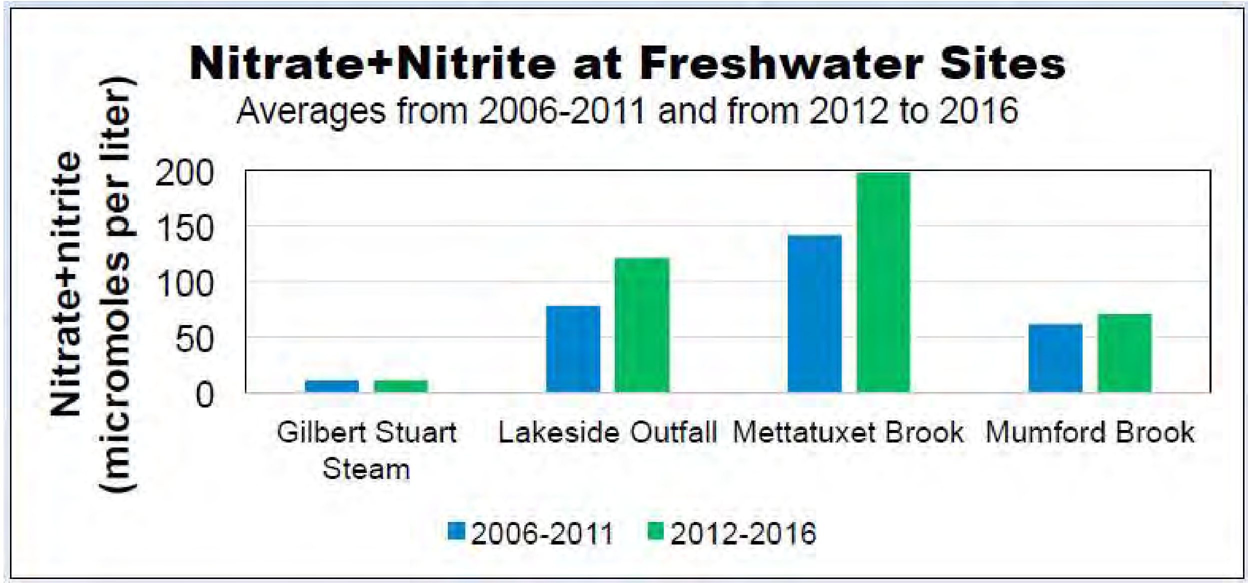


Figure 13

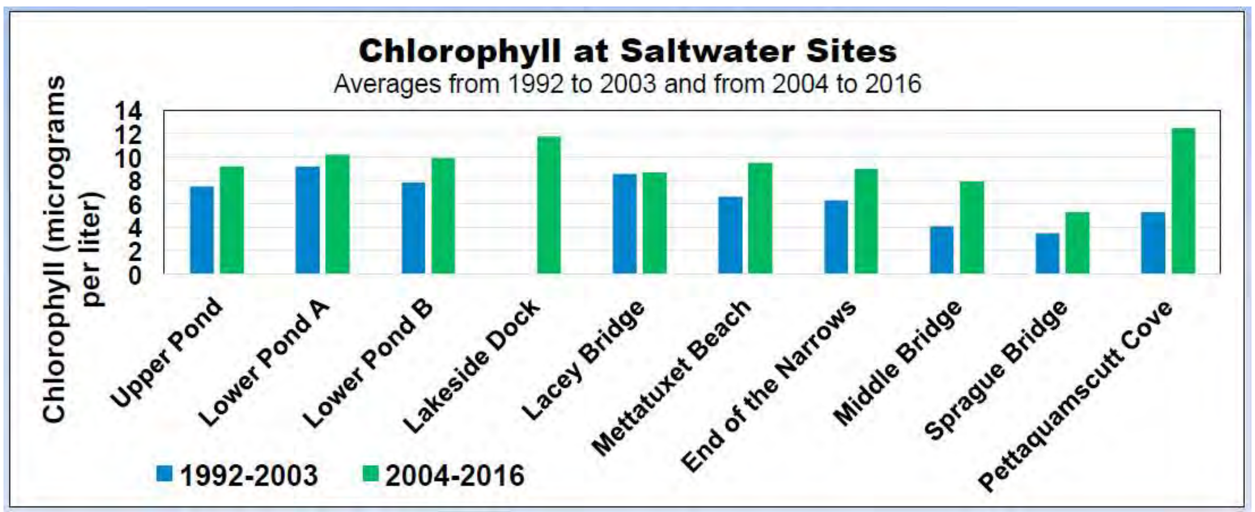


Figure 14

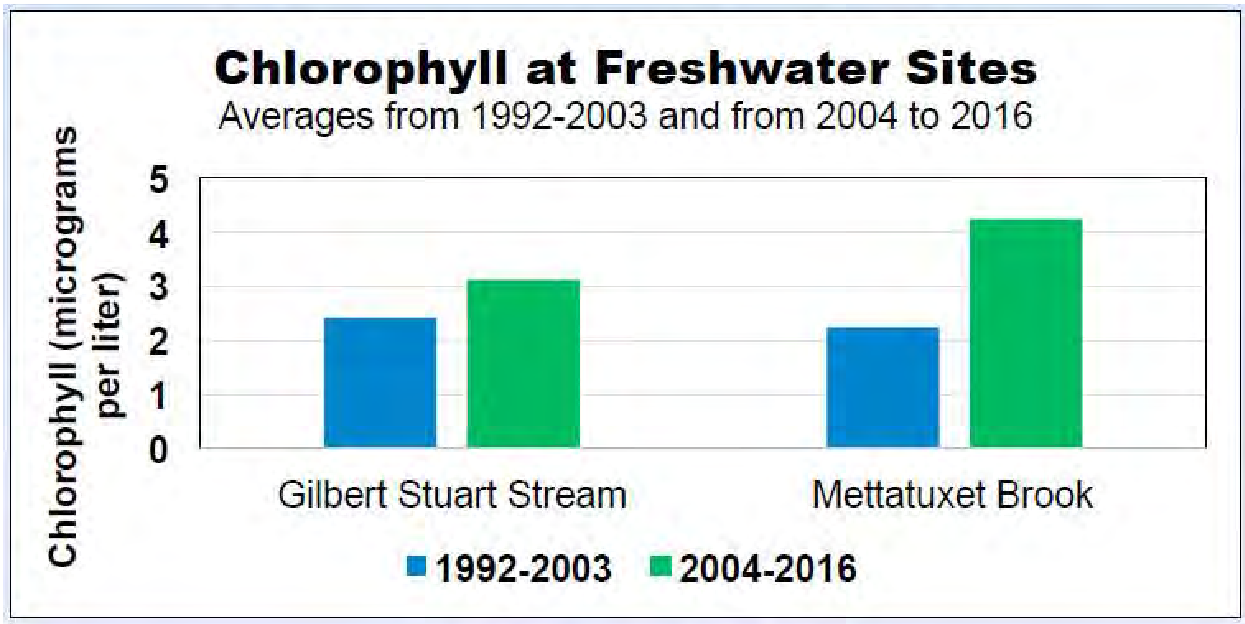


Figure 15

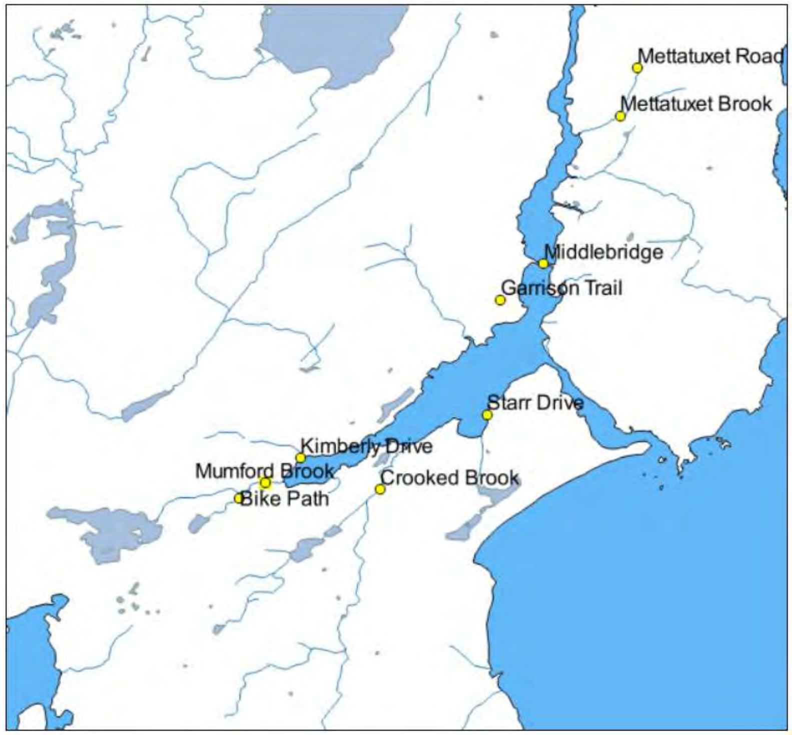
NRPA Special Monitoring Projects

Other monitoring sites have been occasionally added for the duration of special monitoring projects.

Crooked Brook Monitoring (2005-2007)
"On behalf of the Town of Narragansett, SRICD partnered with the Narrow River Preservation Association (NRPA) to monitor two locations on Crooked Brook, a tributary to the Narrow River. Crooked Brook was to be monitored for five years in order to try to determine whether the horse boarding facility on the brook is causing the increased bacteria levels." (SRICD Annual Report, 2006-2007) A site at a school was also monitored. Sites NR 15 and NR 16 are shown on **Map 16**. However, only two years of data was collected.

Mettatuxet Brook and Mumford Brook (2014-2015)
Another special monitoring project was the recent two-year water quality program conducted by NRPA in 2014-2015 for The Nature Conservancy and U.S. Fish and Wildlife Service Cooperative Agreement (No. FI4AC00J04 USFWS) as part of the Narrow River Estuary Resiliency Restoration Program. This project investigated two areas of historically higher bacteria counts—Mettatuxet Brook and Mumford Brook, which are both within a drainage catchment area of the John H. Chaffee National Wildlife Refuge. This water quality monitoring project was in preparation for Alternative 2, Action A, of the USFWS's Narrow River Estuary Resiliency Restoration Program, which is discussed in Section VI. Monitoring locations are shown on **Map 17**.

LOCATION
NR 11 - Mettatuxet Brook
NR 12 - Mumford Brook
NR 17 - Mettatuxet Road
NR 18 - SE Middlebridge
NR 19 - NE Middlebridge
NR 20 - NW Middlebridge
NR 21 - SW Middlebridge
NR 22 - mid Middlebridge
NR 23 - Garrison Trail
NR 24 - Starr Drive
NR 25 - Crooked Brook
NR 26 - Kimberly Drive
NR 27 - Bike Path Culvert



Map 17.
2014-2015 NRPA WW
Special Monitoring Locations

The findings from this monitoring investigation confirm that these areas have very high bacteria, and high nitrite + nitrate, and that the contributing tributary streams had very high bacteria. This study did not pinpoint the sources, however, a subsequent study, discussed below, has yielded more refined clues so that public officials may attempt to have the origins of these pollutants greatly reduced, and/or eliminated.

Originally, the 2014 Narrow River Estuary Resiliency Restoration Program anticipated stormwater water quality structures, or Best Management Practices (BMPs), to be designed and installed in locations prioritized from the findings of this water quality study. However, investigating sources of potential illicit connections, failing on-site wastewater treatment systems, leaking sewer pipes, or excessive waterfowl may prove to have a greater impact on improving water quality for these very high bacteria areas, and should be prioritized. According to the Illicit Discharge Detection and Elimination Guidance Manual by the Center for Watershed Protection, 2004, dry weather water quality data can be used to screen subwatersheds for potential illicit discharge sources, and recommends flagging streams with fecal coliform counts exceeding benchmarks of 1,000 to 5,000 MPN/100 ml.

Lakes and Ponds

Other waterbodies in the Narrow River watershed that are monitored, or have been monitored in the past by volunteers through the URI Watershed Watch program are as follows:

- Silver Spring Lake in North Kingstown (data from 1989 to 2012, 2017-2018),
- Carr Pond in North Kingstown (1989 to 2007, 2011, and 2015-2018), and
- Silver Lake in South Kingstown (1993-2018).
- Little Neck Pond in Narragansett (2011)

Data can be accessed from the Watershed Watch website here:
https://web.uri.edu/watershedwatch/monitoring-data-and-results/

URI Watershed Watch multi-year data summaries for most of these waterbodies (Silver Spring Lake, Carr Pond, and Silver Lake) are shown on the next few pages (**Figures 16 through 18**). Based on the Secchi Depth transparency, Chlorophyll Levels, and Phosphorus Levels data, RIDEM has classified each of these three freshwater lakes/ponds with a Tropic Status of 'Mesotrophic.'

Figure 16.

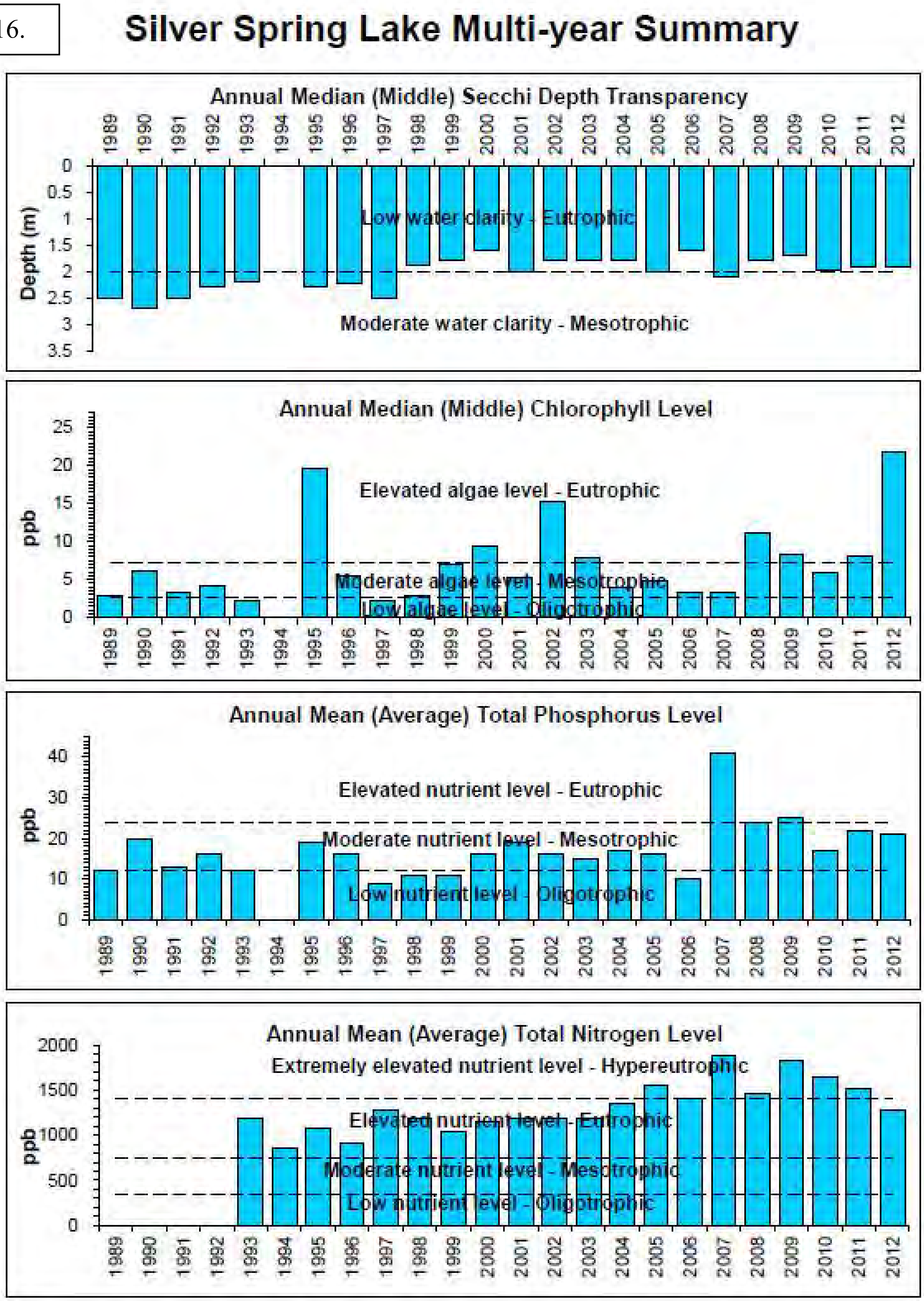

Silver Spring Lake Multi-year Summary
Annual Median (Middle) Secchi Depth Transparency
Depth (m)
Low water clarity - Eutrophic
Moderate water clarity - Mesotrophic
Annual Median (Middle) Chlorophyll Level
ppb
Elevated algae level - Eutrophic
Moderate algae level - Mesotrophic
Low algae level - Oligotrophic
Annual Mean (Average) Total Phosphorus Level
ppb
Elevated nutrient level - Eutrophic
Moderate nutrient level - Mesotrophic
Low nutrient level - Oligotrophic
Annual Mean (Average) Total Nitrogen Level
ppb
Extremely elevated nutrient level - Hypereutrophic
Elevated nutrient level - Eutrophic
Moderate nutrient level - Mesotrophic
Low nutrient level - Oligotrophic

Figure 17.

Carr Pond (NK) Multi-year Summary

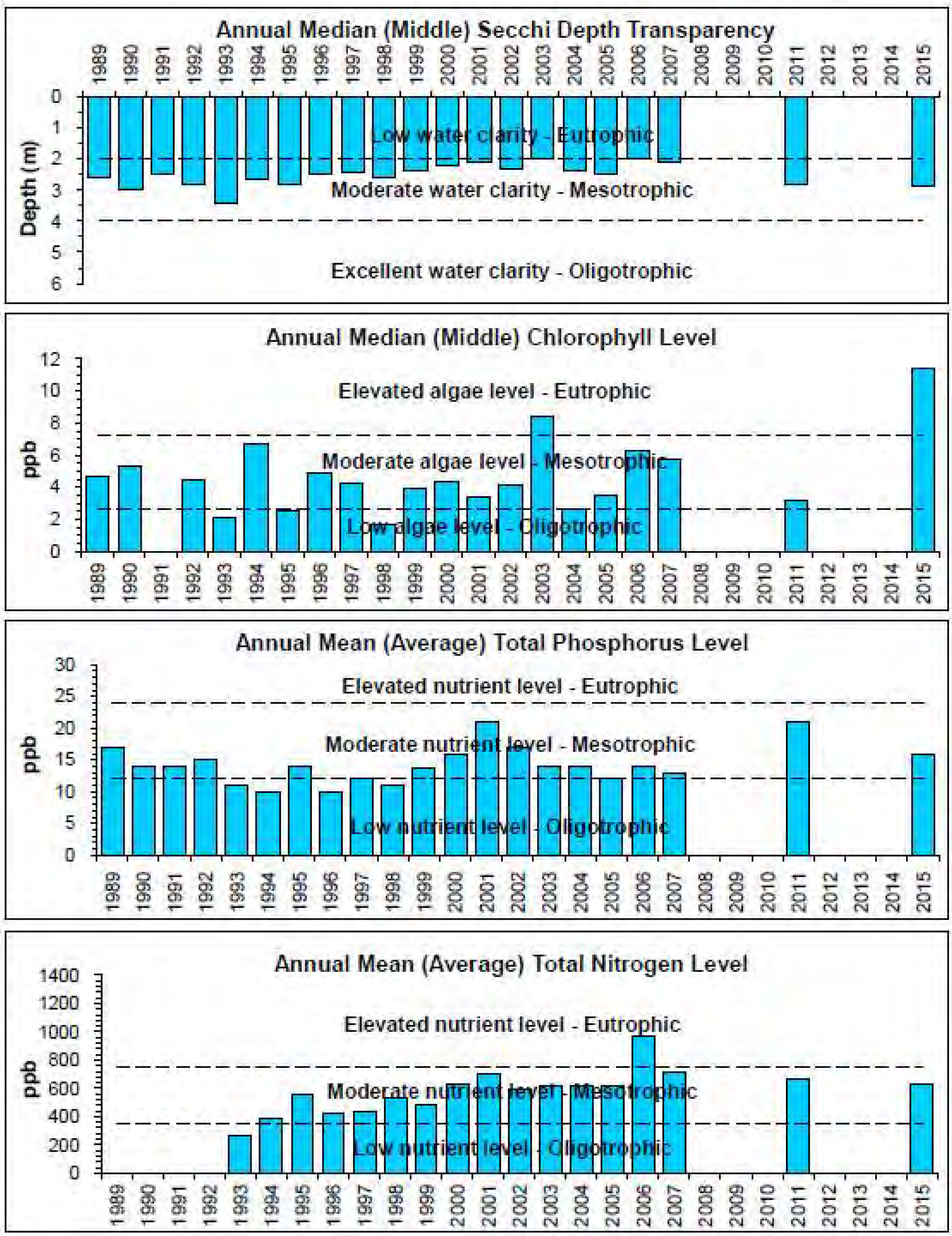
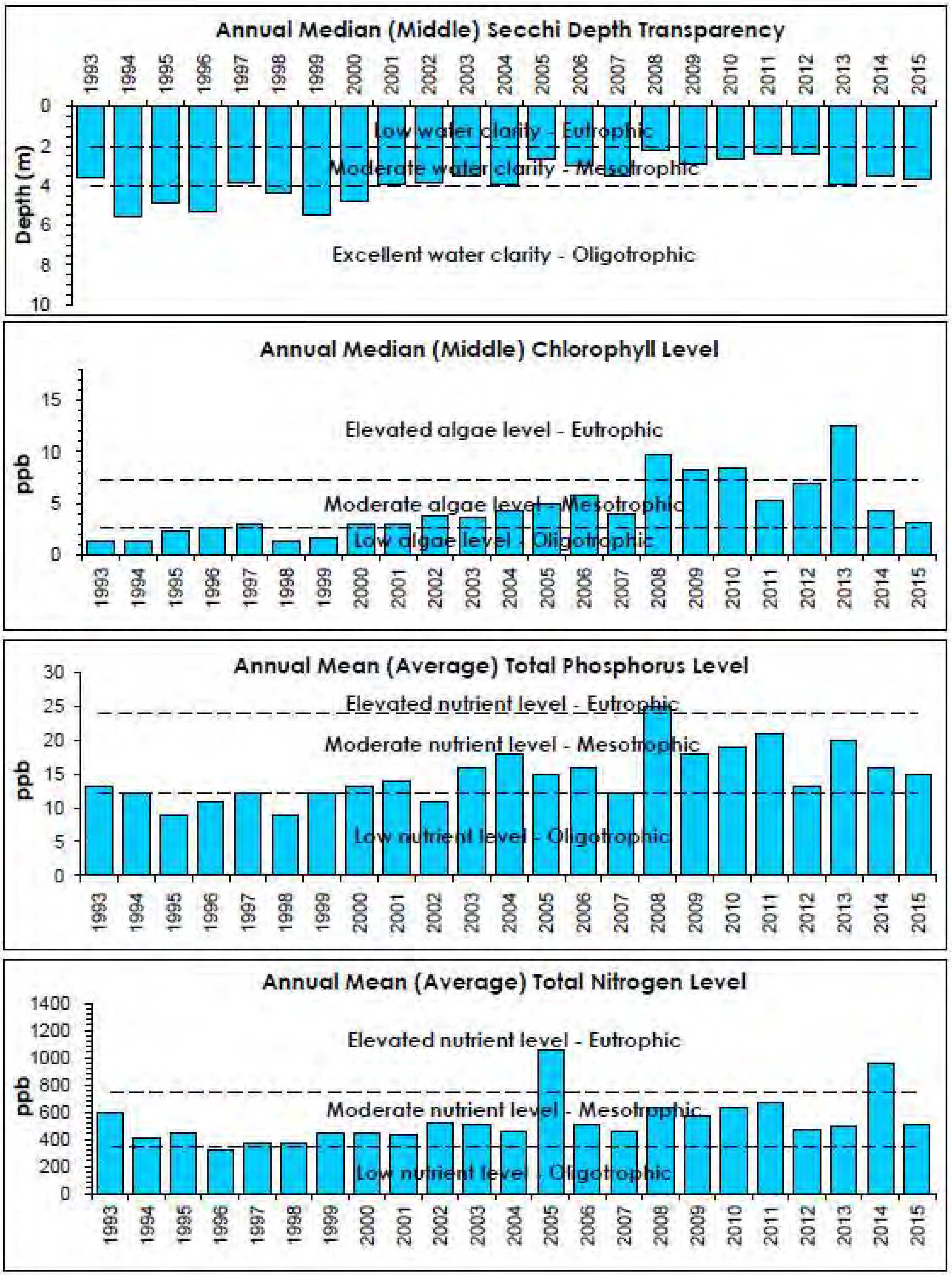


Figure 18.

Silver Lake Multi-year Data



Trophic Status

The process of nutrient accumulation and enrichment of lakes is called eutrophication. This "aging" process is a natural process in the life of all freshwater lakes: all lakes, even the most pristine, will accumulate nutrients and sediments over long scale timeframes. However, natural eutrophication is accelerated by human activities ('cultural eutrophication') in the watershed. High inputs of nutrients can fuel heavy algal blooms and excessive plant growth. When this plant material dies and decays, lakes and ponds can be depleted of oxygen, harming aquatic life. Decay also results in nutrients accumulating in sediments. Nutrients in lake sediments are then released back into the water column in a continual nutrient cycling process.

Lakes may be classified according to the degree of eutrophication using data on nutrient concentrations (P) or algal growth (often measured as Chlorophyll A). This lake classification, also known as trophic status, describes how "productive" a lake is, or how well it supports the growth of plants and algae (see **Figure 19**). All lakes are expected to change their trophic status over time. See **Table 12**, below, for Tropic Status of the lakes that have been assessed in the Narrow River watershed.

Eutrophication: Natural process over time	**Lake Clasification or Trophic State**	**Nutrients**	**Characteristics**
	Oligotrophic	Limited Supply	Low Productivity; Good Water Clarity, Low Sediment Volume
	Mesotrophic	Increased Inputs	Increased productivity; Higher sediment accumulation and decaying matter
	Eutrophic	Surplus Available	High productivity; Reduced Water Clarity; High buildup of sediment and decaying matter; May become oxygen deficient
	Hypereutrophic	Excessive Amounts	Nuisance algal blooms; abundance of aquatic plants; water clarity and quality is reduced

Figure 19. Eutrophication Stage Descriptions

Table 13. Trophic Status of Lakes in Narrow River Watershed

Town	**Water Body** **(Segment ID)**	**Trophic Status Index: Total Phosphorus**	**Trophic Status Index: Chlorophyll**	**Trophic Status Index: Secchi Depth Transparency**	**Overall**	**Notes**
North Kingstown	Silver Spring Lake (RI0010044L-02)	Mesotrophic	Mesotrophic	Eutrophic	**Mesotrophic**	Lots of AIS plant cover may alter trophic calculations
North Kingstown	Carr Pond (RI0010044L-03)	Mesotrophic	Mesotrophic	Mesotrophic	**Mesotrophic**	
South Kingstown	Silver Lake (RI0010045L-05)	Mesotrophic	Mesotrophic	Mesotrophic	**Mesotrophic**	Lots of coves

Other Monitoring and Water Quality Studies in the Narrow River

In efforts to further characterize the sources of pollution to the Narrow River, there have been investigative monitoring studies. A brief discussion of these investigations follows.

Human Bacteria Source Tracking in the Narrow River Watershed Using Environmental Canine Services (2018)
In 2018, the NRPA coordinated with the Towns of Narragansett and South Kingstown, and secured funding from USFWS and technical support from RIDEM, to hire Environmental Canine Services (ECS) out of Maine to conduct human bacteria source tracking on critical areas within the Narrow River watershed using dogs that are trained to detect whether human contamination exists. The dogs can instantly distinguish a human versus an animal waste source, which allows positive hits to be traced upwards in streams, drainage systems, etc. towards a source. (See Section IV. A) 4) for more information.)

Other monitoring studies conducted over the years to differentiate and/or identify human vs. wildlife or domestic pet sources include the following:

- "Evaluation of Microbial Water Quality in the Pettaquamscutt River using chemical, molecular, and culture-dependent methods" by Janet Atoyan, Elizabeth M. Herron, and Jose Amador, published in Marine Pollution Bulletin 62 (2011) 1577-1583
- "Sources of fecal-indicator bacteria in streams and stormwater entering Narrow River: Final Report-Narrow River Watershed – North Kingston, South Kingstown, Narragansett," prepared for Rhode Island Rivers Council (BRWCT Stormwater Project Grant Program), by Craig Wood, Eric Peterson, Veronica Berounsky, and Annette Desilva, March 2017

Aquatic Invasive Species Monitoring

In 2007, the RIDEM Office of Water Resources Surface Water Monitoring Program began to survey Rhode Island's freshwater rivers, lakes, and ponds to map the statewide distribution of AIS. Monitoring allows DEM personnel to determine which species are present in Rhode Island, where they are and to track their spread. DEM uses this information to prioritize where to direct future monitoring efforts to detect new invasions early, and to inform stakeholders about infestations in their lakes and the surrounding watershed. There is no regular schedule of this type of monitoring, which is conducted as resources allow. Additionally, extent of infestation is not tracked. Information is presented in map and report form, available here: http://www.dem.ri.gov/programs/benviron/water/wetlands/pdfs/invasive.pdf

Combining data from all sources including RIDEM surveys, RINHS and URI Watershed Watch, RIDEM has information on the presence of specific aquatic invasive species in 133 lakes covering 15,335 acres of Rhode Island's waters.

Groundwater Monitoring

Drinking Water Source in North Kingstown

The North Kingstown Water Supply Department routinely monitors the drinking water according to Federal and State laws for constituents they are required to test for, and also voluntarily conducts testing of the water for other substances.

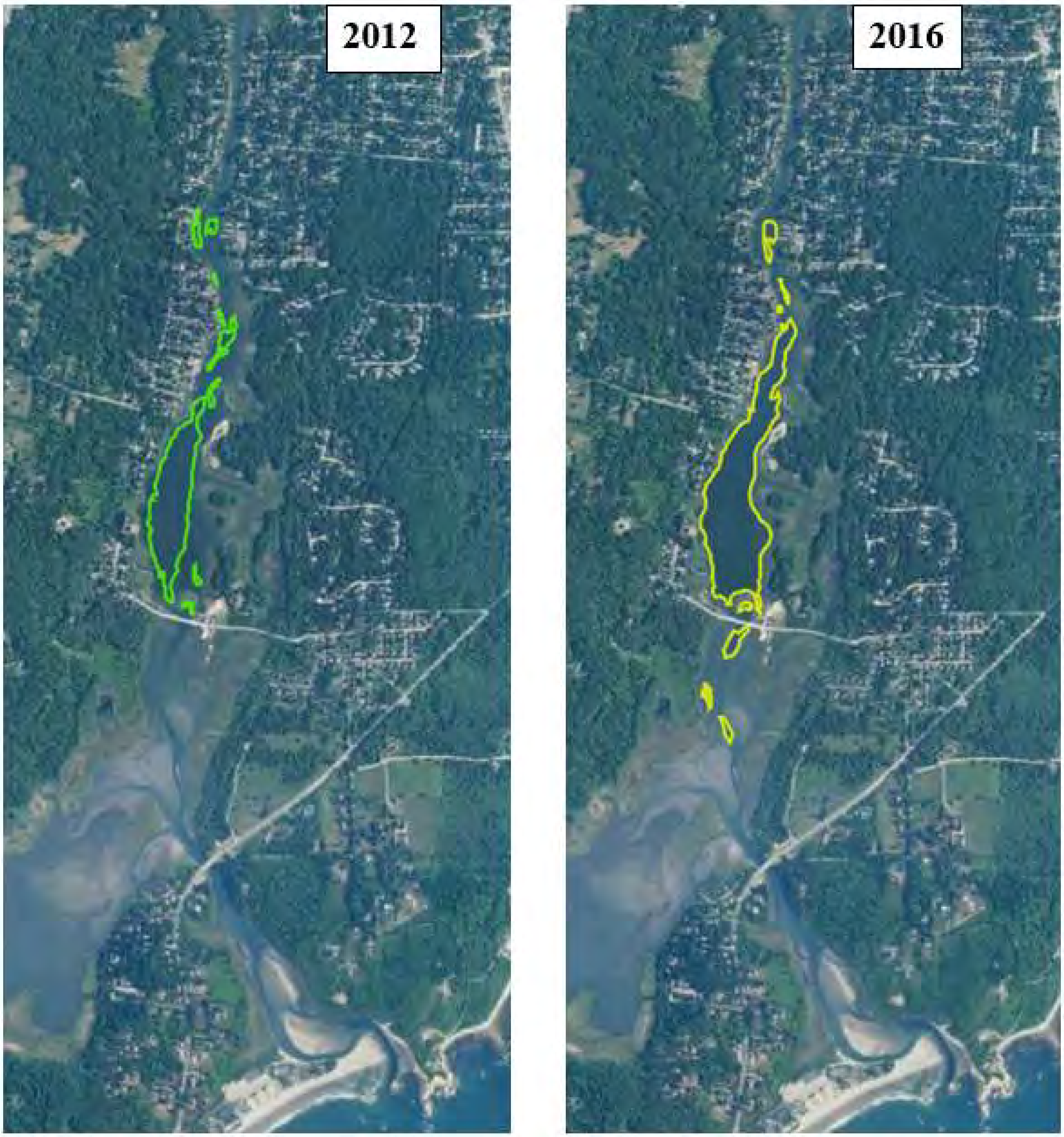
Public, Non-community Wells

The owner of a public, non-community well is required to perform water quality testing and report the test results to RIDOH in accordance with Department of Health regulations.

Aquatic Habitat Monitoring

Eelgrass

A survey in the 1940's documented healthy eelgrass beds in the Narrow River estuary north and south of Middlebridge and extending down to the breachway. Surveys in the 1970's indicate that eelgrass was still present at that time period. Surveys in the 1980's and 1990's found substantial declines of eelgrass had occurred. According to Berounsky and Nixon, 2007, this decline may have been due to the higher nitrogen levels and lower dissolved oxygen levels occurring at that time, which were suspected to be due to the increase in residential development and stormwater runoff. These conditions persisted through 2005. In a 2006 aerial study, no eelgrass was detected in the Narrow River estuary. However, a survey in 2012 recorded 24 acres of eelgrass just north of the Middlebridge, and a survey in 2016 recorded 40.5 acres of seagrass in the Narrow River estuary mostly north of Middlebridge with some patches south of the bridge (see Map 18, below.) Increasing eelgrass beds can be an indicator of improving conditions (particularly for nitrogen), because they need good sunlight and live in areas of low nutrient input (NBEP, 2017). Water quality data would need to be analyzed and assessed in order to determine if nitrogen levels have improved in this area and may be contributing to the increase in eelgrass observed. [2023 Update Note: a 2021 study indicated that no eelgrass was present north of Middlebridge, however the patch of eelgrass south of the bridge had increased.]



Map 18: Extent of Submerged Aquatic Vegetation beds in the Narrow River in 2012 and in 2016. Source: http://www.crmc.ri.gov/sav.html

Wetlands
A wetland monitoring and assessment program has not been fully implemented. See discussion in Section V. A).

Appendix 3. TMDL Implementation Tracking Table

This appendix includes information for tracking implementation of the two Bacteria TMDLs. Pollutant loads by source and location, mitigations actions, and other useful information from the Narrow River TMDL and the Crooked Brook TMDL are paired with the structural stormwater BMPs that have been partially designed or installed to date. Reductions achieved to date due to BMP installation have not been measured or calculated.

Pollutant: Bacteria (fecal coliform)

Goal/ Numeric Target for Narrow River: The geometric mean standard of 14 fc/100mL minus a 10% margin of safety, or **12.6 fc/100mL**, and a 90th percentile value of no greater than **49 fc/100mL** are the numeric water quality targets for the Narrow River TMDL.

Goal/Numeric Target for Gilbert Stuart Stream and Mumford Brook: A geometric mean of 14 fc/100mL and a 90th percentile value of no greater than 49 must be applied to the most downstream sampling station in each of the tributaries. These values will serve as the numeric water quality targets for the Gilbert Stuart Stream and Mumford Brook TMDLs. (Since Gilbert Stuart Stream and Mumford Brook discharge to a Class-SA waterbody and no site-specific data is available to guarantee that Narrow River water quality would be maintained if each tributary discharges at the Class A standard, both must meet the Class SA standard at their points of discharge.)

Context of Goal: To meet minimum quality for designated use, and antidegradation policy: The designated and existing uses for the Narrow River include fishing, shellfishing, swimming, and boating. The goal of the TMDL is to restore all designated uses to the Narrow River that are impacted by elevated levels of fecal coliform.

Goal/ Numeric Target for Crooked Brook: The water quality target for Crooked Brook is set at the state's Class A fecal coliform standard, which is a geometric mean of 20 fc/100 ml with a 90th percentile concentration no greater than 200 fc/100 ml. It is assumed that the conservative assumptions mentioned previously will provide an adequate implicit MOS. Additionally, Crooked Brook must meet the more stringent Class SA fecal coliform standard, which is a geometric mean of 14 fc/100 ml with a 90th percentile concentration of 49 fc/100 ml at the discharge point to Narrow River.

Table 14. Bacteria Concentration Targets in Watershed

Waterbody	Target 90th percentile concentration (fc/100 ml)	Target geometric mean concentration (fc/100 ml)	Notes:
Narrow River- all sections (saltwater)	49	12.6	
Freshwater Tributaries			Need to meet more stringent SA (saltwater) standard at point of discharge to river
Gilbert Stuart Stream	49	14	
Mumford Brook	49	14	
Crooked Brook at Pettaquamscutt Cove	49	14	At CB-1
Crooked Brook freshwater	200	20	Freshwater standard for upstream system

The TMDL identified the 12 largest contributing storm sewer outfalls (all in Narragansett) of fecal coliform bacteria loadings for proposed mitigation. Each outfall in the table below (Column 1) includes its ranking by bacteria load in accordance with Table 5.7 on page 58 in the Narrow River Bacteria TMDL. The format is (x/12). The Table below is in order from North to South of inputs (tributaries and outfalls) and direction of flow through system]

Table 15. Bacteria TMDL Implementation Tracking

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Gilbert Stuart Stream (dry and wet weather)	4,320 290	Upper Pond	Privy at Gilbert Stuart Birthplace Museum		98.9%	Discontinue use of outhouse near Carr Pond. Replace with portable toilet.	Removed during TMDL in 1999. WQ has improved with 2000 sampling (No longer listed on 303 d list)	Complete
Segment 1- Upper Pond	45 15.4		"the largest single source is Gilbert Stuart Stream"	"wildlife and storm water runoff may contribute significant fecal coliform loadings"	18%	(implement above)	NOTE: wet weather sources- after remove privy, what about addressing the other potential sources?	

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Segment 2-Lower Pond	23 (meets) 6.5 (meets)		"Identified sources: Dry weather sources to Lower Pond include two intermittent streams, Walmsley Brook and Crew Brook, trickling discharges from storm sewer outfalls and direct deposition by waterfowl and wildlife. Wet weather sources are dominated by storm water runoff entering the pond from storm sewer outfalls, tributary streams or overland as sheet flow."		Meets standard		Meets standard, but there are some significant sources to this section (4 outfalls) that contribute to downstream, so still need action here. [Question: if 'trickling discharges" during dry weather are an identified source of bacteria, then shouldn't we suspect illicit connections here? If it was groundwater getting in storm pipe cracks, wouldn't it be clean?]	
Segment 2-Lower Pond	1.1×10^{11} fc/storm	Narrow River	Storm sewer outfalls					
Indian Trail outfall (10/12) Segment 2	1.8×10^{10} fc/storm	Lower Pond	Storm water			Structural / non-structural storm water BMPs	Targeted for future BMP (***Indian Head)	Needs to be done.
Shadbush Trail outfall (2/12) Segment 2	4.3×10^{10} fc/storm	Lower Pond	Storm water			Structural / non-structural storm water BMPs	Targeted for future BMP (***Petta Lake Shores 2?)	High load. Needs to be done.

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Lakeside Drive outfall (5/12) and South Ferry Road (Bridgetown Rd) outfall (12/12) Segment 2	L= 3.3×10^{10} fc/storm S= 8.3×10^{9} fc/storm	Lower Pond	Stormwater			Structural / nonstructural storm water BMP(s)	BMP completed in 2010. Check status and effectiveness (*** Edgewater 1 and 2) [Question, see Z, 2008: Lakeside Drive outfall has dry weather flow (in 1993 and in 2007) with bacteria and total Nitrogen- what is going on here? Also, 2007 WW data shows higher [] of TN dry flow than in wet flow. Is this a small stream or a storm drain?]	
Segment 3- Upper River	70 27.3		Dry weather-The principal dry weather source of fecal coliform identified in this segment is wildfowl. Wet weather sources to this segment are dominated by storm water runoff entering the reach from storm sewer outfalls, tributary streams, or overland as sheet flow.		54%			

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Mettatuxet and Rio Vista neighborhoods (Narragansett) Segment 3						Illicit discharge to storm sewer detection and elimination	Was to occur in Fall of 2001- Check Status, quality, and results (is any further investigation needed?) (Is there any dry weather flow out of the outfalls here?)	Note: Mettatuxet Brook is considered a dry weather and a wet weather source of bacteria to the River. Illicit discharge consideration should be revisited here.
Pettaquamscutt Avenue outfall (8/12) Segment 3	2.2×10^{10} fc/storm	Upper River	Stormwater			Structural/ nonstructural stormwater BMPs	BMP constructed in 2010. Check effectiveness. (***Pettaquamscutt Terrace 1 & 2 comb.)	
Wampum Road Outfall (3/12) and Conanicus Road Outfall (4/12) Narragansett Segment 3	W= 3.7×10^{10} fc/storm C= 3.4×10^{10} fc/storm	Upper River	Stormwater			Structural BMP	Wet detention pond design plans were completed at time of TMDL. BMP completed in 2004. 'Montauk Circuit Dr' Check effectiveness. (***Circuit Drive 1 and 2, not assessed b/c already constructed)	
Old Pine Road outfall (6/12) Segment 3	3.2×10^{10} fc/storm	Upper River	Stormwater			Structural / nonstructural storm water BMP(s)	Targeted for future BMP (***Mettatuxet 1)	Not constructed.
Mettatuxet Beach Outfall (11/12) Segment 3	1.6×10^{10} fc/storm	Upper River	Storm water			Structural / nonstructural storm water BMP(s)	SRICD for BMP design. BMP completed in 2006. Check effectiveness. (***Mettatuxet 2)	'Mettatuxet Beach' project. Included a pre- and post- BMP construction monitoring project. See Narragansett MS4 Annual Reports for data.

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Mettatuxet Road Outfall (1/12) Narragansett Segment 3	9.3×10^{10} fc/storm	Upper River	Stormwater			Structural/ nonstructural stormwater BMPs	Targeted for BMP [This is the upper outfall for brook at Sumac Trail] (***not assessed)	Highest loads. Needs to be done. (Also, potential failed private detention pond at Marion and Crest streets.)
Shagbark Road outfall (7/12) Segment 3	2.5×10^{10} fc/storm	Upper River	Storm water			Structural / nonstructural storm water BMP(s)	BMPs completed in 2018. (***Mettatuxet 3) (subsurface infiltration systems throughout neighborhood)	
Woodridge Road outfall (9/12) Segment 3	1.9×10^{10} fc/storm	Upper River	Storm water			Structural / nonstructural storm water BMP(s)	Targeted for future BMP. (***Mettatuxet 4)	Not done.
Segment 4- Lower River	88 29.9		"Identified dry weather sources to this segment include cumulative upstream loadings, Mettatuxet Brook (intermittent) and direct deposition by waterfowl and wildlife. Wet weather sources to this segment are also dominated by storm water runoff entering the reach from storm sewer outfalls, tributary streams or overland as sheet flow."		58%			

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Middle river-Segments 3 and 4	7.3×10^8 fc/day +/- (estimated through mass-balance)	Deposit Directly to Narrow River (and probably some tributaries?)	Birds/ Waterfowl* (Any update on location or abundance of waterfowl?)			Deter waterfowl from river and waterfront areas	Check status on this TMDL abatement measure Note: Birds and waterfowl observed mostly between Bridgetown Bridge and Middlebridge Bridge, (and within the Pettaquamscutt Cove Refuge located in the southern portion of Pettaquamscutt Cove, but load not estimated for Petta cove due to complications.)	
Middle river-Segments 3 and 4	3.4×10^{11} fc/storm (wet weather)	Directly to River	Storm sewer outfalls			Reduce stormwater loadings by educating residents; Reduce pet waste impacts	Check status on these TMDL abatement measures (SK and Narr)	

Location / Source **Includes bacteria load ranking (x/12) for outfalls**	**WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)**	**Loads to:**	**Primary Source (associated with load)**	**Secondary Sources**	**Load Reduction Needed (required)**	**Mitigation Measures Recommended (2001/2002)**	**Status of Implementation and/or Notes** **(BMP type, Install date, Project name)**	**Load Reductions Achieved**
Stormwater (wet weather) (watershed-wide)	(see individual locations for loadings and recommended mitigation) "Storm water runoff is the largest wet weather source of bacteria to the Narrow River and its tributaries."	Narrow River through Tributaries, storm sewer outfalls, and overland sheet flow	"*Nonpoint Sources and Storm Sewers:* The most significant reductions for nonpoint fecal coliform sources can be achieved through non-structural "good housekeeping" efforts by local residents. Good housekeeping practices include: connecting to the municipal sewers if available, restoring vegetated buffers around the river and tributary streams, discouraging the prolonged residence of waterfowl, regularly inspecting and pumping septic systems, disposing of pet wastes away from the river and storm sewer systems, and minimizing the use of fertilizers." **Ultimately all direct discharge outfalls that contribute to the impairment of the Narrow River should be addressed as necessary to meet water quality goals.**** [Segments 3, 4, & 5 only?]** RIDEM suggests that a multi-faceted storm water management strategy be incorporated by the municipalities that utilizes a combination of end-of-pipe structural BMPs, smaller-scale structural retention/infiltration BMPs located up-gradient within the catchment areas and the implementation of nonstructural BMPs throughout the watershed.					

Location / Source **Includes bacteria load ranking (x/12) for outfalls**	**WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)**	**Loads to:**	**Primary Source (associated with load)**	**Secondary Sources**	**Load Reduction Needed (required)**	**Mitigation Measures Recommended (2001/2002)**	**Status of Implementation and/or Notes** **(BMP type, Install date, Project name)**	**Load Reductions Achieved**
Segment 5-Pettaquamscutt Cove	454 120.8		"Identified sources: Dry weather sources to this segment include Mumford Brook, Crooked Brook, and direct deposition by waterfowl and wildlife. Wet weather sources to this segment are dominated by storm water runoff entering from Mumford and Crooked Brooks, intermittent tributary streams, or overland as sheet flow."		90%		[NOTE: according to TMDL, "it is presumed that waterfowl contribute quite substantially to the impairment of Pettaquamscutt Cove" "The southern portion of Pettaquamscutt Cove has been designated as a wildlife refuge. Large populations of permanent and migratory bird species, which undoubtedly contribute significantly to fecal coliform loadings, inhabit the area"	

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Mumford Brook (dry and wet weather)	'The highest fc concentration of any tributary to the River.' 74,892 66,667	Southern Pettaquamscutt Cove (segment 5)	Suspected Human/ wastewater	Wildlife, stormwater runoff	99.9%		Also, "The highest concentrations in Mumford Brook have consistently been measured in close proximity to East Narragansett Avenue in South Kingstown." AND, "RIDEM also feels that significant nonanthropogenic sources to the brook may be present in the fairly remote southern portion of the watershed since concentrations well in excess of state water quality standards were observed at the upstream (background) location, SW-26"	
Close proximity to East Narragansett Avenue (Mumford Road) in South Kingstown		Mumford Brook	"Mumford Brook, the largest fecal coliform source to the Narrow River, appears to be impacted by a failing septic system(s) in the vicinity of East Narragansett Avenue in South Kingstown."			Identify/ repair failing septic system(s) near Mumford Road	Suspected septic systems were being investigated by RIDEM with Projected repairs in 2001-2002 (Need to confirm: is this since resolved? Or is this where the K-9 is looking?]	

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Crooked Brook (dry and wet weather) Fully located in Town of Narragansett		Southern Pettaquamscutt Cove			Different for the different sections, but overall, needs at mouth: 99% reduction	Those specific noted below, AND: "Because bacteria sources to Crooked Brook are primarily non-point in nature, RIDEM feels that significant reductions can be achieved through simple good housekeeping efforts of the municipalities and local residents. Good housekeeping measures include minimizing fertilizer applications, periodic street sweeping, policing pet waste, and discouraging waterfowl from residing in specific areas."	This is for overall, to address the non-point sources. Check how these things are going	

Location / Source **Includes bacteria load ranking (x/12) for outfalls**	**WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)**	**Loads to:**	**Primary Source (associated with load)**	**Secondary Sources**	**Load Reduction Needed (required)**	**Mitigation Measures Recommended (2001/2002)**	**Status of Implementation and/or Notes** **(BMP type, Install date, Project name)**	**Load Reductions Achieved**
Crooked **B**rook (CB-xx) Segment 1	**CB-09**: 3580 CB-10: 220 WGM: 1192	Upper part of Crooked Brook branch (south of South Pier Road) CB-09 is stream channel upstream of S.P. rd.	Wildlife, storm drain (South Pier Road CB-09 is storm drain discharge from SP rd		98%	CB-09: Non-structural/ structural storm water BMP	Targeted for future BMP.	

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Crooked Brook Segment 2 (CB-03 through CB-08, see rows below for specific) loadings and/or recommendations at specific locations)	"This segment had the highest elevations of the entire (CB) watershed." WGM: 18,587	Middle of Crooked Brook branch, (most developed portion of watershed- between South Pier and Kingstown Roads)	Overall: Wildlife, horse farm, swale behind High School, storm drain (Kingstown Road) (incl. CB-3 pet waste)	At CB-04, also overland runoff from Kingstown rd. (see below)	99+%	Those specific areas below AND: "Station CB-04 through station CB-07 are located along a path which connects Kingstown Road with the local high school. This path is located on the Town of Narragansett's property. It was observed that an abundance of litter was collecting in this area. It is recommended that maintenance and policing of this area take place to minimize the amount of trash dumping taking place in this area."	Check on status of this. Has it been included in a regular program?	
CB Segment 2, cont.	**CB-08**: 52,420	Stream channel passing by horse farm	Runoff collecting bacteria from horses and associated pasture area			Agricultural BMP including manure and runoff management, deter horses from stream. **see details	At time of 2002 TMDL, RIDEM Div. of Agriculture had contacted property owner to devise effective management strategy. Status unknown.	No buffer here. May no longer be a horse farm. Needs follow-up. [NRPA conducted monitoring for 5 years. Monitoring sites NR-15 and NR-16, see Narragansett MS4 Annual Reports for 2005-2008]

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
CB Segment 2, cont.	CB-07: 1860							
CB Segment 2, cont.	CB-06: (?)	Storm swale passing by high school	Runoff from Middle School and High School parking lots and associated fields	CB-06 not here, but huge wet weather source (swale from schools) and sheet flow directly to stream		Non-structural/ structural storm water BMP	Targeted for future BMP.	
CB Segment 2, cont.	CB-05: 1170							
CB Segment 2, cont.	CB-04: 791	Stream channel passing behind Pier Ice Plan	Overland stormwater runoff coming from Kingstown Road			Non-structural/ structural storm water BMP	Targeted for future BMP.	
CB Segment 2, cont.	CB-03: 3950	Stream channel running through Sprague Park	Storm drain discharge from Kingstown Road, Pet waste			CB-03: Nonstructural / structural stormwater BMP, enforce existing town pet ordinances	CB-03 – Stream Targeted for future BMP.	

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Crooked Brook Segment 3 (Sprague Brook) (CB-11 through CB-14)	WGM: 45 CB-11: 239 **CB-12**: 672	Entire Sprague Brook branch (south of Kingstown Rd) CB-12 is stream channel upstream of South Pier Rd.	Overall: Wildlife, Storm drain (Kingstown Road CB-12 is storm drain discharge from SP rd.		70%	CB-12: Non-structural / structural storm water BMP, and Enforce existing Town pet ordinances	CB-12: Targeted for future BMP.	
Crooked Brook Segment 3 (Sprague Brook), cont.	CB-14: no flow				"At station CB-14, which is along South Pier Road (see Figure 3.3), an abundance of sand from wintertime street sanding activities was noticed in the stream channel. It is recommended that more frequent street sweeping be conducted to minimize the amount of sand and sediment being introduced to the stream."		Check status of program- has this been captured?	

Location / Source **Includes bacteria load ranking (x/12) for outfalls**	**WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)**	**Loads to:**	**Primary Source (associated with load)**	**Secondary Sources**	**Load Reduction Needed (required)**	**Mitigation Measures Recommended (2001/2002)**	**Status of Implementation and/or Notes** **(BMP type, Install date, Project name)**	**Load Reductions Achieved**
Crooked Brook Segment 4	**CB-01**: 5760 CB-02: 8430 WGM: 1522	Mouth/ Lower part of brook fed by the two tributaries and enters Petta Cove at CB-01	Wildlife, waterfowl		99%		From Crooked Brook TMDL: "The final segment of the watershed, segment 4, includes the lower watershed area within a large hardwood swamp. Instream fecal coliform concentrations increase as the stream passes through the reach despite the absence of anthropogenic sources. The concentration in this area is the second highest of the entire watershed."	
Narrow River Watershed (area-wide)			Suspected ISDS/ cesspools			Identify any residents (and businesses and institutions not connected to sewers and require that they connect as failing systems are identified.	As of 2001 TMDL: Completed by Narragansett. South Kingstown was in process. Check Status- any need to re-verify?	

Location / Source Includes bacteria load ranking (x/12) for outfalls	WGM Loadings (fc/100 ml) (both forms: 90th percentile and WGM []) (and Method)	Loads to:	Primary Source (associated with load)	Secondary Sources	Load Reduction Needed (required)	Mitigation Measures Recommended (2001/2002)	Status of Implementation and/or Notes (BMP type, Install date, Project name)	Load Reductions Achieved
Narrow River TMDL Segment 6- The Narrows	70 20.2		"Identified sources: Dry weather sources to this segment are limited to cumulative upstream impacts. Wet weather sources to this segment include upstream impacts and storm water runoff from Boston Neck Road."		38%			

*Note: Birds and waterfowl observed mostly between Bridgetown Bridge and Middlebridge Bridge, and also within the Pettaquamscutt Cove Refuge located in the southern portion of Pettaquamscutt Cove, but load was not estimated for the Cove due to complicating factors.

** Note: Details for Implementation for Horse Farm from Crooked Brook TMDL, 2002:
The horse farm on upper Crooked Brook is a significant bacteria source immediately upstream of station CB-08. The BMPs proposed below will address the pathogen contributions to the brook from the pasture area and will reduce both dry and wet weather impacts. A description of the BMPs recommended for the horse farm is provided below:

1. Create a buffer around the stream to keep horses away and to reduce the introduction of bacteria to the stream from manure on the ground. This would include the installation of fencing on both sides of the stream to create a buffer. Natural vegetation should be allowed to grow in the buffer area to enhance retention of bacteria in the buffer area. A bridge should be installed to allow horses to access both sides of the stream.
2. Move and cover the manure pile that is presently adjacent to the stream so bacteria will not be washed off the pile and into the stream by rain or snowmelt.
3. Runoff from the horse barn should be diverted away from the area of the manure pile and grazing area so that overland runoff and the resulting wet weather bacteria loadings are minimized.

***Note: Town of Narragansett has taken action to address: see "Narrow River Stormwater Abatement Study," for RIDEM (all in Town of Narragansett), November 2006 by Fuss & O'Neill. BMPs have been designed and installed over the years, and is still on-going. [Need to find out actual BMP designs (all subsurface infiltration?), locations, and pollutant load reductions]

****Note: Town of South Kingstown has taken action to address 10 outfalls in Segments 3, 4, and 5: see “Stormwater Attenuation and Source Reduction Strategy for the Pettaquamscutt River, for Town of South Kingstown, July 2014, Revised December 2016, by Fuss & O’Neill. 2017 BWRF grant awarded to implement structural BMPs in Table 12 of study. (See report for estimated bacteria pollutant loadings per catchment area calculated based on 2010 RI Stormwater Manual equation. Approach: Linear bioretention in roadways and Qualifying Pervious Areas. Due to site constraints, can only achieve varying percentages of the WQV per catchment. See report for estimated potential bacteria pollutant load reductions per catchment area with structural BMP installation.)

Other important notes from 2001/2002 TMDL’s:

- No reliable site-specific data pertaining to groundwater loadings or wildlife populations was available.
- The data indicate conclusively that in-stream fecal coliform concentrations are highest during the warmest summer months (July – September) and for a 72-hour period following significant rainfall.
- The three largest perennial streams entering the Narrow River act as the principal pathways by which nonpoint loadings enter the Narrow River during periods of dry and wet weather. (the other streams are small and dry up so don’t contribute)
- the source to Mumford Brook was isolated to the western channel of the brook that most closely approaches the abutting homes in South Kingstown
- Storm water runoff is the largest wet weather source of bacteria to the Narrow River and its tributaries.
- Storm sewer outfalls discharging to Segments 2, 3 and 4 represent the only point sources of fecal coliform to Narrow River.
- During wet weather, storm sewer outfalls discharging to Segments 2, 3 and 4 also severely degrade water quality.
- Significant nonpoint sources to the Narrow River and its tributaries include overland storm water runoff, wildlife, and birds.
- The twelve (12) largest storm sewer outfalls (shown on Figure 3.4), represent an estimated ninety-three (93) percent of the total fecal coliform load from outfalls to the Narrow River.
- Special consideration should be given to those outfalls discharging to, or immediately upstream of, Segments 3 and 4.
- Although twenty-three (23) (24?NK) storm sewer outfalls discharge directly to the river, only four or five of the largest have been consistently monitored during wet-weather conditions.
- Ultimately all direct discharge outfalls that contribute to the impairment of the Narrow River should be addressed as necessary to meet water quality goals.
- RIDEM suggests that a multi-faceted storm water management strategy be incorporated by the municipalities that utilizes a combination of end-of-pipe structural BMPs, smaller-scale structural retention/infiltration BMPs located up-gradient within the catchment areas and the implementation of nonstructural BMPs throughout the watershed.
- Flow in Mettatuxet Brook originates as storm sewer discharge.
- TMDL acknowledges that achieving 98/99 % reduction with Stormwater structural BMPs is impossible b/c each type of BMP treats only a certain amount. So, see TMDL for why need for both structural and non-structural BMPs (or what about in tandem/ chain of structural?)
- The most significant reductions for nonpoint fecal coliform sources can be achieved through non-structural “good housekeeping” efforts by local residents.

Appendix 4. Stormwater Retrofit Projects

A number of municipal stormwater retrofit projects have been installed in the watershed to address the Narrow River Bacteria TMDL. These projects were preceded by feasibility studies and engineering design, which are also discussed in this section. Where grant funding amounts are known, they are included with the project narrative. Note that funding for the projects below from federal and state grants all involved a substantial local match of 40-50% of the project total cost, therefore, grant amounts listed below do not reflect total project costs.

Narrow River Tri-Town Stormwater Management Study and Program (completed 1995)
Funding: $275,000 grant from DEM's Aqua Fund

This program consisted of a problem assessment and design feasibility study and the establishment of the first citizens' water quality monitoring program. The grant was awarded in 1991. The project study began in 1992, with field work conducted in 1993. The project was completed in 1995, with the study entitled, "Narrow River Stormwater Management Study: Problem Assessment and Design Feasibility," prepared for the towns of Narragansett, South Kingstown, and North Kingstown. It is commonly referred to as the "Tri-Town Study." This study involved:

- mapping the land use, sewer and stormwater infrastructure, and the drainage sub-basins in the study area;
- a sampling program for current water quality and flow data;
- modelling of three parameters—wet weather, dry weather, and receiving water—in order to simulate flows and pollutant loadings from stormwater runoff; and to calculate flushing times (and resulting pollutant concentrations) in the estuary;
- identification of structural Best Management Practices (BMPs) and locations for potential installation; and recommended watershed-wide non-structural source control BMPs.

Montauk - Circuit Drive Stormwater Treatment System (for 2 outfalls in Narragansett)
Construction Funding: $61,872 grant from Federal Clean Water Act (NPS 319) funds

This structural BMP was installed on Circuit Drive in the Summer of 2004 to treat stormwater from the Wampum Road and Canonicus Road outfalls—two of the top 4 bacteria contributing outfalls identified in the Narrow River Bacteria TMDL. The construction project had received a Federal Clean Water Act (NPS 319) grant in 2001, however, funds were distributed for reimbursement of eligible expenses only in 2006. Grant paid for a portion of BMP excavation, soil disposal, and wetland plantings.

Mettatuxet Beach Water Quality System (for 1 outfall in Narragansett)
Constructed BMP in 2005, final planting and grading in May 2006
Construction Funding: $85,714 EPA Targeted Watershed Initiative Grant (TWIG)
Additional funding related to this project:

$28,000 AquaFund grant for:

Design and Permitting: $18,051

Formation of Watershed Action Team and development of a Watershed Action Plan: $ 9,949 (plan dated December 2002)

$30,006 CRMC funding for pre- (2004-2006) and post- (2007 and 2008) construction water quality monitoring study.

This stormwater management BMP consisted of three treatment sections and was designed to treat stormwater from about 10 acres of the Mettatuxet neighborhood, which discharges at the Mettatuxet Beach outfall. This outfall was identified in the Narrow River Bacteria TMDL as the 11^{th} most significant out of 12 outfalls in Narragansett contributing bacteria to the river. The system consisted of: a Vortechnics pre-treatment sediment removal structure, a series of infiltration chambers (under the parking lot), and a vegetated detention pond to take overflow from the infiltration chambers.

This project also involved water quality sampling of discharge from each point in the treatment process to evaluate BMP success. According to the project 2009 update report to the Town of Narragansett, "The Mettatuxet BMP demonstrates a good ability to remediate E coli and Enterococci bacterial loads. The system has not done as good a job with total coliform, but there are no state regulations for this criteria. There also appears to be a seasonal effect in which bacteria reproduce better in warmer months."

Prior to construction, the project design was partially funded through an AquaFund grant, which also included the formation of a Watershed Action Team and the development of a Watershed Action Plan, dated December 2002.

Narrow River Stormwater Abatement Study, Final Report November, 2006
Funding: $31,700 Federal Clean Water Act (NPS 319)
Eight subwatersheds in Narragansett were comprehensively analyzed to identify and assess feasibility and cost of structural BMPs to manage stormwater to reduce pathogens and nutrients and to increase baseflow in the river. (Seventy-five percent designs were then developed for the Edgewater and Pettaquamscutt subwatersheds.)

Narrow River Stormwater Abatement Implementation Project
Pettaquamscutt Terrace 1 &2 and Edgewater 1 & 2 (4 outfalls in Narragansett)
Project completed in 2010 (funding awarded in 2008)
Combined Final Design and Construction: $1,110,975 total grant from combined sources
NPS 319 ($450,456) and BWRF ($660,519) (Bay Watershed Restoration State Bond Funds)
Design Funding: $20,000 State Revolving Fund (2008 agreement) (Town Matching Funds)

Construction Funding: $568,000 State Revolving Fund (2010 agreement) (Town Matching Funds)

This project was for construction of water quality BMPs in two neighborhoods to address the 4 highest priority remaining catchments/outfalls identified in the Narrow River Bacteria TMDL. This project was also designed to recharge the entire pre-development groundwater recharge volume. The grant funded project involved the final design and installation of the following stormwater management BMPs in the Pettaquamscutt and Edgewater neighborhoods in Narragansett:

- 4,300 linear feet of sub-surface infiltration systems along town owned roads in various locations throughout the neighborhood;
- 10,000 square foot sand filter on RIDOT –owned property at Bridgetown Road; and
- Level spreader north of Wilson Drive pumping station.

Mettatuxet 3, Neighborhood Stormwater BMP Improvements, construction 2017-2018
To address Shagbark Road outfall in Town of Narragansett
Funding: $518,300 from the 2015 State Bond Fund (BWRF)

This project installed 380 feet of subsurface infiltration chambers and one bioretention system within the public right of way in the Mettatuxet 3 subwatershed. This is considered a further implementation project of the findings from the 2006 Feasibility/Design project.

Projects that are currently in the works, or otherwise secured funding:

Town of South Kingstown, Implementation Strategy for the Pettaquamscutt (Narrow) River TMDL
Total Funding $658,130 from the 2015 and 2017 State Bond Funds (BWRF)

This project proposes to install linear bioretention in publicly owned areas for stormwater management at all 10 outfalls at Middlebridge Road and surrounding local streets as identified in "Stormwater Attenuation and Source Reduction Strategy for the Pettaquamscutt River," revised Final Plan, December 2016.

Town of Narragansett, Road and Stormwater Projects
Local Bond Fund: $17 million bond – 'Road Reconstruction Phase 2'

Local dedicated funding for road reconstruction and drainage BMPs for the following roads: Checkerberry Trail, Inkberry Trail, South River Drive, Spice Bush Trail, Sumac Trail, and Wayland Trail in the Mettatuxet neighborhood/drainage area; Raymond Drive (off West Bay Drive); and Lambert Street and Jean Street in the Crooked Brook subwatershed.
[Follow up - find out more from Town on what stormwater BMPs have been done.]

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Appendix 5. Individual Actions and Public Education Materials

Outreach materials for Individual Actions

- Brochure: "Simple Ways You Can Help Keep Rhode Island's Waters Clean" provided below and link: http://www.dem.ri.gov/programs/benviron/water/quality/pdf/tenthing.pdf
- URI Stormwater Solutions webpage: http://ristormwatersolutions.org
- Save the Bay's "Bay Friendly Living: Yard Care and Lifestyle Tips to Save Time, Money, and the Bay" https://www.savebay.org/wp-content/uploads/Bay-Friendly-Living.pdf
- Brochure: "Feeding Waterfowl is Harmful" http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/dontfeed.pdf
- Fact Sheet: "Dealing with Resident Canada Geese" http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/cangeese.pdf
- The Rhode Island Resource Recovery Corporation runs a drop-off Eco-Depot program for residents of RI to properly dispose of Household Hazardous Waste, including off-site collections scheduled in various municipalities throughout the year. For more information: https://www.rirrc.org/recycling-composting-disposal/hazardous-waste/household-hazardous-waste

Other Resources for Public Education and Awareness

Watershed Signage

- See "Creek Signs: Guide to Developing a Local Watershed and Creek Signage Program" by Southern Sonoma County Resource Conservation District, March 2007. Link: https://oaec.org/wp-content/uploads/2014/12/creek-sign-guide.pdf)

RI DOH: http://www.health.ri.gov/water/about/yourwater/
RI DEM: http://www.dem.ri.gov/programs/water/quality/
RI NEMO: http://web.uri.edu/nemo/
(see also: https://web.uri.edu/riss/stormwater-managers/educational-materials/
EPA: https://www.epa.gov/ground-water-and-drinking-water and https://cfpub.epa.gov/watertrain/
RI USDA/NRCS: https://www.nrcs.usda.gov/wps/portal/nrcs/main/ri/home/
Southern RI Conservation District: http://sricd.org/

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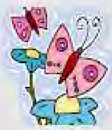
REDUCE YOUR LAWN by creating "no-mow zones" of native wildflowers, grasses, shrubs, and trees, especially as buffers near ponds and streams. This reduces water, fertilizer, and pesticide use and provides a welcoming habitat for wildlife.



FERTILIZE SMART Have your soil tested before applying fertilizer to your lawn to see if it even needs it. Don't over-fertilize - more is not better. During rainstorms, nutrients from fertilizers can wash off lawns into local waters where the excess nutrients promote algae blooms, including some algae that are harmful to people and pets. Algae blooms cause a decrease in oxygen in the water which endangers aquatic life and can cause fish kills. Use phosphorus fertilizer for new lawns only, unless the soil test shows a need for phosphorus on an established lawn. Sweep up fertilizer that spills on hard surfaces. Leaving grass clippings on your lawn can reduce your fertilizer needs by up to 25%. For more information on soil testing see www.URIMasterGardeners.org

REDUCE USE OF LAWN AND GARDEN PESTICIDES Investigate use of biological controls and products with natural ingredients. Read the labels—apply the right amount at the right time and be aware of the toxicity warnings.

REDUCE RUNOFF Increase the amount of stormwater absorbed into the ground by directing downspouts onto your lawn, not onto paved surfaces where the runoff could pick up oil, yard waste, and other debris. Install a rain barrel— use the water for plantings. Install a rain garden to increase the amount of stormwater absorbed into the ground. For more information, see www.RIStormwaterSolutions.org

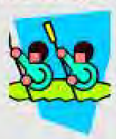
DON'T DRAIN YOUR SWIMMING POOL into storm drains, wetlands, rivers, or ponds. Instead drain it onto the ground away from your drinking water well. Drain your pool only when your test kit does not detect chlorine levels so that it won't harm vegetation.

PUMP IT, DON'T DUMP IT! If you own a boat, have your holding tank emptied at one of the local pumpout stations around Rhode Island. For a list of pumpout locations contact DEM.

VOLUNTEER with clean-up efforts or water quality monitoring. Participate in local activities that benefit the environment. Find out if there is a watershed council for your area. YOUR opinion counts! Attend public meetings. Your participation makes the statement that your community is concerned about local waterways. If you see a problem or want something done, say something! If you don't have time to attend meetings, call or contact a city or town official, a state representative, or DEM.

NOW...GET OUT AND ENJOY THE WATER !

Swim, sail, surf, kayak, fish, boat, shellfish, go birding or walk along the shore. Explore Rhode Island's waters.



If you need more information on any of these topics contact DEM Water Resources

RI DEM

RI Department of Environmental Management
Office of Water Resources
235 Promenade Street
Providence, RI 02908-5767
401-222-4700
www.dem.ri.gov

Rev 3/2015

Simple Ways YOU Can Help Keep Rhode Island's Waters Clean

YOU Can Make A Difference!

- **DO YOU EVER STOP AND WONDER** what you can do to make a difference in keeping our waters safe enough to swim in, fish from, or use for drinking? What you can do to protect the groundwater that supplies your drinking water well?
- **WHEN IT RAINS** water travels across our properties collecting pollutants such as animal feces, fertilizers, soil, oil, and chemicals. This runoff then flows untreated into local rivers, lakes, and streams; polluting water for human use as well as plant and animal life.

LEARN ABOUT YOUR LOCAL WATERS Everyone lives in a watershed, which is the area that drains to a nearby river, stream, lake, or pond. Think about washing everything in a sink then letting it go down the drain. The sink is your watershed and the drain is your local river or stream. Find out what waters are closest to you and where they flow.

TAKE CARE OF YOUR SEPTIC SYSTEM Faulty septic systems can pollute local waters. Systems should be inspected every three to five years and tanks pumped as recommended. Don't drive or park anywhere on your septic system. Plant only grass over and near the system. If you have a cesspool, consider replacing it with a septic system.

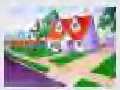
DON'T FEED THE DUCKS! Feeding geese, ducks, gulls, and other waterfowl can cause large populations of birds to become concentrated in areas that are incapable of supporting them. The waste they produce contributes bacteria to our waterways and results in beach closures and pollution of shellfishing areas.

SCOOP THE POOP Pet waste left on sidewalks, streets or yards can be washed away by rainwater and carried into storm drains and drainage ditches which flow untreated to nearby rivers, ponds and beaches. Pet waste contains bacteria that can cause human illness and contribute to the closing of beaches and shellfish beds. Always carry a baggie - scoop up waste, bag it, and put it in the trash.

DON'T FLUSH MEDICATIONS Old or unwanted prescription drugs and over the counter medications flushed down the toilet or drain can end up in our waters and harm organisms living there. Check to see if you can drop off medications at your police station. If not, properly dispose of them in the trash. Crush pills and tablets. Put the medicine into a sealable plastic bag. Place the sealed bag in the trash.

MINIMIZE THE USE OF HAZARDOUS PRODUCTS as much as possible. Cleaning and other household products contain many hazardous chemicals. Read labels and try to use the least harmful products available. Don't dispose of products down the toilet or drain. Dispose of household hazardous chemicals (e.g., oil based paint, pesticides, drain cleaner, oven cleaner, pool chemicals) using the RI Eco-Depot Program. See www.rirrc.org

DRIVEWAY CARE Driveway sealant can be either an asphalt or a coal tar mixture. Coal tar has much higher levels of chemicals harmful to human health and aquatic life. As sealants wear down, particles wash off in stormwater. If you must seal your driveway, use an asphalt sealant.



WASH VEHICLES ON YOUR LAWN (away from your drinking water well) or use a commercial car wash. Washing on your lawn minimizes the amount of dirty, soapy water flowing into the storm drains that run directly into our waterbodies. If you are unable to wash your car on your lawn, use only biodegradable, phosphate-free cleaners. If washing near a storm drain, temporarily divert the water towards grassy areas. Commercial car washes typically use far less water, recycle their wash water, and treat their water prior to releasing it into the sewer system.

RECYCLE USED MOTOR OIL AND ANTIFREEZE Don't dump automotive fluids down the storm drain or dispose of them in your trash. Contact your local Department of Public Works or see the RI Eco-Depot Program at www.rirrc.org

CONSERVE WATER Don't overwater your lawn. Lawns need only one inch of water per week (from either watering or rain). Excessive water use, especially in summer, can dramatically reduce flow in rivers and streams, harming aquatic life.

If your house is connected to a public sewer, conserving water will help reduce the discharge from your wastewater treatment facility into local waters AND save you money! If you use a septic system, water conservation helps prevent system failures.

Appendix 6. Regulated Facilities

Table 16: Regulated Facilities in the Narrow River Watershed (excluding Above-ground Storage Tanks and all tanks at residences)

Name of Site/ Operation	Location	Town	Notes	Status
Tier 2 Facility/ Hazardous Materials Handler				
South Kingstown Wastewater Facility	275 Westmoreland Rd	Narragansett	Tier 2 Facility	
RIPDES Point Source Discharge				
South Kingstown Wastewater Facility	275 Westmoreland Rd	Narragansett	(discharge point is outside watershed)	
Industrial Stormwater Multi Sector General Permit				
(none)				
Contaminated Sites				
Mobile Service Station #12005	3079 Tower Hill Rd	South Kingstown	ELUR + RIDEM Site Investigation + 2 LUST's	Inactive
Narragansett DPW Garage	Westmoreland Street	Narragansett	ELUR+ RIDEM Site Investigation	Active
Saunderstown Standpipe Water Tower	Snuff Mill Rd	North Kingstown	RIDEM Site Investigation	Inactive
Bell Residence	1000 Gilbert Stuart Rd	North Kingstown	RIDEM Site Investigation	Inactive
Plum Hill and Walmsley Properties	2800 Tower Hill Rd	North Kingstown	RIDEM Site Investigation	Inactive
Mooresfield Road Improvements	Intersection with	South Kingstown	RIDEM Site Investigation	Active

Name of Site/ Operation	Location	Town	Notes	Status
	Bridgetown road			
North End Water Storage Tank	1164 Boston Neck Road	Narragansett	RIDEM Site Investigation	Inactive
Narragansett Town Dump	South Pier Rd	Narragansett	RIDEM Site Investigation	Inactive
Kinney Ave Water Storage Tank Lot 1 SR-20-0710 C	Old Point Judith Rd	Narragansett	RIDEM Site Investigation	Active
Kinney Ave Water Storage Tank SR-20-0710 A	Old Point Judith Rd	Narragansett	RIDEM Site Investigation	Inactive
Kinney Ave Water Storage Tank DEM Lot 27 SR-20-0710 B	Old Point Judith Rd	Narragansett	RIDEM Site Investigation	Inactive
Narragansett Laundry	88 Point Judith Rd	Narragansett	RIDEM Site Investigation & Remediation	Active
70 Point Judith Rd, Plat P Lot 325	70 Point Judith Rd	Narragansett	RIDEM Site Investigation & Remediation	Inactive
Narragansett Mobil	66 Point Judith Rd	Narragansett	RIDEM Site Investigation & Remediation + Storage Tank - Underground L-UST	Both Active
Leaking Underground Storage Tanks				
Narragansett Town Hall	25 Fifth Street	Narragansett	Underground L-UST	Inactive

Source: http://www.dem.ri.gov/maps/ Environmental Resource Map

Appendix 7. Climate Change Issues

Table 17: Summary of Climate Change Issues Pertaining to Water Resources

Climate Change Effect	Environmental Concerns	Strategies to Address
Sea Level Rise	• Coastal flooding • Storm surge reach • Infrastructure flooding and damage (roads, bridges, sewage treatment plants, septic systems, storage of hazardous materials, etc.) • Salt marsh submersion (without space to migrate to, loss of salt marsh leads to loss of water quality and buffer functions, habitat, carbon sequestration function, and other important values) • Saltwater intrusion of coastal groundwater affects drinking water wells and performance of septic systems	• (Managed) Retreat • Insurance to reflect risk • Public policy to consider risk and useable lifespan of investment (while shifting risk and responsibility to private sector in order to disincentivize dependence and encourage appropriate transitions/adaptation) • Allow coastal aquatic habitats and geologic (geomorphologic) features to migrate--remove barriers to migration/ natural physical change.
Increased Storm Frequency and Intensity	• Ability of stormwater infrastructure to handle the increased load • Scouring of streambeds and stream banks (erosion and sedimentation) • Increased riverine flooding-due to flood storage saturation points being reached without chance to dry out before next storm event; and due to undersized stormwater infrastructure backing up. • Increased coastal flooding (storm surge) • Ability of ground to absorb water for groundwater recharge	• Consider future conditions in stormwater design criteria • Protect and restore riparian buffers • Protect and restore (or enhance) wetlands with flood storage capabilities • Implement Low Impact Development for new and redevelopment projects • Retrofit stormwater storage and transmission capacity and maximize infiltration opportunities

Climate Change Effect	Environmental Concerns	Strategies to Address
Changing patterns of precipitation and snowmelt	• Increased snow storms interspersed with rain events increases winter sand and salt runoff to waterbodies. • Increased runoff and flooding in winter during rain events while ground is frozen (essentially impervious surface) [Can water quality BMPs function as well this time of year?]	• Practice street sweeping in winter between snow storms and prior to rain events.
Longer dry periods	• Drought • Decreased stream base flow • Increased demand for irrigation when supply is low • Saltwater intrusion to wells in coastal areas due to (larger) drawdown • Increased vulnerability to wildfires (which also leads to deforestation or removal of vegetated ground cover, increasing susceptibility of erosion) • Loss of functioning aquatic habitats-Shrinking wetlands and shorter periods of vernal pools (which may no longer meet the needs of dependent species for breeding) • Change in hydroperiod of wetlands may reverse carbon sequestration function, thereby exacerbating climate change	• Maximize groundwater recharge (engineering and low impact development methods) • Limits on withdrawals • Water use conservation for indoor and outdoor use restrictions; limit lawn areas (LID). • Practice water re-use and recycling • Adjust water rates to reflect truer costs (including ecosystem damage with base flows), and as an incentive to conserve water. • Minimize leaks in water supply infrastructure • Reduce dependence on fossil fuels- invest in renewable energy and energy efficiency. • Reforest deforested or bare areas. • Restore deteriorated or destroyed wetlands; (consider creating new wetlands, where possible)
Average warmer temperatures (for air and water)	• Soil moisture and temperature change may affect biological function of OWTS	• Study effect and redesign OWTS in response to changing conditions

Climate Change Effect	Environmental Concerns	Strategies to Address
	• Warmer air and warmer water temperatures impact Aquatic habitat (and the organisms themselves) • Ability of water to hold oxygen • Increased evaporation of surface waterbodies and wetlands (leads to increasing concentration of pollutants; and loss of aquatic habitats, wetlands, stream flows, and ecosystem functioning; and less drinking water and irrigation water; (also feeds moisture into the climate system, affecting other locations.) • Growth of algae and bacteria	• Protect and restore Riparian Buffers • Maximize groundwater recharge and infiltration • Install stormwater BMPs to reduce nutrients, sediment, and bacteria to waterbodies • Institute regulations for water conservation and reuse. • Implement LID • reduce use of fossil fuels
Increased Vulnerability to Wildfires (and Hurricanes)	• Deforestation (loss of benefit of trees and forest on impact of stormwater, groundwater recharge, temperature moderation, soil stabilization, habitat) • Erosion (loss of fertile topsoil, sedimentation into wetlands and waterbodies)	• Maximize groundwater recharge • Emergency response and public education-to heighten awareness and response to preventing and controlling fires. • Clear deadwood to reduce fuel source.

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Appendix 8. Assessment of Waterbodies

This appendix gives a detailed description of the resources and the conditions of each waterbody in the watershed. The waterbodies and aquatic habitats in the Narrow River watershed provide us with fishing, swimming, boating, picnicking, fish and wildlife habitat, shellfish habitat, and scenic, historic, and cultural resources.

The Narrow River (Estuary)

The Narrow River Estuary is the largest waterbody in the watershed. It is brackish and tidally influenced, with saltwater concentrations increasing from its freshwater inflow edges, down towards its mouth with the Narragansett Bay.

The Narrow River Estuary consists of a number of identifiable segments:

- Upper and Lower Ponds - two distinct ponds, very deep and very wide compared with the body of the river, separated by a shallow sill, and stratified in temperature, salinity, and dissolved oxygen concentrations.
- Narrow, shallow part of river (upper river is more narrow than lower river)
- Pettaquamscutt Cove
- The Narrows tidal inlet (river outlet to Narragansett Bay)

Highlights of the water resources this estuary provides include:

- recreation (popular for fishing, swimming, boating, birding, scenic enjoyment)
- fish and shellfish habitat
- subject of scientific research
- John H. Chafee National Wildlife Refuge at Pettaquamscutt Cove (internationally significant for certain migratory birds)
- the area around Pettaquamscutt Cove provides a habitat that is used by both migrating and local waterfowl
- Rare species habitat

Due to its geology and hydrology, the estuary is naturally sensitive to pollution loads, and the allure of the river has attracted development to the extent that it has caused negative impacts to the water quality and aquatic habitat. Over the years, concerted efforts have been implemented to address the impact development has had on the river, including sewering of high density areas and installing stormwater water quality management structures.

Special Resource Protection Waters (SRPW)

The Narrow River (Pettaquamscutt River) is also designated in the State's Water Quality Regulations, July 2006, amended December 2009, as 'Special Resource Protection Waters.'

(from the regs) "Special Resource Protection Waters (SRPWs) are high quality surface waters identified by the Director of RIDEM as having significant ecological or recreational uses. Under Tier 2½ of the Antidegradation Provisions, Protection of Water Quality for SRPWs, the State cannot allow any measurable degradation of the existing water quality necessary to protect the characteristic(s) which cause the waterbody to be designated a SRPW. The new or increased discharge or activity will not be allowed unless the applicant can provide adequate scientific and technical documentation and engineering plans which can prove, to the satisfaction of the Director, that specific pollution controls and/or other mitigation measures and BMPs will completely eliminate any measurable impacts to water quality necessary to protect the characteristics which cause the waterbody to be designated a SRPW."

The Narrow River is listed as SRPW for the features in the SRPW categories indicated in **Figure 20.**

Figure 20. Narrow River Special Resource Protection Water Categories

	SRPW Categories											
Name	Recreation	Ecological Habitat	State Park	Federal Park	State Estuarine Area	Federal Estuarine Area	Critical Habitat (Rare and Endangered Species)	Unique Freshwater Wetland	Wild & Scenic	Drinking Water Supply	Conservation Area	
Narrow River		X					X	X			X	

Water Quality and Aquatic Habitat Conditions

The water quality and the aquatic habitat of the Narrow River Estuary are impaired or threatened by the below pollutants. Conditions applicable to these pollutants are also noted, as follows:

- **Bacteria**
  - Entire estuary is permanently closed to use of shellfish consumption
  - Sometimes beach is closed to swimming
- **Nitrogen** (high in some spots, evidence of good conditions in other spots)
  - No water quality standard for nitrogen in saltwater, though high
  - Watch out for algae blooms and low dissolved oxygen conditions, which negatively affect habitat
  - Eelgrass beds were expanding, sign of improved conditions in these spots (but is there a link with the WQ numbers?)

The Narrow River Estuary is impaired by bacteria resulting in this resource being permanently closed to shellfishing because it is not safe to eat, and the bacteria sometimes also is high enough to exceed the safe swimming standard. In 2018, the beach at the Boys and Girls Club's Camp Grosvenor was closed for 4 days this season because of bacteria.

Data from RIDEM's Shellfish Monitoring program continues to confirm that bacteria levels are high enough to maintain the closed to shellfishing designation. However, data from the Narrow

River Preservation Association's monitoring program through URI Watershed Watch indicates that bacterial levels in some areas in the estuary have improved, such that delisting these areas as impaired for shellfish consumption may be a viable goal to prioritize. Partnering with RIDEM to evaluate this potential and to make any changes in current monitoring and management programs to allow this possibility would be needed. This is an important opportunity for a potential success story for the years of effort by the various parties to improve water quality for bacteria and restore the estuary for its designated uses.

Also, while not officially listed as impaired by nitrogen (because there is no saltwater numeric standard for nitrogen in the Narrow River), there are high levels of nitrogen in the Narrow River Estuary. This poses a threat to the ecosystem because nitrogen can cause algae blooms. This can set off a chain reaction of conditions detrimental to the fish and other aquatic organisms that need oxygen and light.

Sources of Bacteria

In 2001 and 2002, RIDEM undertook a Total Maximum Daily Load study (also called a 'Water Quality Restoration Study') to identify the sources of bacteria to the river, and to calculate the loading rates of bacteria by the input locations, including stormwater outfalls and freshwater tributaries collecting bacteria from higher up in the watershed. This study included informed mitigation actions to be taken to reduce the bacteria and improve the water quality. [In what years was this TMDL incorporated into each of the three local SWMPP's?] The loadings, locations, recommended actions, and strategies since employed are presented in **Table 14** in **Appendix 3** in order to document the progress on this effort and to show what still needs to be done.

In general, fecal bacteria in the Narrow River today are likely to come from the following sources:

- wastewater (failing septic systems, illicit connections, cracked/ leaking sewer pipes)
- stormwater
- pet waste
- wildlife/ waterfowl waste

As part of the development of this watershed plan, stakeholder input to address the bacteria sources has added some additional ideas for action items to boost progress on this issue. [See Implementation Table]

Sources of Nitrogen

Nitrogen in its various forms has been measured along the Narrow River estuary since the monitoring program began. In 1992, Total Nitrogen was monitored at ten saltwater sites and in 1997 Total Nitrogen began to be monitored at four freshwater sites, as well. In 2006 Ammonia and Nitrate plus Nitrate forms of nitrogen were added to the monitoring data collection at all sites. To celebrate the 25-year milestone of monitoring water quality, the Narrow River

Preservation Association presented their data in a report and presentation, which summarized the trends by splitting the data to show averages from the early years versus the later years.

While Total Nitrogen is observed to have increased at all saltwater and freshwater sites, Ammonia has decreased at all saltwater and freshwater sites. Nitrate plus Nitrate have noticeably decreased at all saltwater sites, however, these forms of nitrogen have increased at the freshwater sites (incoming tributaries), which are very high. These different forms of nitrogen can be indicative of the sources [I would say but it is difficult to determine without further testing]. It is very likely that the decrease in Ammonia and Nitrate plus Nitrate in the saltwater locations is due to the sewering of the neighborhoods which stopped the large amounts of wastewater effluent from septic systems from getting into the river. Since the inorganic forms of nitrogen have decreased, yet Total Nitrogen has increased, it is the organic form of nitrogen that has increased. As organic nitrogen decomposes, it is converted into usable forms of nitrogen favored for plant growth. Therefore, nitrogen (regardless of its form?) is still a concern in the river due to its contribution to eutrophication, though the predominant source may have changed.

A study or modelling program should be conducted to identify and prioritize the sources of nitrogen to the contributing tributaries and to the river in order to help prioritize areas to target to reduce nitrogen inputs.

In general, the sources of nitrogen to the Narrow River (and its contributing tributaries) are likely to come from the following:

- wastewater
    - illicit connections
    - septic systems
    - cracked/ leaking sewer pipes
- groundwater flow (legacy from septic systems)
- fertilizer
- stormwater
- pet waste
- wildlife/ waterfowl
- combustion emissions

Eelgrass- Special Indicator Habitat in Narrow River

Submerged aquatic vegetation, specifically seagrasses, are integral to the health of shallow coastal estuaries. Seagrass beds are highly valued habitat that support large numbers of plants and animals and have a high level of productivity. Good water quality is required to for seagrasses to survive and as a result they are susceptible to nutrient pollution and sedimentation. This makes eelgrass a good indicator of water quality and aquatic habitat conditions. Unfortunately, SAV habitats are also often adversely affected by a number of anthropogenic activities, such as boat propellers, dredging, or any activity that rips, shades or smothers it, including elevated nutrient levels that create algal blooms and high turbidity. Located in shallow waters (generally less than 2 meters at low tide) with lots of sunlight, eelgrass beds have historically existed in the Narrow River Estuary.

Substantial declines in eelgrass were reported in the 1980's and 1990's, most likely due to increased development and nitrogen levels. In a 2006 aerial study, no eelgrass was detected in the Narrow River estuary. Eelgrass was reported to be on the increase, however, in 2012, and a survey in 2016 recorded 40.5 acres of seagrass in the Narrow River estuary mostly north of Middlebridge with some patches south of the bridge. This increase in eelgrass may be an indicator of improving nitrogen water quality conditions in this area. It would be interesting to continue to track water quality changes and changes in eelgrass locations and extents. (

Lakes and Ponds

The Narrow River watershed contains a number of freshwater lakes and ponds, and two salt ponds, described below from north to south. Most of the freshwater ponds are connected to the Narrow River Estuary by freshwater rivers and streams. One freshwater pond is hydraulically connected through groundwater and not by a perennial flowing surface waterbody. The two salt ponds are connected via a wetland complex and a drainage ditch and are, therefore, also included in this watershed.

Silver Spring Lake

The Silver Spring Lake is in the Town of North Kingstown and was formed historically by a dam along the Mattatuxet River. The dam has survived and been reconstructed over the years and the lake is now owned by the RIDEM as a recreational resource. This lake is stocked with trout by RIDEM Fish and Wildlife and is a popular area for fishing, paddle boating, and picnicking at the Shady Lea Grove picnic area.

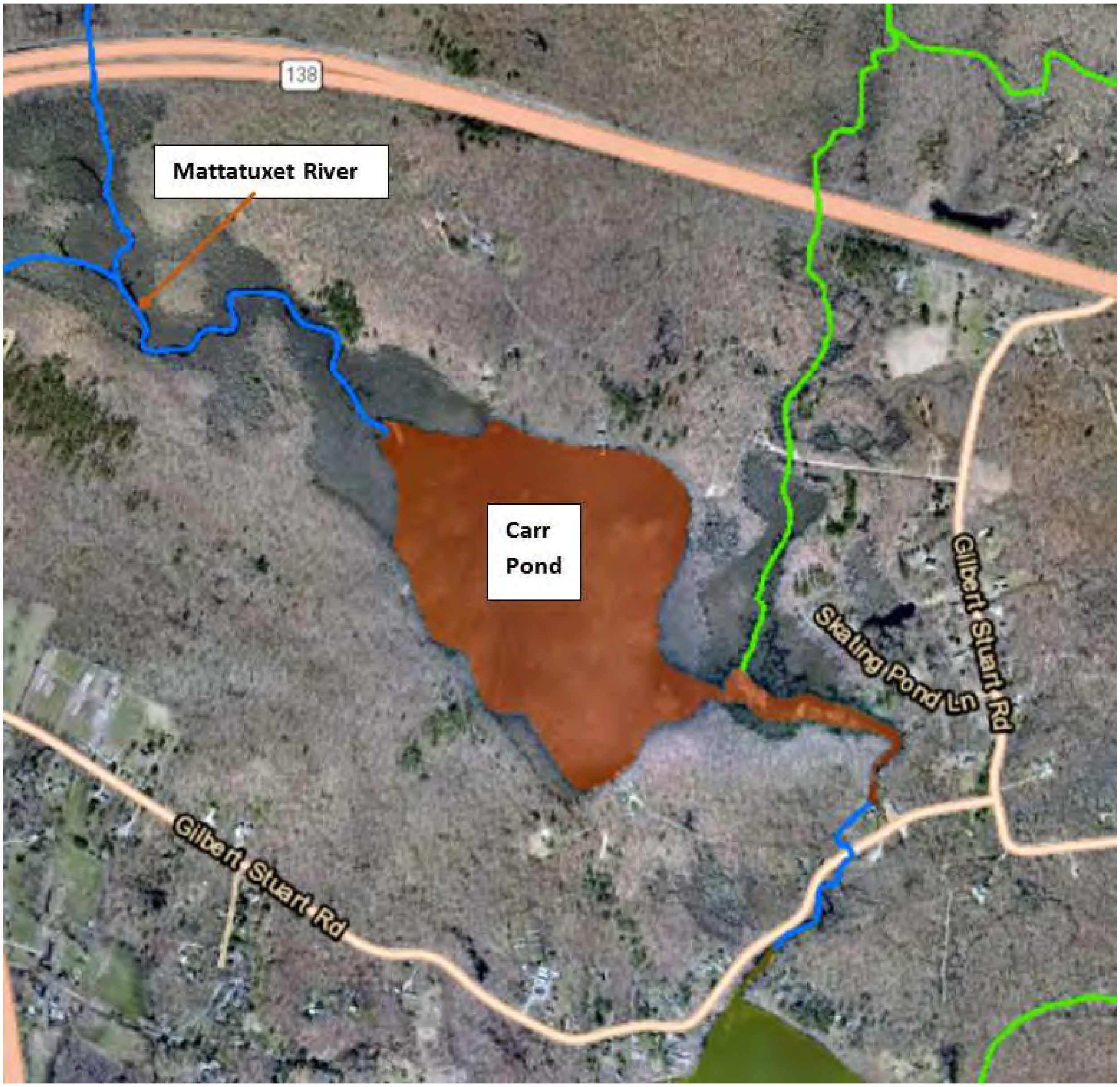
The Silver Spring Lake is impaired for its designated use of fish and wildlife habitat due to the below pollutants and/or stressors. Conditions applicable to these pollutants and stressors are also noted, as follows:

- **Phosphorus**
    - Excess phosphorus can cause algae blooms leading to eutrophication and an imbalance in the ecosystem, affecting the health of the aquatic habitat (discussion on the Trophic Status of this pond is below)
    - A TMDL for Phosphorus is scheduled to be developed by RIDEM in 2023
- **Invasive Plants (Aquatic Invasive Species)**
    - Variable milfoil (spreads easily through fragmentation)
    - Fanwort (spreads easily through fragmentation)
    - Invasive Plants can take over and outcompete the native conditions, negatively affecting the health of the aquatic habitat
    - Negatively affects the recreational values for fishing, swimming, and boating; and the aesthetic values of the lake
    - Herbicide treatments were administered in the Summer and Fall of 2018 to control these AIS.
- **Mercury in fish tissue**
    - Consumption advisory for (resident?) fish
    - Does not affect stocked trout
    - Atmospheric deposition source (see Northeast Regional Mercury TMDL) http://neiwpcc.org/our-programs/nps/mercury/mercury-tmdl/

See also discussions on the Trophic Status and Sources of pollutants, below.

Carr Pond (aka Gilbert Stuart Pond, aka Pausacaco Pond)

The Carr Pond is also called the Gilbert Stuart Pond, as it is formed by the dam for this historic site, which was the first snuff mill in the American colonies (Gilbert Stuart Birthplace and Museum website), and the birthplace of the famous American painter in the Town of North Kingstown. The dam is on the Mattatuxet River, at a segment which is also called the Gilbert Stuart Stream, and now serves as a historic resource with the Gilbert Stuart Birthplace & Museum. Carr Pond is also called Pausacaco Pond. This pond provides fish and wildlife habitat and recreational resources, as well. There is a fish ladder and an eel passage at this dam, and river herring counts are taken each spring during the herring run. This is the first dam running upstream that fish encounter along the Mattatuxet River.



The Carr Pond is impaired for its designated use of fish and wildlife habitat due to the following stressor and the conditions it creates:

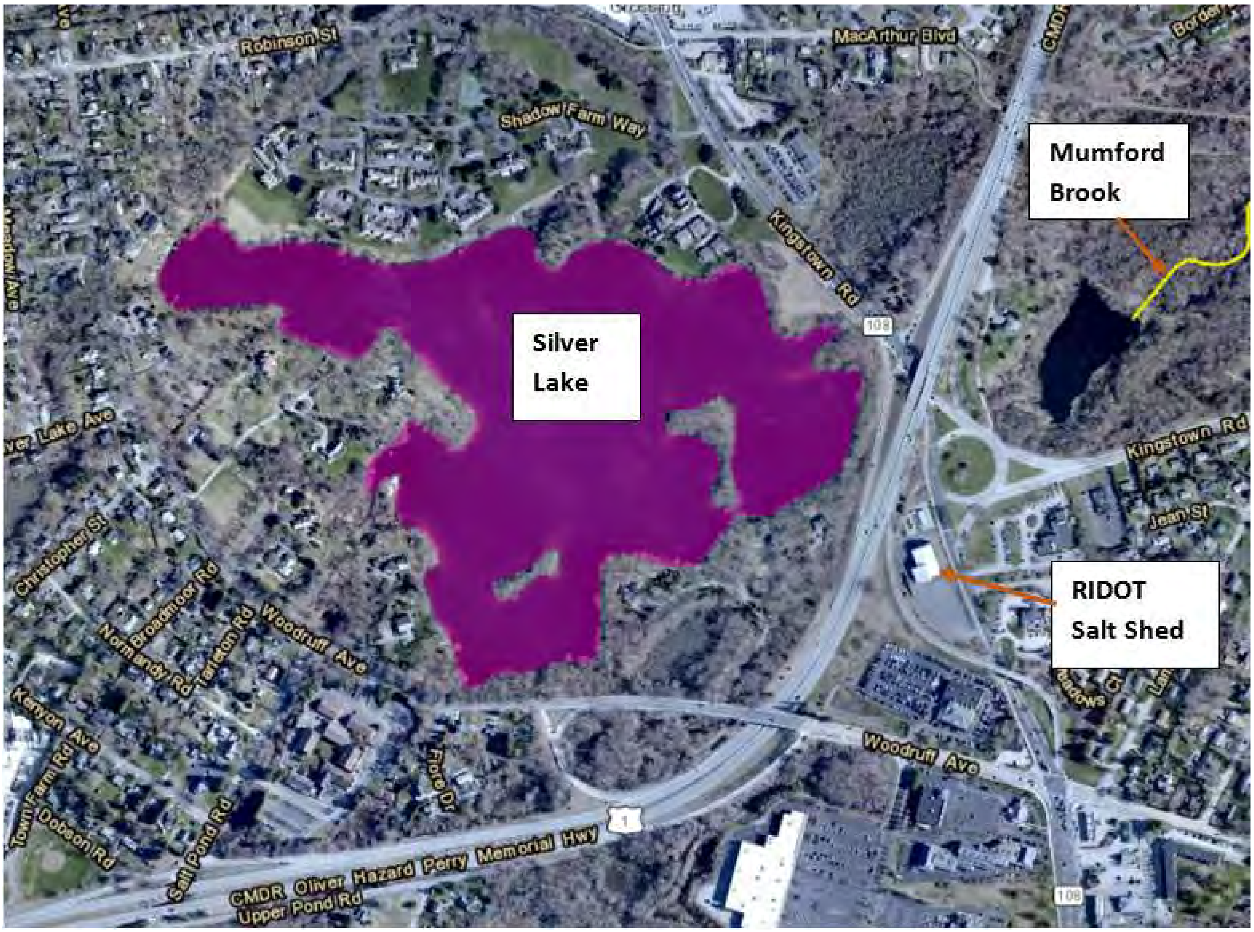
- **Invasive Plants (Aquatic Invasive Species)**
  - Variable milfoil (spreads easily through fragmentation)
  - Fanwort (spreads easily through fragmentation)
- Conditions:
  - Invasive Plants can take over and outcompete the native species, negatively affecting the health of the aquatic habitat
  - Negatively affects the recreational values of the pond for fishing, swimming, and boating; and the aesthetic values of the lake

See also discussions on Trophic Status and Sources of pollutants, below.

Silver Lake

The Silver Lake is the third major surface waterbody in the watershed which has had a water quality assessment. The Silver Lake is in the Town of South Kingstown and is included in the Narrow River watershed due to its connectivity through groundwater. There is no surface connection to a river or stream, though in the past there appears to have been surface connection with the upper reaches of Point Judith Pond in the Saugatucket River watershed.

This lake should meet the water quality standards for primary and secondary recreational swimming and paddle boating, and fish and wildlife habitat.



The Silver Lake is impaired for its designated use of fish and wildlife habitat due to the below pollutants and stressors. Conditions applicable to these pollutants and stressors are also noted, as follows:

- **Phosphorus**
    - Excess phosphorus can cause algae blooms leading to eutrophication and an imbalance in the ecosystem, affecting the health of the aquatic habitat
    - A TMDL for Phosphorus is scheduled to be developed by RIDEM in 2023
- **Low dissolved Oxygen**
    - A TMDL for Low Dissolved Oxygen is scheduled for 2023 (The Low Dissolved Oxygen TMDL and the Phosphorus TMDL may be grouped together in one

document since it is likely that the Phosphorus impairment is causing the Low Dissolved Oxygen impairment for this lake.)

Also, the Silver Lake in South Kingstown was investigated on August 8, 2017, and no AIS was observed. See also discussions on the Trophic Status and Sources of pollutants, below.

Trophic Status- Freshwater Lakes and Ponds

Lakes may be classified according to the degree of eutrophication using data on nutrient concentrations (P) or algal growth (often measured as Chlorophyll A). In order of increasing nutrient concentrations, lakes undergo a transformation from Oligotrophic, to Mesotrophic, to Eutrophic, to Hypereutrophic. Eutrophic conditions accelerated by human activities affect the stability of the ecosystem.

Based on the Secchi Depth transparency, Chlorophyll Levels, and Phosphorus Levels data, RIDEM has classified each of these three freshwater lakes/ponds with a Tropic Status of 'Mesotrophic.' See **Table 12** in Appendix 2 for monitoring data and information on Trophic Status.

Sources of Excess Phosphorus to Freshwater Lakes and Ponds

Sources of excess phosphorus to the Silver Spring Lake in North Kingstown and the Silver Lake in South Kingstown are likely, but not confirmed, to come from the following:

- Wastewater:
  - failing septic systems
  - illicit connections (don't know if any exist around these ponds- need to investigate and confirm)
- Pet waste
- Waterfowl/wild animal and bird waste
- Fertilizer
- Eroding sediments (P binds to sediment and travels with it)
- Vehicle exhaust and combustion of fossil fuels
- Recirculation of excess phosphorus from lake bottom sediment

Sources of Aquatic Invasive Plant Species

Sources of Aquatic Invasive Plant Species to the Silver Spring Lake and the Carr Pond are likely to come from the following:

- Increased traffic of boats with AIS fragments from other ponds
- lack of AIS awareness and boat hygiene
- Fragmentation of non-native species
- aquarium/water garden trade
- wildlife movement

Little Neck Pond/ Lake Canonchet

The Little Neck Pond and Lake Canonchet are currently considered by the RIDEM Water Quality Regulations as saltwater ponds, with a Water Use Classification for seawater of "SA." In the past, they had been classified under freshwater. Further information on salinity and species of fish living in the ponds could lead to reclassification in the future. These two ponds are connected to each other under Anne Hoxsie Lane and are located in the Town of Narragansett. They are hydrologically connected to Pettaquamscutt Cove by a wetland complex (and a drainage ditch). These ponds run parallel to Narragansett Town Beach on the northwest side of Route 1, and are within the Canonchet Farm property owned by the Town of Narragansett. They are separated by an access road (Anne Hoxsie Lane) leading to a parking lot servicing beachgoers and Canonchet Farm. These ponds provide fish and wildlife habitat and recreational fishing resources. However, there is insufficient water quality information on the status of these waterbodies for the safe use of 'Fish Consumption.'

These ponds have not been assessed for water quality or aquatic invasive species, however the presence of invasive Phragmites—a wetland invasive plant species—exists around these ponds. The Friends of Canonchet Farm have been working on a plan for herbicide treatment of this invasive plant.

Other Ponds
The Sprague Pond and other small ponds such as the Pendar Pond, have not been assessed for water quality, aquatic habitat conditions, or conditions of associated wetlands or buffers. Information pertaining to impoundments (dams) is provided in discussions on Freshwater Streams and in Section V. E) Barriers to Stream Connectivity.

Freshwater Streams

There are a number of freshwater rivers and streams in the watershed that flow to the Narrow River estuary. Some of these streams have water quality monitoring stations sampled by the NRPA, however all of the rivers and streams shed from an area that is too small to be include in the State's 'rotating basin' water quality monitoring program (also called 'Ambient River Monitoring' (ARM) program). Rather, the Watershed Watch data is used to make assessments for the 303d/Integrated Water Quality list. Streams are presented below from north to south in the watershed.

Mattatuxet River
The Mattatuxet River is in the Town of North Kingstown and it is the largest freshwater body flowing to the Narrow River estuary. In addition to fish and wildlife habitat, this river has historically supported a textile mill at the Shady Lea Mill, which is artist studios today. A number of dams have historically been constructed along this river, noted in the discussions above with their impounded lake or pond. In the summer of 2018, the Shady Lea dam was removed to restore this section of the riverine habitat and reconnect the ability for fish and other wildlife to pass. Some portions of the river also flow under State and local roads. The Atlantic Coast Fish Habitat Partnership has expressed concern to evaluate the conditions of these road crossings as potential barriers to fish passage, particularly the crossings at Route 1 and at Route 138, which are discussed in Section V E).

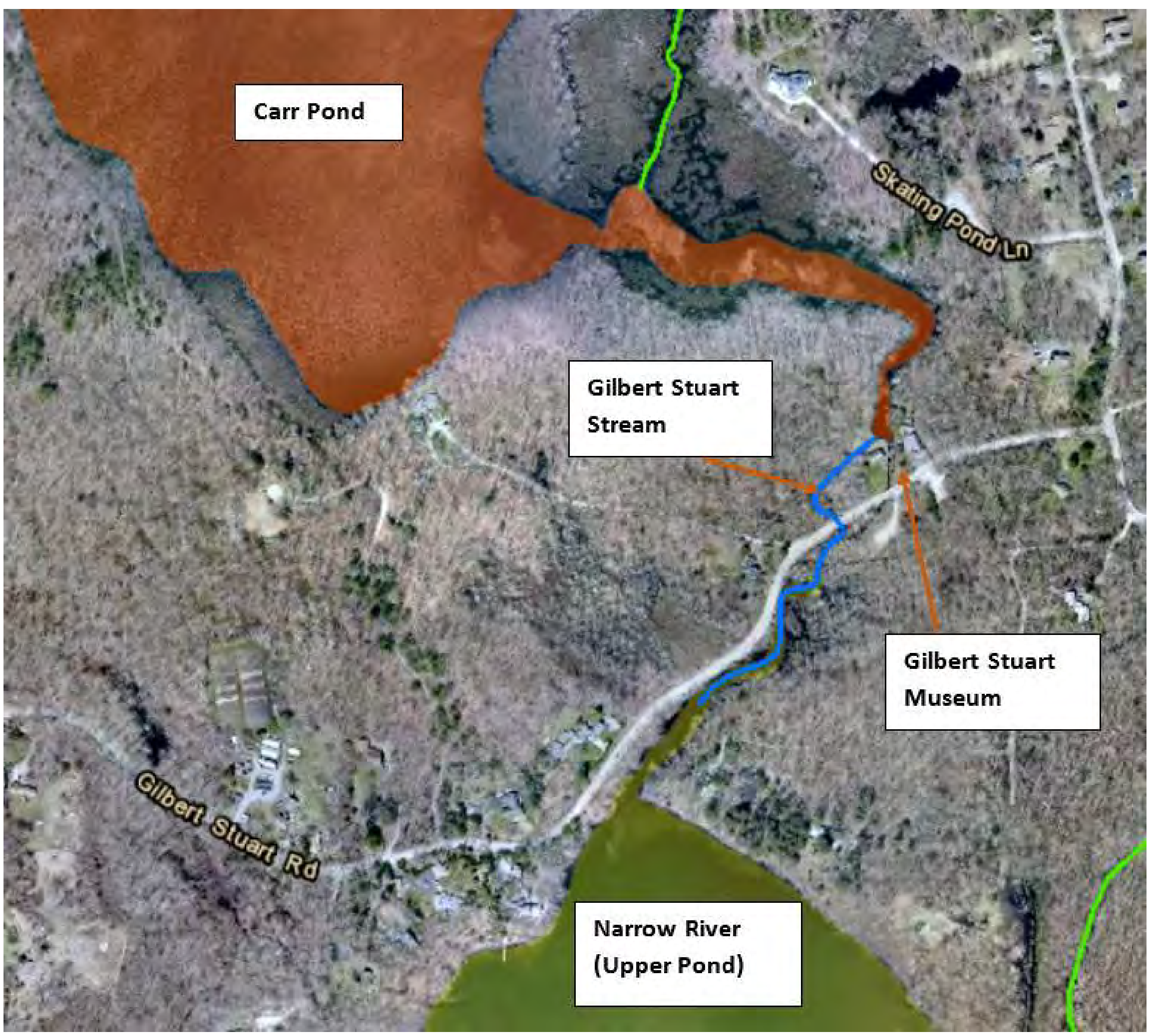
This river is designated Class B for fish and wildlife habitat and primary and secondary recreation, and its water quality condition is such that it supports these uses, however the river has not been assessed for fish consumption.

No assessment has been conducted pertaining to the condition of this river's riparian buffer, associated wetlands, geomorphology, or stream bank and bed conditions.

Gilbert Stuart Stream

Gilbert Stuart Stream is the southernmost portion of the Mattatuxet River, flowing south of the dam for Carr Pond at the Gilbert Stuart Birthplace & Museum to the Upper Pond of the Narrow River Estuary. However, it has a different use designation than the upper parts of the river. This section is designated Class A for fish and wildlife habitat, primary and secondary contact recreational activities, and shall have excellent aesthetic value. This portion of the river has been assessed for water quality and is fully supporting all designated uses. This stream flows under local Gilbert Stuart Road.

In the past, as of the time the Bacteria TMDL was being developed for the Narrow River, this stream had very high fecal coliform bacteria levels, and it was placed on the State's 303 (d) List of Impaired Waterbodies in 2000. It was suspected that an outhouse that was in use at the museum was likely to be the source of the bacteria. In accordance with the mitigation recommendations in the TMDL, action was taken to remove the outhouse, and the bacteria levels upon subsequent testing decreased to the point where this stream met the state water quality standard for bacteria, and it was removed from the Impaired Waters list in 2008. (See 319 Success Story, next page.)



Section 319

NONPOINT SOURCE PROGRAM SUCCESS STORY

Rhode Island

Outhouse Removal Eliminates Source of Bacteria

Waterbody Improved Rhode Island placed Gilbert Stuart Stream on its 2000 303(d) list of impaired waters because it did not meet the state's fecal coliform bacteria water quality standard. The bacteria impairment was caused by an outhouse near the shore of a pond that serves as the stream's source. After removing the outhouse, bacterial levels dropped, and the segment now meets water quality standards. Rhode Island removed the stream from its list of impaired waterbodies in 2008.

Problem

Gilbert Stuart Stream is the largest freshwater tributary to Narrow River and an important anadromous fish run. Narrow River is in southern Rhode Island, west of Narragansett Bay. Its watershed lies within the towns of North Kingstown, Narragansett and South Kingstown. Gilbert Stuart Stream originates at the discharge spillway of Carr Pond at the Gilbert Stuart Museum historical site in North Kingstown, travels approximately 0.3 km through hardwood wetlands and terminates at the northern end of Upper Pond, which is the beginning of the Narrow River (Figure 1). The surrounding watershed is sparsely settled with several camps and low-density residential development. Local organizations and the general public enjoy hiking, camping and canoeing in the watershed.

Figure 1. An aerial view of the project location. Inset pictures show a fish ladder at the Carr Pond Dam (top left) and two views of the Gilbert Stuart Museum site (right).

Water quality monitoring data collected during the development of the Narrow River Total Maximum Daily Load (TMDL) for pathogen impairments indicated that Gilbert Stuart Stream's fecal coliform (FC) levels were sporadically very elevated and consistently violated the state's bacteria water quality standards. Rhode Island classifies Gilbert Stuart Stream as a Class A waterbody. The water quality standard for fecal coliform (an indicator of pathogen contamination) in Class A waters requires that concentrations do not exceed a geometric mean value of 200 MPN (per 100 milliliters (mL), and not more than

10 percent of the total samples shall exceed a value of 400 MPN/100 mL, where MPN is the most probable number.

Rhode Island Department of Environmental Management's (DEM's) 1999 water quality data showed that, at a sampling station immediately downstream of the Gilbert Stuart Museum, the dry-weather geometric mean of the stream was 182 FC/100 mL, while the wet-weather geometric mean was 573 FC/100 mL. The calculated weighted-geometric mean for the segment was 290 FC/100 mL, and the 90th percentile value was 4,320 FC/100mL. DEM determined that Gilbert Stuart Stream did not meet standards necessary to support its designated use (primary recreation) and added the stream to its 2000 303(d) list of impaired waters.

Project Highlights

DEM determined that human activity was likely the dominant source of fecal coliform bacteria. A failing septic system at the Gilbert Stuart Museum (at the headwaters of the stream) was replaced around 1997; however, fecal coliform concentrations in the stream remained elevated. During the 1999 sampling effort, the primary source of fecal coliform contamination to the stream was localized to the Gilbert Stuart Museum property (Figure 2). DEM identified an outhouse within 35 feet of Carr Pond as the probable source. Museum curators agreed to replace the outhouse with a portable toilet in 1999. Removal of this outhouse was the only remedial measure deemed necessary for Gilbert Stuart Stream in the Narrow River TMDL report.

Figure 2. The Gilbert Stuart Museum and waterwheel.

Results

Data indicate that Gilbert Stuart Stream water quality has improved significantly. Project partners collected and analyzed 29 water samples from 2000 to 2005. Results show a geometric mean of 45.75 FC/100 mL with only 2 of the 29 samples exceeding 400—a drastic decrease in fecal coliform levels. The stream now meets the state's Class A water quality standard and supports its designated use for primary recreation. Therefore, Rhode Island removed the stream from its 303(d) list in 2008.

Partners and Funding

University of Rhode Island Watershed Watch volunteers contributed to the water quality monitoring effort. Rhode Island DEM used Clean Water Act section 319 funding to develop the Narrow River TMDL.

U.S. Environmental Protection Agency
Office of Water
Washington, DC

EPA 841-F-08-001J
August 2008

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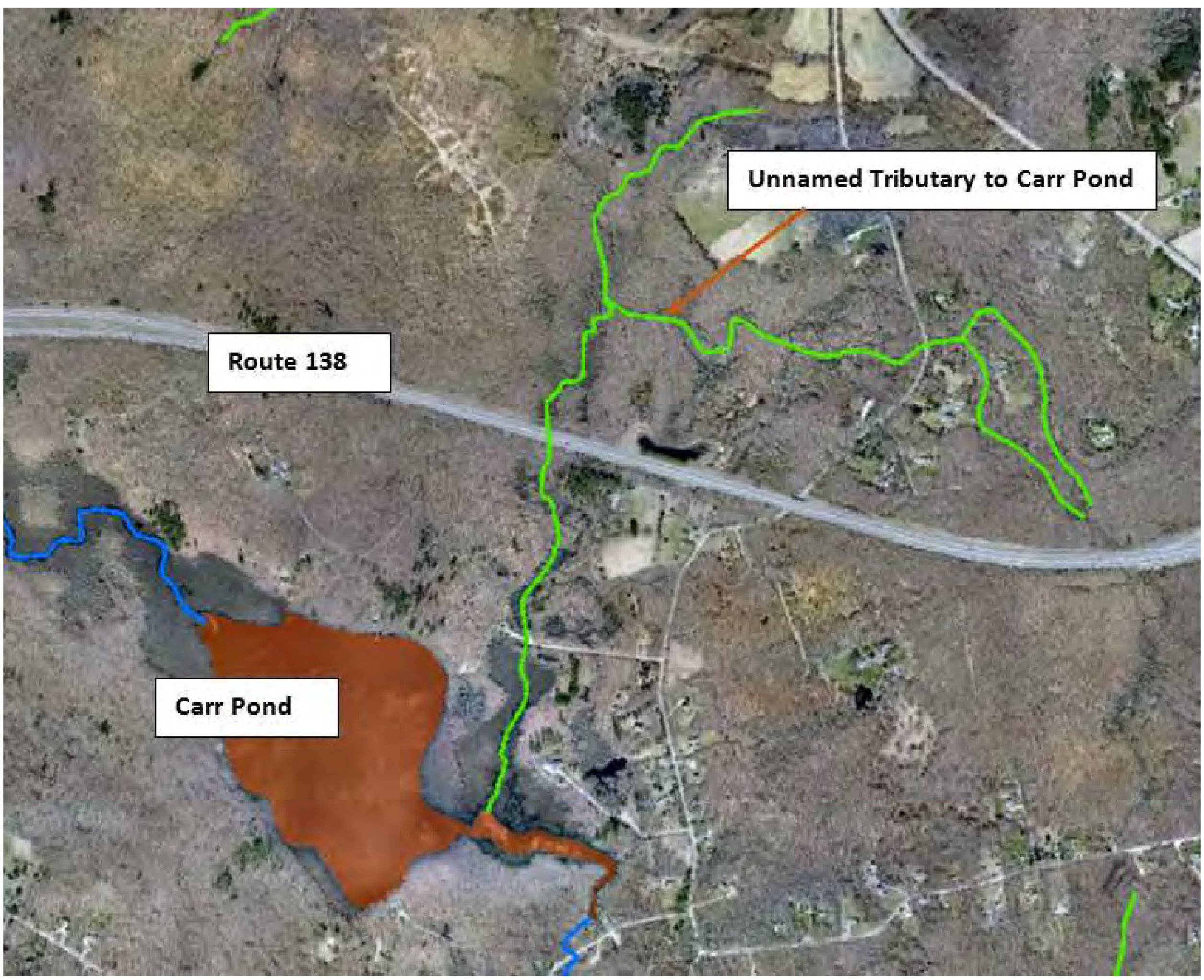
According to NRPA Watershed Watch data, Gilbert Stuart Stream has relatively low Total Nitrogen, Ammonia, and Nitrate + Nitrite values.

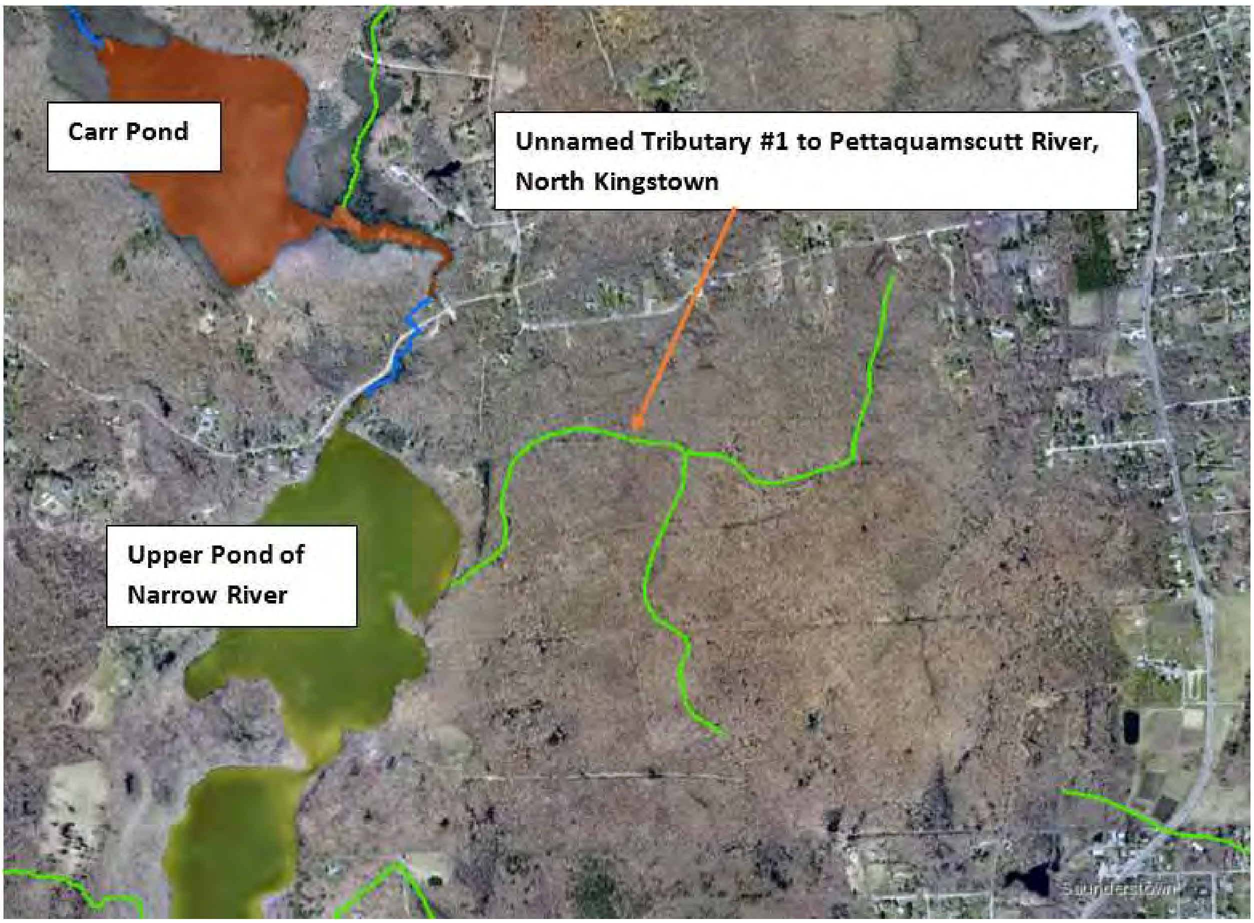
No assessment has been conducted pertaining to the condition of this section of the river's riparian buffer, associated wetlands, geomorphology, or stream bank and bed conditions.

Unnamed Tributary to Carr Pond
Waterbody ID RI0010044R-04
This stream flows from the north side of Route 138 in North Kingstown through mostly undeveloped land into the north side of a narrow portion of the Carr Pond (/Mattatuxet River?). Two lower order branches to it each cross under Gilbert Stuart Road, and the main stem passes under Route 138 and then through some private access ways and a driveway on its way through a wetland connected to the Carr Pond. This waterbody has not been assessed for water quality or aquatic habitat condition.



Unnamed Tributaries to Pettaquamscutt (Narrow) River # 1 through #5, and Mettatuxet Brook

Waterbody ID RI0010044R-05
Unnamed Tributary # 1: (potentially aka “Girl Scout stream”)
This freshwater tributary to the Narrow River flows through undeveloped land in North Kingstown, mostly consisting of the Dave King Preserve/Girl Scout Camp owned by The Nature Conservancy, and the adjacent Casey Farm owned by Historic New England, into the east side of Upper Pond. This tributary is well protected with ample vegetated buffer. This waterbody has not been assessed for water quality or aquatic habitat condition. A substandard culvert for wildlife passage has been identified here.



Waterbody ID RI0010044R -06

Unnamed Tributary #2: (potentially aka "Crew Brook")

This waterbody flows east from the Mayo Farm Pond on the west side of Route 1 (Tower Hill Road) in North Kingstown, through undeveloped land, half of which is owned by the Narrow River Land Trust, then through Lafarge Point Park where it enters the west side of Lower Pond. This waterbody has not been assessed for water quality or aquatic habitat condition.

Waterbody ID RI0010044R-07

Unnamed Tributary #3: (potentially aka "Seven Farms stream")

This small stream begins in a wetland complex within the Seven Farms conservation development in North Kingstown, and flows northwest under Carpenter Lane, then southwest into the east side of Lower Pond, where there is a conservation buffer along the pond. This waterbody has not been assessed for water quality or aquatic habitat condition.

No Waterbody IDs
Walmsley Brook:
(and Walmsley Lane Culvert)

The Walmsley Brook begins in a forested wetland just north of a point between Wintman Drive and High Ridge Drive in South Kingstown. (This waterbody is south of Unnamed Tributary #2 to the Pettaquamscutt River.) The brook flows north through forested wetland, and along the

west edge of some residential fields where it turns to flow northeast and under Bridgetown Road, where it continues east-northeast under Walmsley Lane and into the lower west side of the Lower Pond segment of the Narrow River. This area appears as an intermittent stream in the RI Soil Survey book. There is a storm drain on Bridgetown Road that discharges into this brook (and probably a culvert under the road here). A paved waterway takes stormwater off Walmsley Lane into a swale that discharges into the Brook before it passes under the road through a stone culvert (identified outfall SK-311).

This waterbody does not have a RIDEM Waterbody ID. It was identified in the Narrow River TMDL as a smaller tributary to the Narrow River which stops flowing in the warmest summer months, but which was sampled when flowing in Spring and early Summer during a previous water quality study, called the "Narrow River Storm Water Management Study Problem Assessment and Design Feasibility" by Applied Science Associates (ASA), RI Watershed Watch, SAIC Engineering, Inc. and UWR completed in 1995. It was not sampled by RIDEM during the 1999 TMDL water quality sampling. However, it is an identified dry weather and wet weather source of bacteria to Lower Pond. (though much lower amounts than other sources)

There is another small intermittent stream just north of it which also flows under Walmsley Lane and is called "Walmsley Culvert" in the Narrow River TMDL (outfall SK-418).

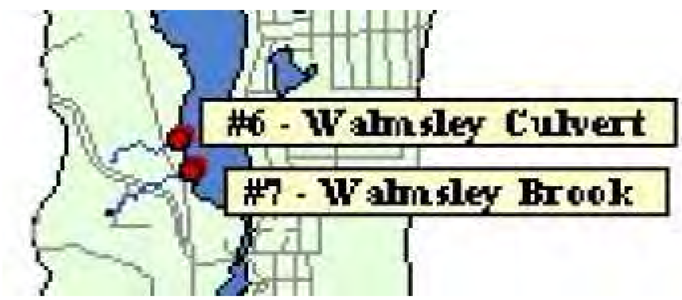


Figure 21. Excerpt from map Figure 3.3 in Narrow River TMDL, 2001, depicting the Tri-Town Study Tributary Monitoring Locations from 1993, which was discussed in the TMDL.

No Waterbody ID

Mettatuxet Brook:

Mettatuxet Brook is in Narragansett just north of Unnamed Tributary #4 and originates in a deciduous forested wetland extending from west of River View Road to east of Tupelo Trail. The brook flows from a stormwater discharge point around Sumac Trail in a southerly direction along the west boundary of a section of the John H. Chafee Wildlife Preserve, which is surrounded by the densely developed Mettatuxet neighborhood, then flows southwest through some conservation land from the North Bay Drive subdivision, and then west-southwest through another parcel of the John H. Chafee National Wildlife Refuge where it discharges into the Narrow River (in ‘Segment 4’ used for the Bacteria TMDL). It crosses under local West Bay Drive.

This waterbody has not been assigned a Waterbody ID by RIDEM, does not have a designated Use Classification, and has not been assessed through the ARM program. However, this freshwater brook is monitored by NRPA at location NR-11 and was also tested for water quality during the development of the Narrow River Bacteria TMDL. This brook has high levels of fecal coliform bacteria, exceeding both the shellfishing consumption and safe swimming standards. According to the TMDL, the Mettatuxet Brook is an identified dry weather source and wet weather source of bacteria to Segment 4 of the Narrow River. However, the stream ran dry during the summer of 1999 when RIDEM was conducting the testing, and it was therefore considered an insignificant dry weather source of bacteria to the Narrow River (compared to the continually flowing freshwater tributaries). The TMDL contemplated sources of bacteria to this brook and recommended a mitigation measure of 'illicit discharge to storm sewer detection and elimination' for the Mettatuxet and Rio Vista neighborhoods and to 'reduce stormwater loadings by educating residents, addressing all direct discharge outfalls, and nonpoint source and storm sewer good housekeeping practices such as connecting to municipal sewers, restoring vegetated buffers around the river and tributaries, and education and actions pertaining to waterfowl, pet waste, septic system maintenance, and household fertilizers.'

Since flow in the Mettatuxet brook originates as storm drain discharge, the TMDL noted that it was understandable that the wet weather fecal coliform concentrations observed in Mettatuxet Brook were consistent with those observed at other storm drain outfall locations during the wet weather events. Sources of bacteria could come from anywhere in this sub-drainage area to this outfall. Though the TMDL recommended structural and nonstructural BMPs for this outfall, this subwatershed was not assessed in the Narrow River Stormwater Abatement Study completed in November of 1996, which assessed and planned other stormwater BMPs throughout this area in Narragansett. The Town of Narragansett may wish to revisit this opportunity for a potential stormwater BMP.

According to NRPA Watershed Watch data, the Mettatuxet Brook also has very (extremely) high Total Nitrogen and Nitrate + Nitrite values.

Waterbody ID RI0010044R-08

Unnamed Tributary #4:

This tributary runs from a forested wetland east of the power line easement in Narragansett, west through open space land of the South Bay Drive conservation development, under Leeann Drive, and through undeveloped land where it discharges at a salt marsh on the east side of the lower river. This waterbody has not been assessed for water quality or aquatic habitat condition.

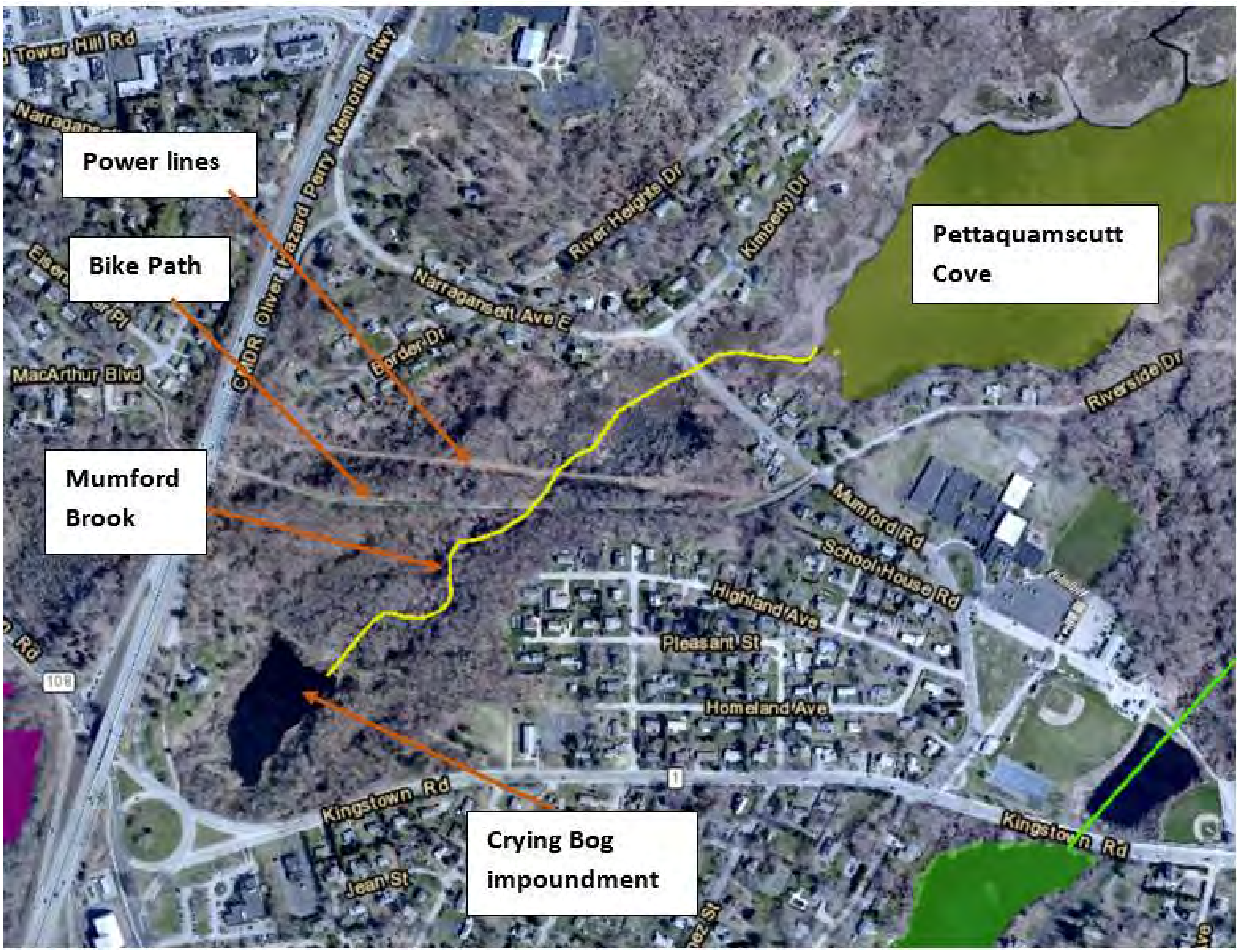
Waterbody ID RI0010044R-09

Unnamed Tributary #5:

This tributary originates from a forested wetland east of Route 1 and on the north side of Faraway Road in South Kingstown, and runs across Faraway Road through undeveloped land. It discharges at a salt marsh to the west side of Pettaquamscutt Cove at the Audubon Society of RI's Shadblow Preserve. This waterbody has not been assessed for water quality or aquatic habitat condition.

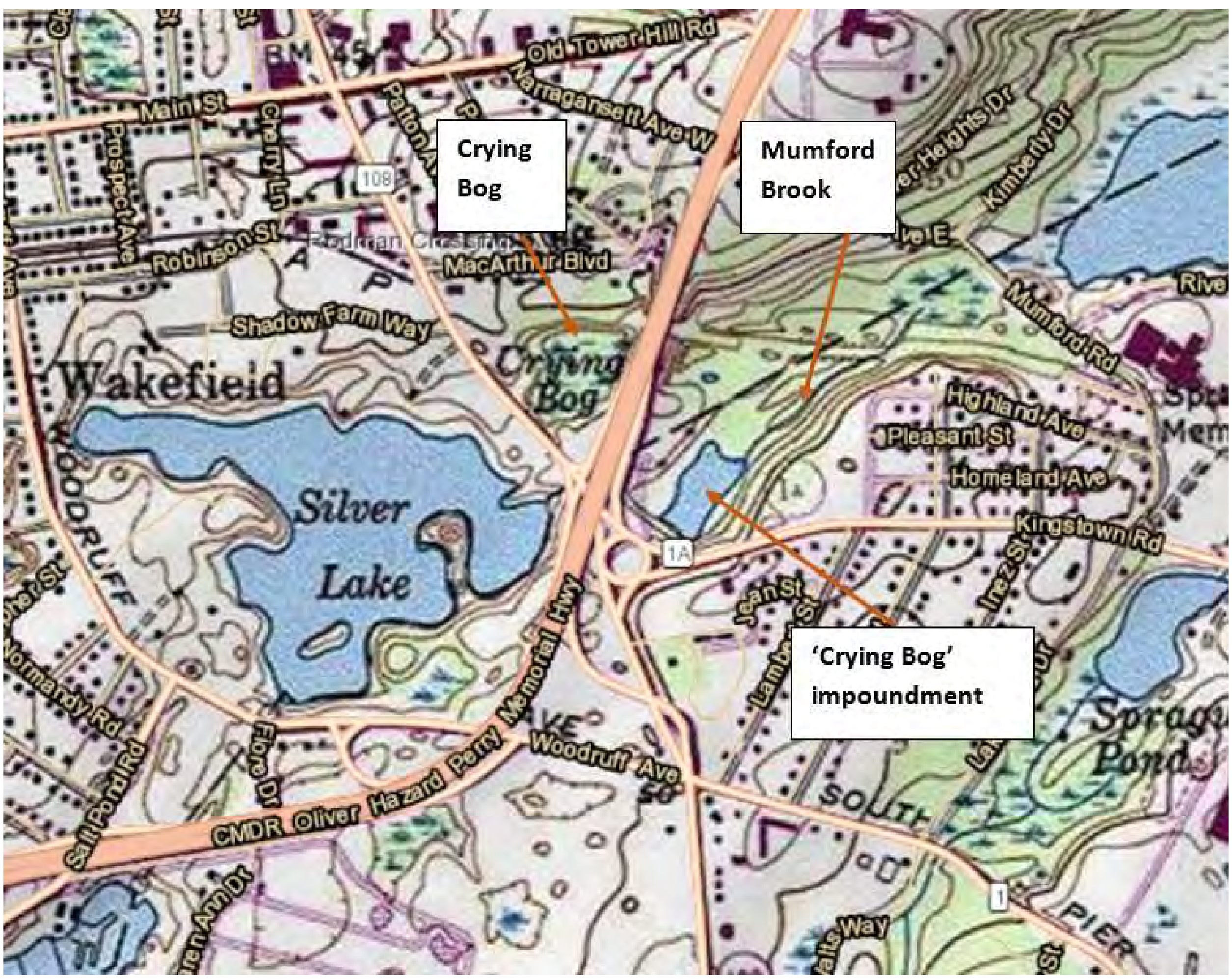
Mumford Brook

Mumford Brook is a tributary to the Narrow River at the southwest point of Pettaquamscutt Cove, contributing the most volume of water to the cove. It is the second largest contributing tributary of flow to the Narrow River. It provides fish and wildlife habitat resources. The brook originates from an unnamed impounded open body of water (called the 'Crying Bog' for dam management purposes) which is located in the northeast quadrant of the interchange of Route 1 and Kingstown Road. This waterbody may have been connected to the Crying Bog located on USGS Topography Map between Route 108 and Route 1. The brook flows northeast though undeveloped wetlands and crosses the William C. O'Neill Bike Path and a power line easement before continuing through wetland complexes in land of the John H. Chafee National Wildlife Refuge. The brook then crosses under Mumford Road and continues through another small portion of the National Wildlife refuge and some estuarine emergent wetlands (salt marsh) where it discharges into Pettaquamscutt Cove.



Mumford Brook is listed as impaired by fecal coliform bacteria for exceeding the water quality standard for primary and secondary contact recreation. It has been identified in the Narrow River Bacteria TMDL as having the highest fecal coliform levels of any tributary to the river, contributing both dry and wet weather sources of bacteria to Pettaquamscutt Cove. The TMDL suspected primarily human wastewater sources, with wildlife and stormwater runoff as secondary sources. More specifically, the TMDL suspected failing septic systems in the vicinity of East Narragansett Avenue and Mumford Road in South Kingstown. More recent data from NRPA Watershed Watch monitoring shows that this brook still has extremely high fecal coliform and enterococci bacteria levels. The canine field investigation that took place in Summer of 2018 detected the presence of sewage in the storm drain system all along Mumford Road in Narragansett up to Highland Avenue and around School House Road and Therese Street. The canines also detected the presence of sewage in the storm drain system in the Town of South Kingstown on the entire length of Narragansett Avenue East. The canines also detected sewage at the base of the hill on River Heights Drive. These areas are planned for further investigation, as noted in Section IV. A) 4).

Most of the extent of the brook appears to be well vegetated and protected. Aside from potential failing septic systems or leaking sewer pipes, it is likely that the brook is influenced by the source pond, which receives runoff from the highway and an extensive amount of road network around it. There are also some areas of open grass in close proximity to this pond. The presence of wildlife, such as birds roosting under the overpass, and the presence of geese and dogs on the open grassed areas should be investigated.



According to NRPA Watershed Watch data, the Mumford Brook also has very high Total Nitrogen and Nitrate + Nitrite values.

This brook has not been assessed for aquatic habitat, other than the stressors noted above pertaining to the headwater proximity to major road infrastructure and grassed areas, the dam at the upper reach, and the crossings at Mumford Road, the bike path, and the powerlines.

Crooked Brook

Crooked Brook is in the Town of Narragansett. While it is the longest tributary to the Pettaquamscutt Cove, it is the second largest contributing tributary of flow volume to the Cove, and the third largest contributing tributary to the Narrow River (according to ASA report, reflected in TMDL). This brook provides fish and wildlife habitat resources. It flows northerly into the southeasterly side of the Pettaquamscutt Cove and has two distinct branches. The westerly branch, called Sprague Brook, is discussed in the section below.

The easterly branch of the Crooked Brook originates in a forested wetland east of Route 108 and flows north through mostly undeveloped land (some of which is owned or protected by easement by the Town of Narragansett) crossing under Kinney Avenue and South Pier Road. North of South Pier Road, the brook flows through a developed area, with dense residential neighborhoods to the east, and public schools and associated athletic fields to the west, where it also flows exposed (no vegetated buffer) through a former horse farm at the end of Rodman Street.

Continuing north, the brook flows through a parcel of protected land owned by the Town of Narragansett, which abuts Kingstown Road. At this property, there is a deciduous forested wetland and a low hazard dam creating what is called 'Crooked Brook Pond,' however, this may be a seasonal pond due to the dam, which backs up water into the wetland. The brook then flows closely behind the Pier Ice Plant and through some house lots where it then crosses through culverts under a driveway and then under Kingstown Road/Narragansett Avenue, through Sprague Park where there is no vegetated buffer, and then through undeveloped land and wetlands owned by the Town of Narragansett for Canonchet Farm where the Sprague Brook meets up with it. The combined brook continues north through the wetlands of the Canonchet Farm property and travels through salt marshes where it discharges into the Cove.


Sprague Park
Kingstown Rd 1
Narrag
Pier Ice Plant
Prospect Ave
Dam
Catch basin
Atlantic Ave
Crooked Brook
Wetland ('Crooked Brook Pond')
5th Ave
Central St

The Crooked Brook is listed as impaired by fecal coliform for exceeding the water quality standard for primary and secondary contact recreation. It has been identified in the Narrow River Bacteria TMDL as contributing both dry and wet weather sources of bacteria to Pettaquamscutt Cove. Because there was insufficient data for Crooked Brook while the 2001 Bacteria TMDL was being developed for Narrow River, there is a separate TMDL for Crooked Brook.

The 2002 Bacteria TMDL for Crooked Brook identifies the section of the brook flowing between South Pier Road and the confluence with Sprague Brook (called Segment 2 in the TMDL) as having the highest elevations of fecal coliform bacteria in the entire Crooked Brook watershed (which includes Sprague Brook). Identified sources of bacteria in this area were from stormwater runoff from a horse farm; overland runoff and stormwater drainage from the high school and Kingstown Road, where pet waste was also observed; and stormwater drainage from the middle school and high school parking lots and associated fields. Stormwater structural and non-structural BMPs were recommended for a number of specific locations. (See Table 14. Bacteria TMDL Implementation Tracking, in Appendix 3 for details.)

According to the 2002 Bacteria TMDL for Crooked Brook, storm drainage discharge from South Pier Road and wildlife are the identified sources of bacteria to the upper reaches (Segment 1 in the TMDL) of the Crooked Brook. The portion of the brook leading into the Pettaquamscutt Cove (Segment 4) is identified to have sources of bacteria from waterfowl and wildlife. This section of the brook is well protected with vegetation and a lack of development, however, it also had the second highest bacteria levels in the Crooked Brook watershed.

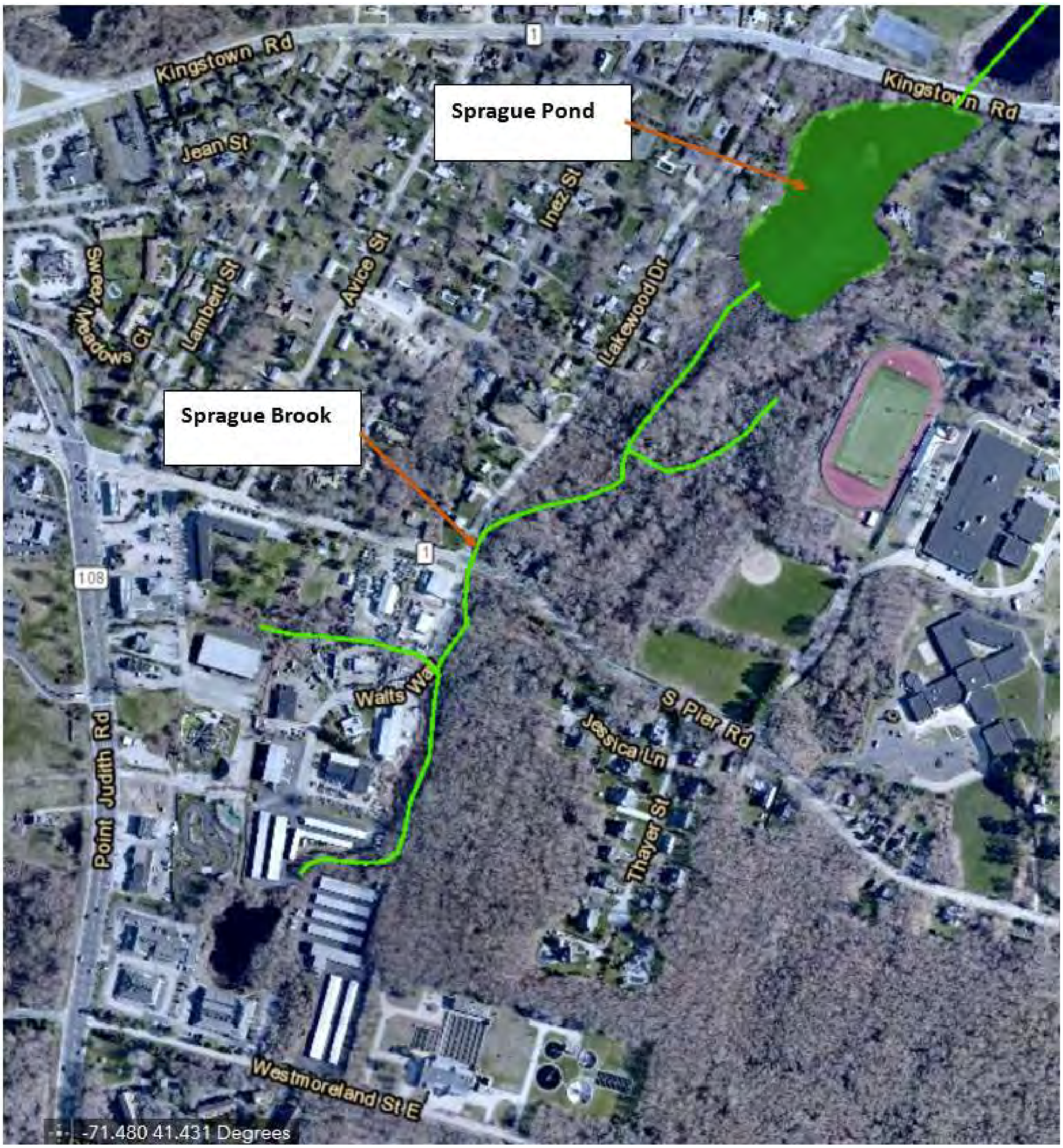
To date, no structural or non-structural stormwater abatement projects have been implemented to address the Crooked Brook TMDL. The Town of Narragansett mentions efforts to monitor the Crooked Brook in their Annual MS4 Reporting for program years 2005, 2006, and water quality monitoring data is included in the 2007 annual report. According to the 2006 annual report, a proposal was submitted to RIDEM to assess feasibility and design BMPs in the Crooked Brook watershed. The 2007 annual report noted the town received a grant to conduct the pathogen reduction study for the Crooked Brook watershed based on the TMDL. However, this study and grant were not pursued. The 2005 annual report notes that no horses were present at the time of the inspection. Additionally, this property was up for sale in 2018. There may be an opportunity for a buffer restoration project at this location.

Since this brook is not included in a monitoring program, the bacterial levels are unknown today. NRPA had conducted a special monitoring project of all the typical Narrow River Watershed Watch testing parameters for freshwater at two spots along this brook—NR-15 and NR-16— for a few years (2005, 2006, and 2007). Bacteria levels were high at that time.

This brook has not been monitored for other water quality parameters, and has not been assessed for aquatic habitat conditions, other than the observations noted above pertaining to the stressors of road crossings, lack of buffer at the horse farm, development proximity, the small dam, and lack of buffer at Sprague Park. In addition to the horse farm, there is an opportunity for a buffer restoration project and potentially a structural stormwater management BMP at Sprague Park for the Crooked Brook.

Sprague Brook

Sprague Brook is a tributary to the Crooked Brook in the Town of Narragansett, flowing in as a western branch to the Crooked Brook. It provides fish and wildlife habitat and recreational resources.



Sprague Brook originates at an impounded pond on the north side of Westmoreland Street, which is surrounded by commercial development. The brook flows northeasterly under a commercial access road, and then flows closely along the back of an industrial developed area to the west, and undeveloped forested land to the east. There is a small tributary to the brook through the middle of the industrial developed area. Continuing northerly, the brook flows under South Pier Road to the east side of Lakewood Drive then northeasterly through a wooded swamp between a densely developed residential area to the west and the athletic fields and high school and middle school to the east. In this area, the book flows in to Sprague Pond where it is dammed at Kingstown Road, and connects under the road to another small dammed pond at Sprague Park which is flanked by Sprague Memorial Field ball fields to its west and east. It then flows under an access road for Sprague Park and the Narragansett Community Center into an undeveloped forested wetland on the Canonchet Farm property where it meets up with the Crooked Brook.

The Sprague Brook has not been listed as impaired or assessed for water quality through the RIDEM ARM program, however it is already included in a TMDL. According to the 2002 Bacteria TMDL for Crooked Brook subwatershed, the sources of bacteria to the Sprague Brook (Segment 3) are wildlife and storm drainage from Kingstown Road and South Pier Road. Mitigation measures recommended in the TMDL for this brook are to install structural and non-structural stormwater BMPs for South Pier Road, and to enforce existing Town pet ordinances. Increased street sweeping was also recommended for South Pier Road to prevent the abundance of winter sand observed in the stream channel.

This brook has not been monitored for other water quality parameters, and has not been assessed for aquatic habitat conditions, other than the observations noted above pertaining to the stressors of commercial, industrial, and residential development proximity; road crossings; the three dams; lack of buffer and proximity to turf and ball fields at Sprague Park; and sediment in the stream channel.