Wood-Pawcatuck Watershed Flood Resiliency Management Plan

Creating Resilient Infrastructure & Watersheds: Strategies for Planning, Implementation, & Funding

July 12, 2017

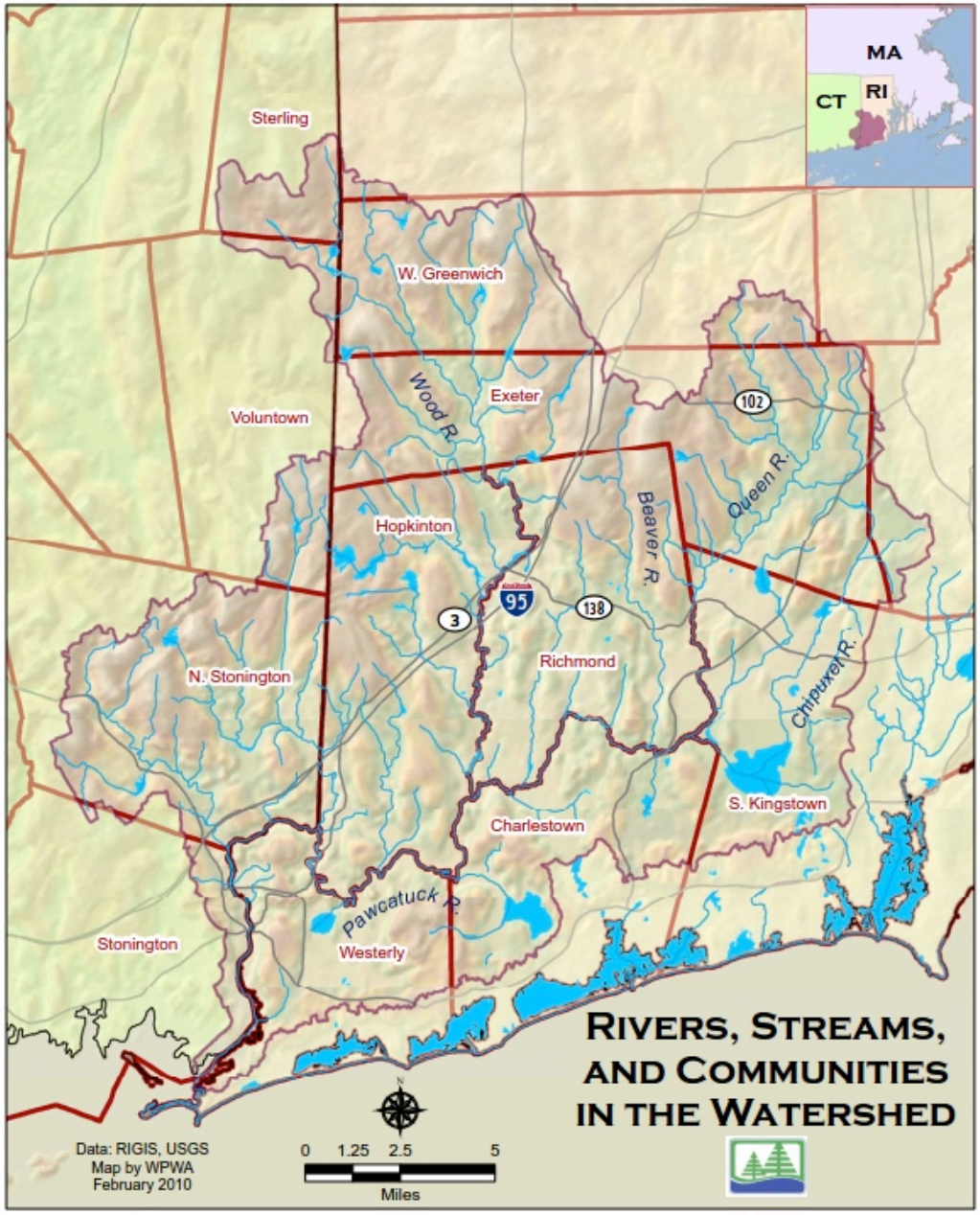
NFWF

Wood-Pawcatuck Watershed Association

FUSS & O'NEILL

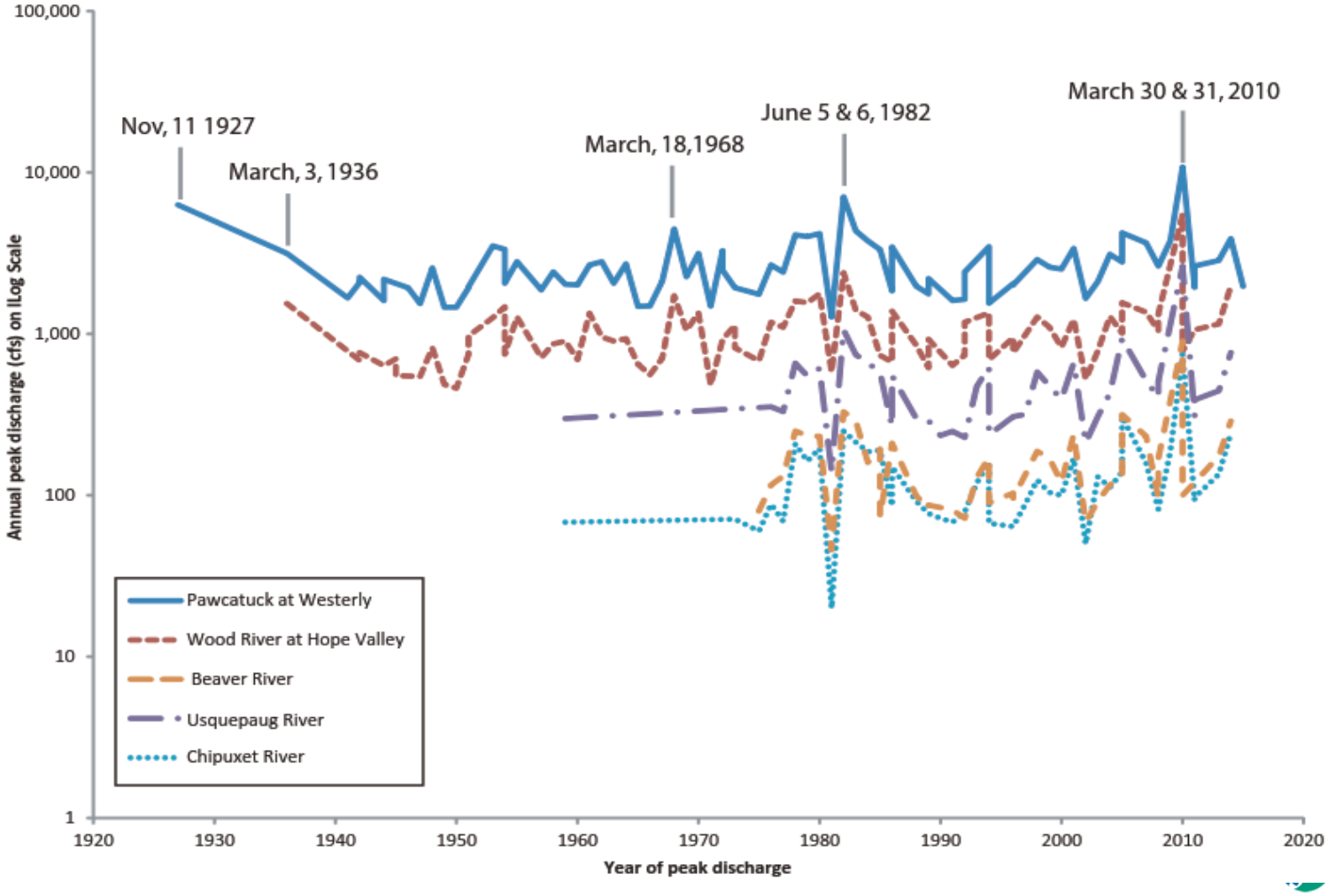
Wood-Pawcatuck Watershed

- 317 mi^2 in RI and CT
- Major portions of 11 municipalities
- 84,000 population
- 380 stream miles
- Drains to Pawcatuck River Estuary and Little Narragansett Bay
- Mostly rural and forested with development in villages/town centers



Flooding in the Wood-Pawcatuck

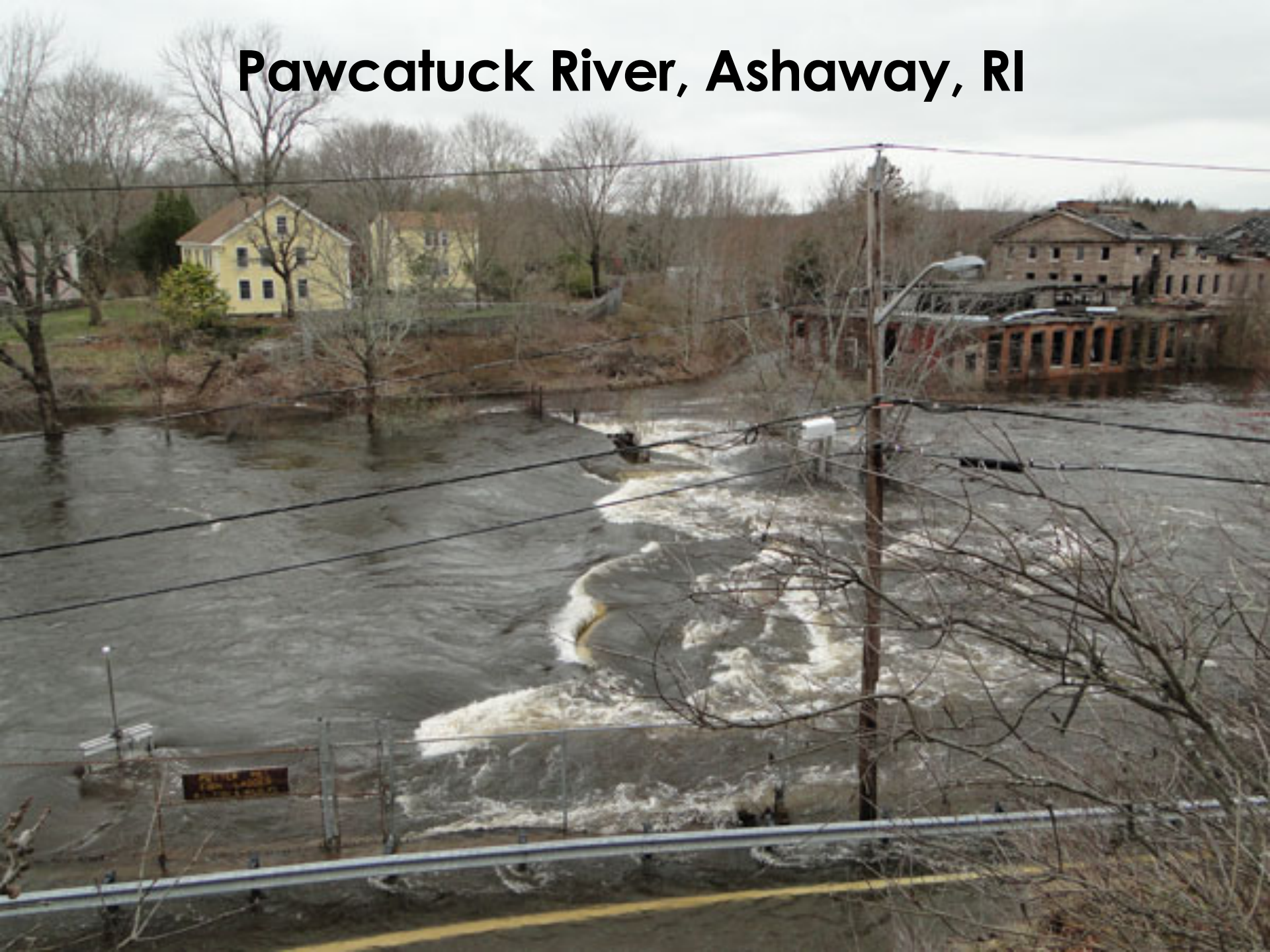
- History of flooding in the watershed
- The Great Flood of 2010 (>"500-Year Flood")




Wood River, Hope Valley, RI


Pawcatuck River,
Westerly, RI

Pawcatuck River, Ashaway, RI



River Corridor & Floodplain Development

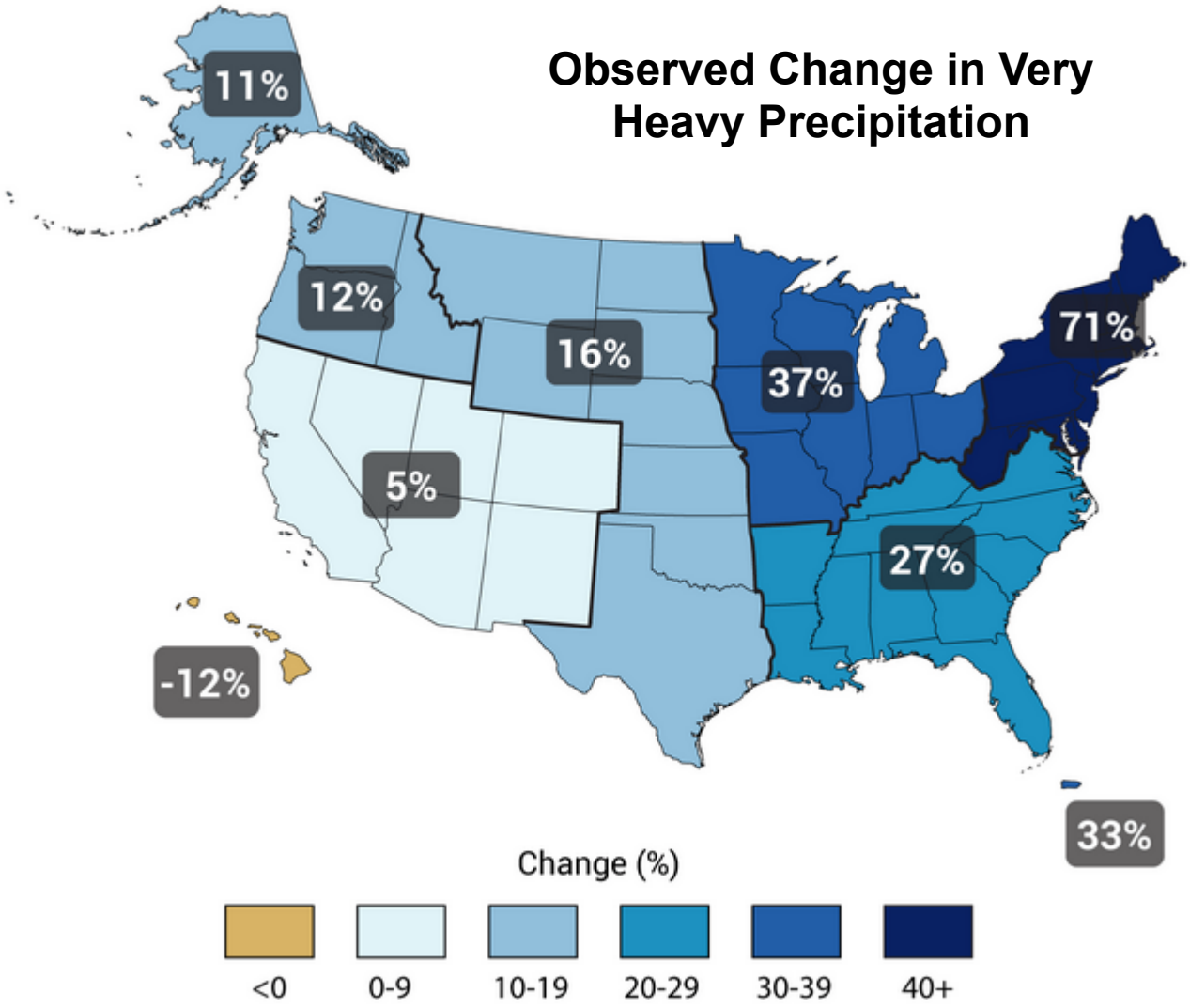

Channel Straightening

Dams and Impoundments

Road Stream Crossings

Natural Green Infrastructure

More Frequent Extreme Storms



Source: Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009

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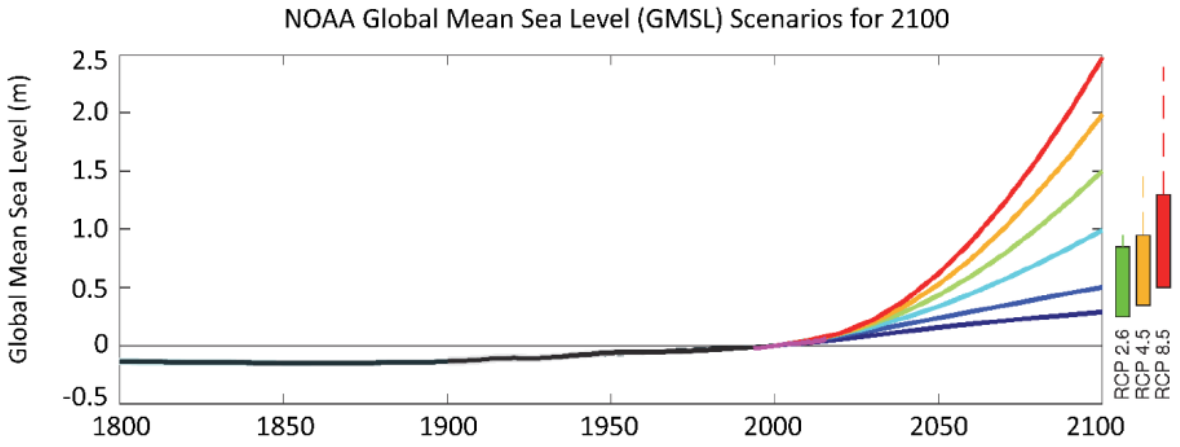
Future Development Pressure

- **Sprawl from nearby urban areas**
- **Inland "retreat" in response to sea level rise**




NOAA Technical Report NOS CO-OPS 083

GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES

Photo: Ocean City, Maryland

Silver Spring, Maryland
January 2017

noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

Hurricane Sandy Coastal Resiliency Grant

- **U.S. DOI & National Fish and Wildlife Foundation (NFWF) competitive grant program**
  - Communities affected by Hurricane Sandy
  - Increase flood resilience
  - Focus on strengthening natural ecosystems

- **NFWF Grant awarded to Wood-Pawcatuck Watershed Association**
  - Development of watershed-based flood resiliency plan
  - Encourage local decision-makers to think more strategically about natural systems approaches

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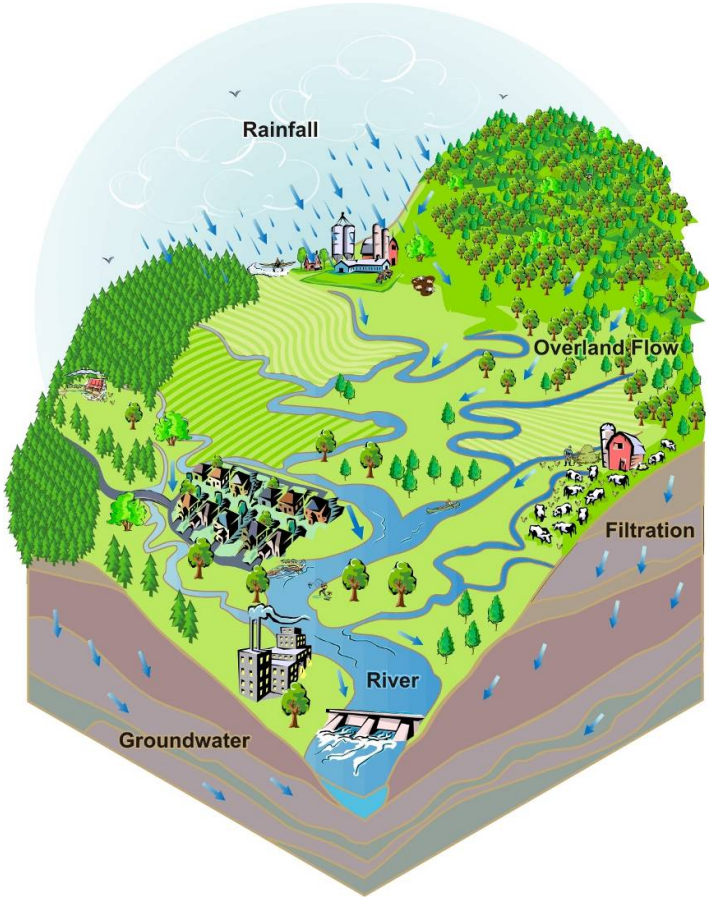
Why Develop a Watershed Plan?

- Water flow does not follow political boundaries
- Upstream activities affect downstream flooding
- Watersheds are logical frameworks to address water resource issues
- Improves chances of success and future funding



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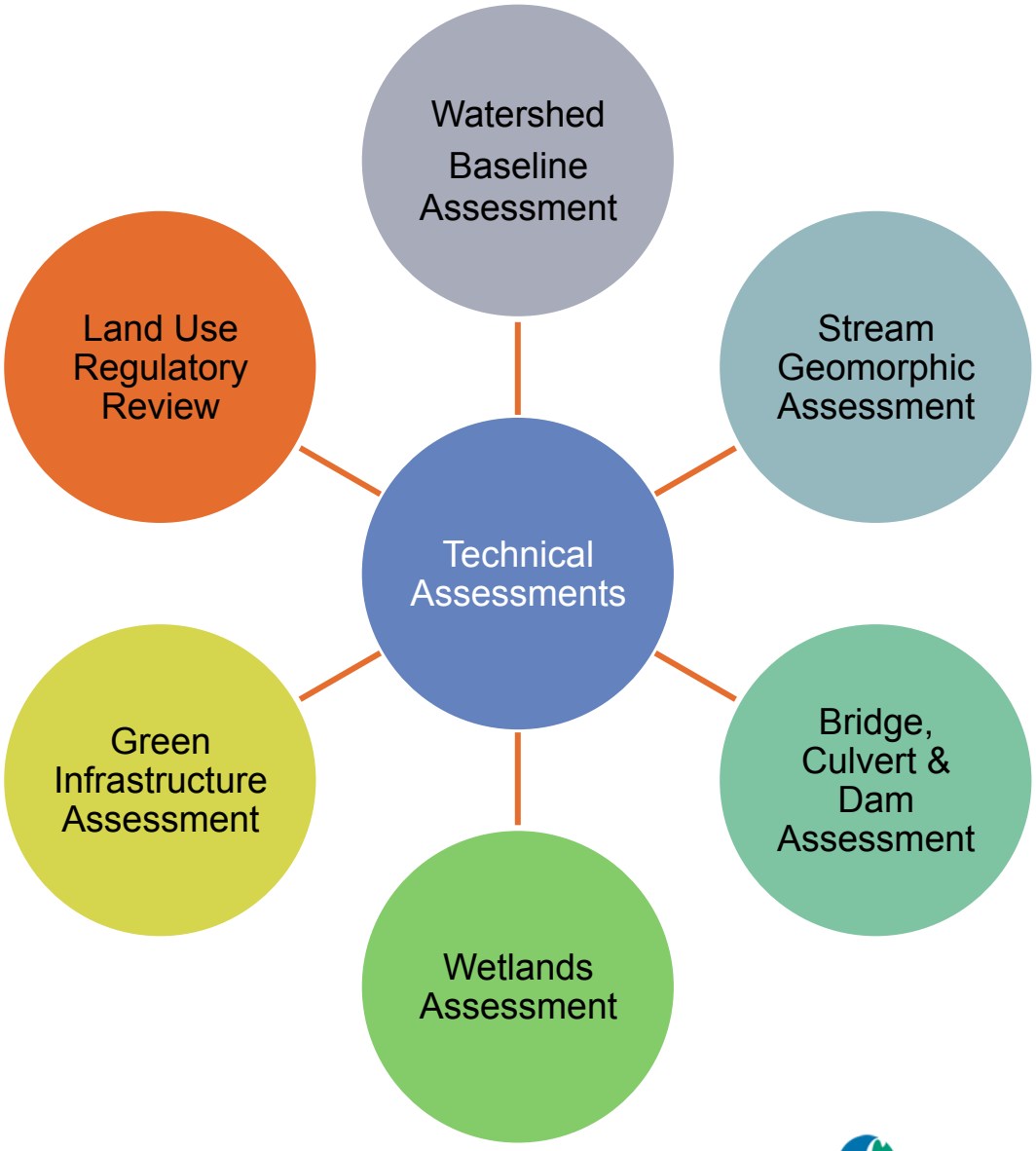
Watershed Planning Process

- **Stakeholder and Community Involvement**
- **Technical Assessments**



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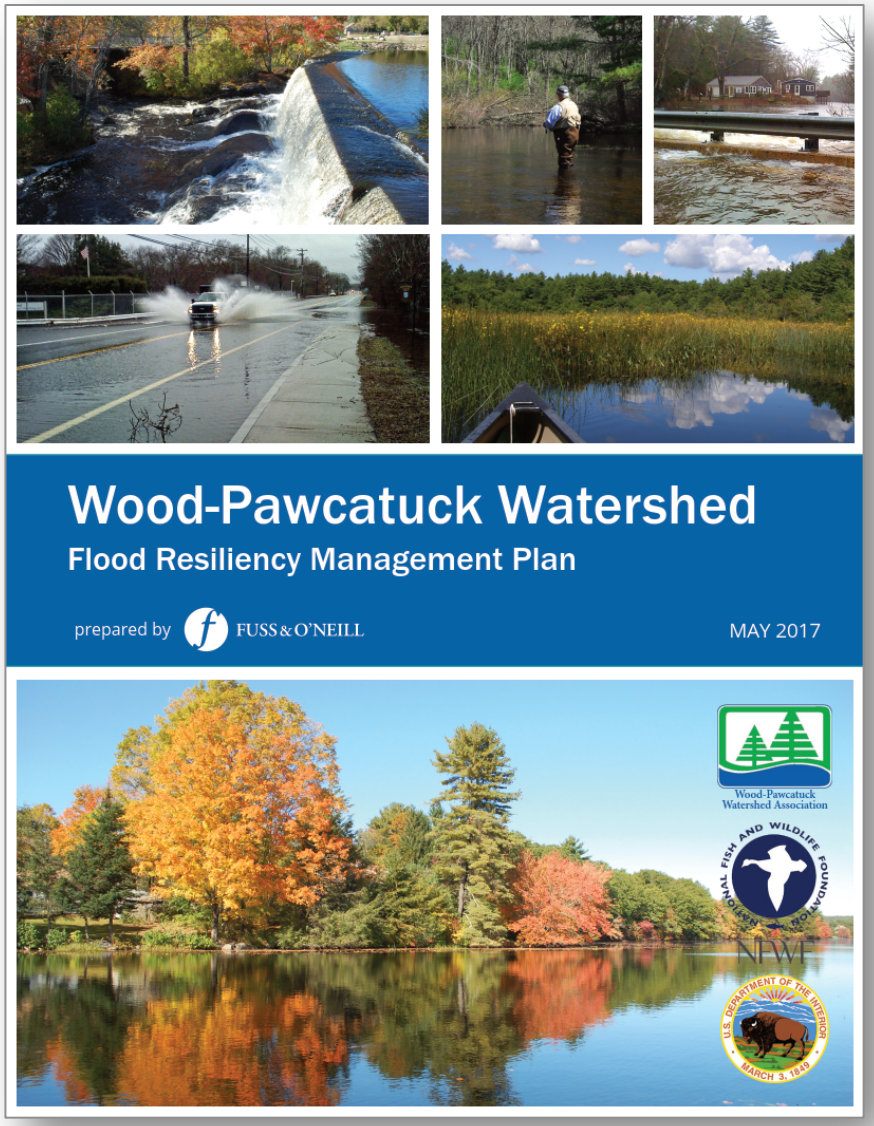
Flood Resiliency Management Plan

- **Watershed Overview**
- **Management Recommendations**
  - Actions
  - Timeframe
  - Lead groups
  - Relative costs
  - Funding sources



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Town Summaries

Recommended Actions Summary
Town of Charlestown, RI

The **Wood-Pawcatuck watershed** is vulnerable to flood-related damages, as evidenced by the devastating flooding that occurred in 2010. The Wood-Pawcatuck Watershed Association, working with the watershed municipalities and partner agencies, has developed a **watershed-based management plan** to enhance the resiliency of the watershed communities to future flooding and protect river and stream ecosystems, including water quality and habitat. The following is a **summary of key findings and recommendations** of the watershed plan for the Town of Charlestown.

Quick Facts – Charlestown

- 66% of town within watershed
- Includes portions of the Pawcatuck River (Charlestown's northern boundary), smaller tributaries, freshwater ponds, and their associated watersheds
- 27 stream crossings assessed
- 1 dam assessed

Road Stream Crossings

- 7 crossings are hydraulically undersized
- 12 crossings have high geomorphic vulnerability
- 11 crossings have high flood impact potential
- 9 crossings limit or restrict aquatic passage

Recommendations:

- Replace and upgrade priority crossings (see table below) to meet flood resilience and aquatic organism passage (AOP) goals
- Consider other upstream and downstream crossings and dams on the same river system
- In general, replace downstream crossings first
- Perform site-specific data collection, geotechnical evaluation, hydrologic and hydraulic evaluation, and structure type evaluation to support design

Priority Stream Crossings (Sorted in Order of Priority)

Road	Stream	Crossing Type
Burlingame State Park - Management Area	Unnamed	Double 24" Concrete Circular Conduit
Burlingame State Park - Management Area	Unnamed	12" Concrete Circular Conduit
Narragansett Trail	Unnamed	12" Concrete Circular Conduit
Buckeye Brook Road	Poquiant Brook	38" and 12" Concrete Circular Conduit (2 total)
Shumankanuac Hill Road	Unnamed	36" Concrete Circular Conduit
Saw Mill Road	Unnamed	12" Concrete Circular Conduit
Kings Factory Road	Pawcatuck River	57'W x 9'H Concrete Bridge
Shannock Road	Pawcatuck River	67.5'W Concrete Bridge; openings 3.3'H 7.8'H
Old Shannock Road	Pawcatuck River	48'W X 9.4'H Concrete Bridge

Dams

- A single low hazard dam – Burdickville Dam – was assessed in Charlestown, on the Charlestown/ Hopkinton border

Recommendations:

Burdickville Dam (Pawcatuck River)

- Consider dam removal
- Burdickville Dam has been partially breached but may currently prevent passage of some fish species, such as shad
- The impoundment does not appear to support any active uses

Burdickville Dam

Dual concrete culverts at a high priority stream crossing in Burlingame State Park Management Area

Project funding was provided by the National Fish and Wildlife Foundation Hurricane Sandy Coastal Resiliency Competitive Grant Program

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Wood-Pawcatuck Watershed Flood Resiliency Management Plan August 2017

Green Infrastructure

A screening-level assessment of potential green infrastructure (GI) retrofit sites was performed within the Wood-Pawcatuck watershed. When applied throughout the watershed, GI can help mitigate flood risk resulting from outdated and undersized storm drainage systems and increase flood resiliency, as well as improve water quality.

Sites Identified for GI Retrofits:

- **Vin Gormley Trailhead Parking**
  - Retrofit parking lot with underground infiltration and a bioretention basin
  - Cost: $123,000
- **St. Mary's Catholic Church**
  - Install a bioretention practice in the grassed island at the Carolina Back Road and Old Carolina Back Road intersection
  - Cost: $143,000

Typical installation of underground infiltration system below an existing parking lot.

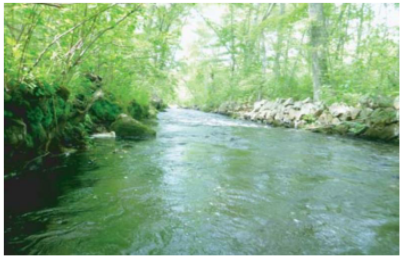
View of a typical bioretention cell with mature plantings.

River Corridor

A detailed geomorphic assessment was performed for approximately 40 miles of rivers and streams in the watershed. Based on the results of the geomorphic assessment, river corridor planning recommendations were developed to identify restoration projects that will reduce flood hazards and downstream sediment loading and improve aquatic habitat.

Recommendations:

- Remove granite blocks confining channel downstream of Route 112 to allow floodplain access; use granite blocks to build in-stream habitat structures
- Protect wetlands, including Indian Cedar Swamp, as well as stream connections to wetlands and floodplains
- Install log jams in select locations along the stream corridor to protect banks, create habitat, and re-form meanders



Granite-lined, straightened mill-race channel with restricted floodplain access, located downstream of Route 112.

Land Use Policy and Regulations

Municipal land use policies and regulations can help communities become more resilient to flooding by:

- Preserving undeveloped land
- Siting development in locations less vulnerable to flooding, and
- Promoting designs that reduce runoff and are less likely to be damaged in a flood

Recommendations:

A review was conducted of the land use policies, plans, and regulations of the watershed municipalities. Key recommendations of this review include:

- Consider adopting a No Adverse Impact (NAI) Floodplain Management policy
- Amend zoning ordinance to strengthen flood management standards
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards
- Consider amendments to the existing conservation/cluster development provisions in the zoning ordinance and subdivision regulations to strengthen flood management provisions
- Amend street and parking lot design standards to reduce impervious cover and remove barriers to LID
- Update design storm precipitation amounts
- Implement road stream crossing standards for new and replacement culverts and bridges

Project funding was provided by the National Fish and Wildlife Foundation Hurricane Sandy Coastal Resiliency Competitive Grant Program

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Recommendations by Category

1. Dams
2. Culverts and Bridges
3. Floodplains and River Corridors
4. Wetlands
5. Stormwater

Dams

- **Over 160 documented dams in watershed**
- **Many no longer used for original purpose and are in poor condition**
- **None constructed for flood control**
- **Backwater during floods and downstream hazard in event of dam failure**
- **Barriers to fish and other aquatic life**
- **Important recreational, habitat, and cultural values**

Objective: *Reduce the flood risk posed by dams in the watershed, and restore the connectivity of streams for fish and other aquatic organism passage.*

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Dams – Field Inspections

- **Dam inspection protocols modified from the Massachusetts Office of Dam Safety (Phase 1 Formal Dam Safety Inspection Checklist)**

Inspection Items
Name, Location, Uses
Size
Hazard Classification
Condition and Deficiencies:
• Embankment
• Dikes
• Upstream Face
• Downstream Face
• Appurtenances
• Concrete Structures
• Masonry Structures
• Spillway

Dams – Alternatives Assessment

- Removal/ Breach
- Repair
- Repurposing
- Aquatic Organism Passage
- No Action/ Maintain

Evaluation Criteria
Hazard Classification
Dam Condition
Owner's Ability to Maintain
Capacity
Benefits vs Loss of Current Uses
Downstream Continuity
Cost effectiveness
Ease of Permitting
Feasibility of Repurposing
Hydraulic Impacts
Wetland Impacts

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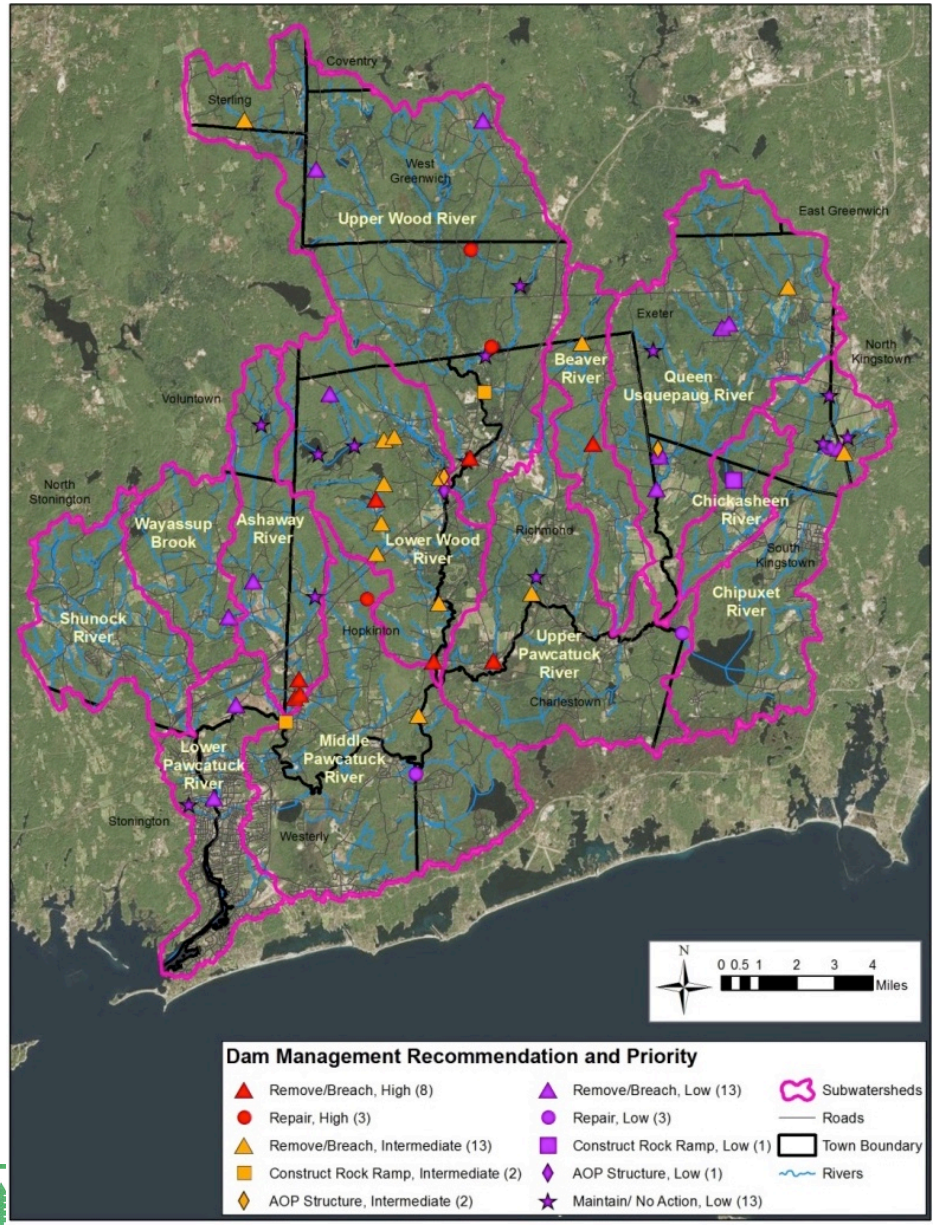
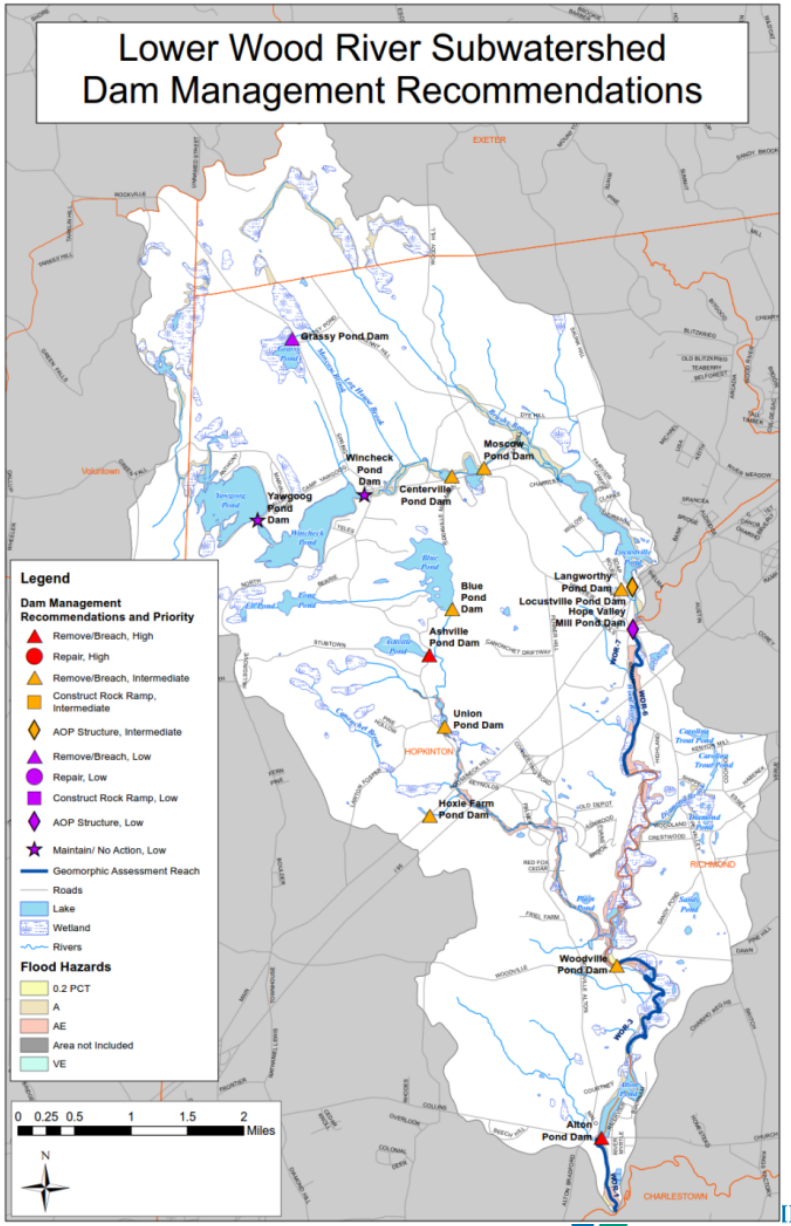
Dams Assessment Results





Dams – Recommendations

- **Incorporate priority dam management recommendations into local hazard mitigation plans**
- **Perform site-specific feasibility studies to confirm feasibility of recommendations and to support design and permitting**
- **Obtain funding for and implement dam removal projects**
- **Dam removal costs are highly site-specific**
  - Most projects: $100,000 to $1 million
  - Lower Shannock Falls Dam (2011): $825,000
  - White Rock Dam (2015): $950,000

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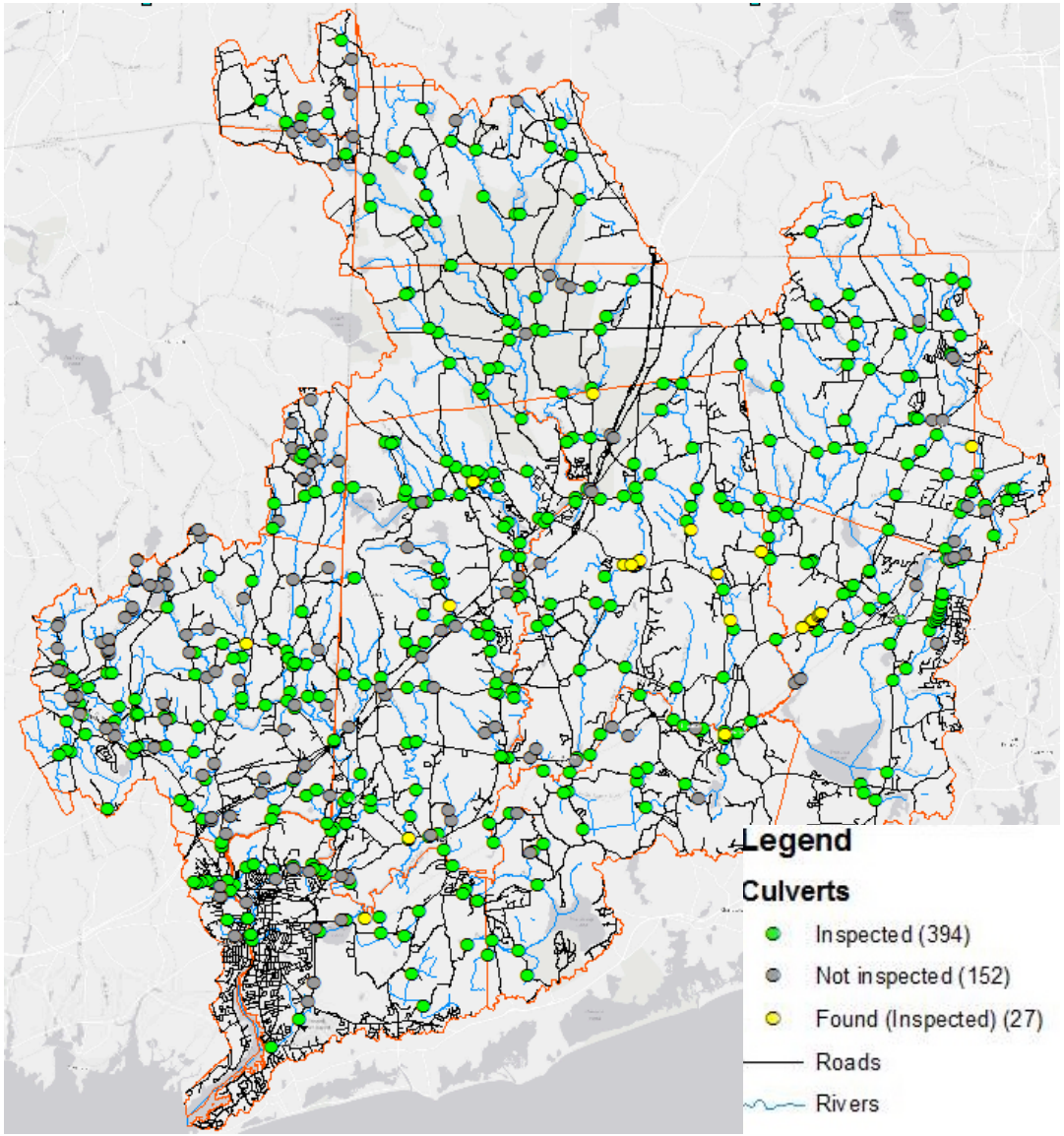
Road Stream Crossings

- **Undersized crossings (culverts and bridges) can be flooding and washout hazards**
- **Barriers to fish and other aquatic life**

Objective: *Reduce the flood risk and erosion hazards posed by culverts and bridges in the watershed, and restore the connectivity of streams for fish and other aquatic organism passage.*

Wood-Pawcatuck Bridges and Culverts

- **573 structures identified using GIS**
- **421 structures were inspected (**May – September 2015)



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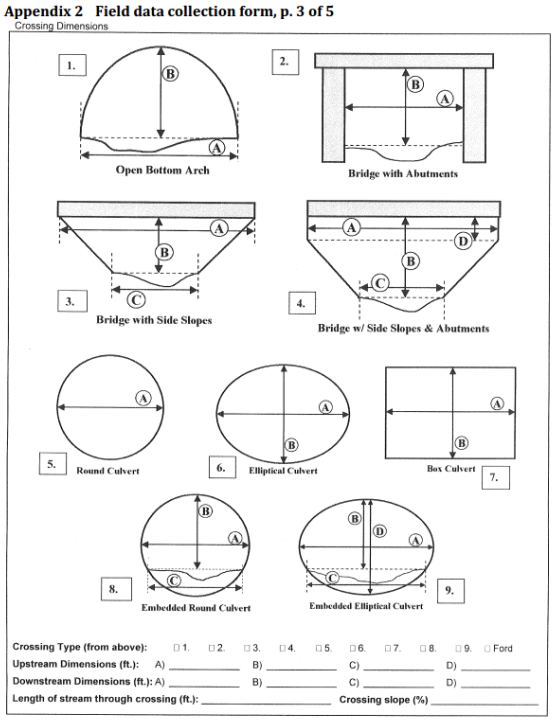
Assessment Approach

- **Adapted from Vermont's Stream Geomorphic Protocols and others used in the Northeast**
- **Information gathered**
  - Site characteristics (e.g. sketch, street name, stream name)
  - Structure dimensions needed to assess hydraulic capacity
  - Deficiencies and condition of the structure
  - Upstream and downstream geomorphic conditions


Appendix 2 Field data collection form, p. 3 of 5

Crossing Dimensions

1. Open Bottom Arch
2. Bridge with Abutments
3. Bridge with Side Slopes
4. Bridge w/ Side Slopes & Abutments
5. Round Culvert
6. Elliptical Culvert
7. Box Culvert
8. Embedded Round Culvert
9. Embedded Elliptical Culvert

Crossing Type (from above): ☐1. ☐2. ☐3. ☐4. ☐5. ☐6. ☐7. ☐8. ☐9. ☐Ford

Upstream Dimensions (ft.): A) _____ B) _____ C) _____ D) _____

Downstream Dimensions (ft.): A) _____ B) _____ C) _____ D) _____

Length of stream through crossing (ft.): _____ Crossing slope (%) _____

VERMONT AGENCY OF NATURAL RESOURCES

UMASS AMHERST

North Atlantic Aquatic Connectivity Collaborative NAACC

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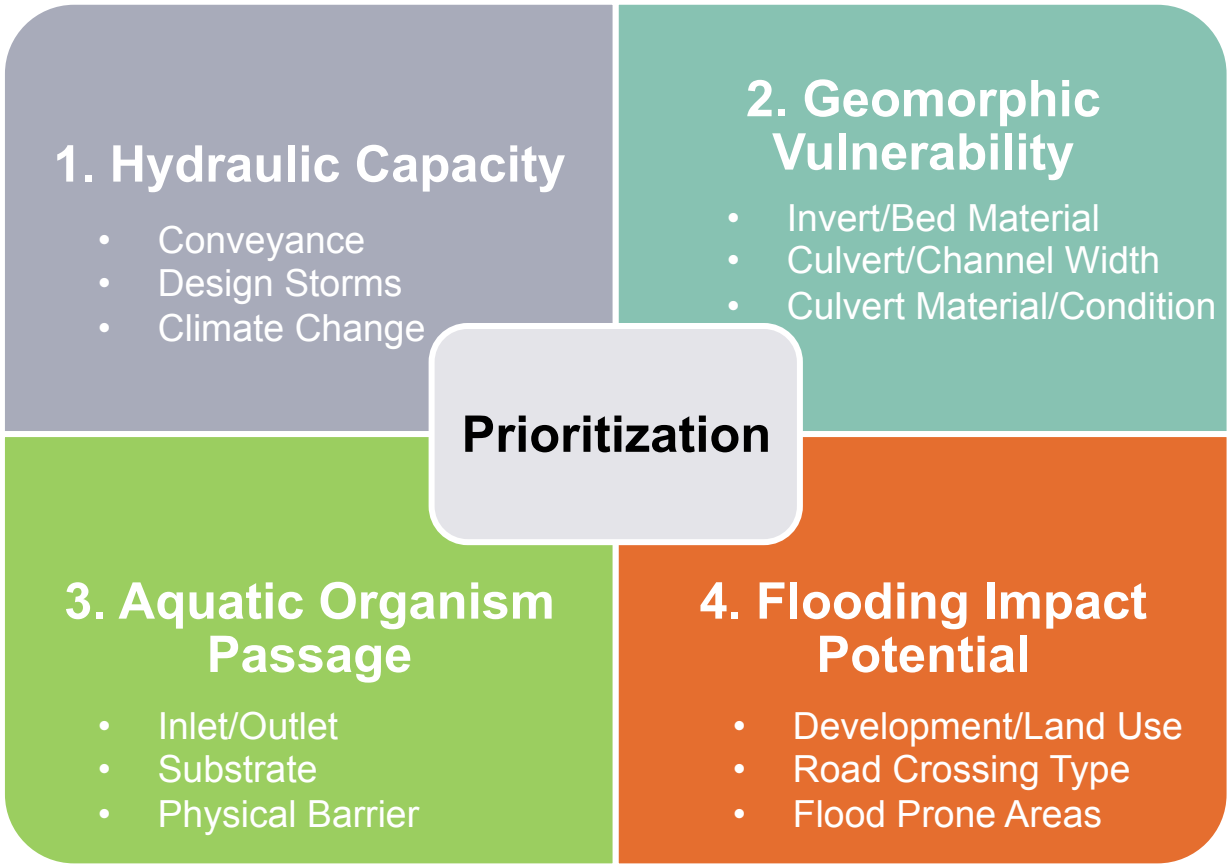
Prioritization Criteria



Road Stream Crossings – Findings

- **38% are presently hydraulically undersized (less than 25-year design flow capacity)**
- **49% will be undersized under a Year 2070 climate change scenario**
- **Only 40% of road stream crossings provide for full passage of aquatic organisms**

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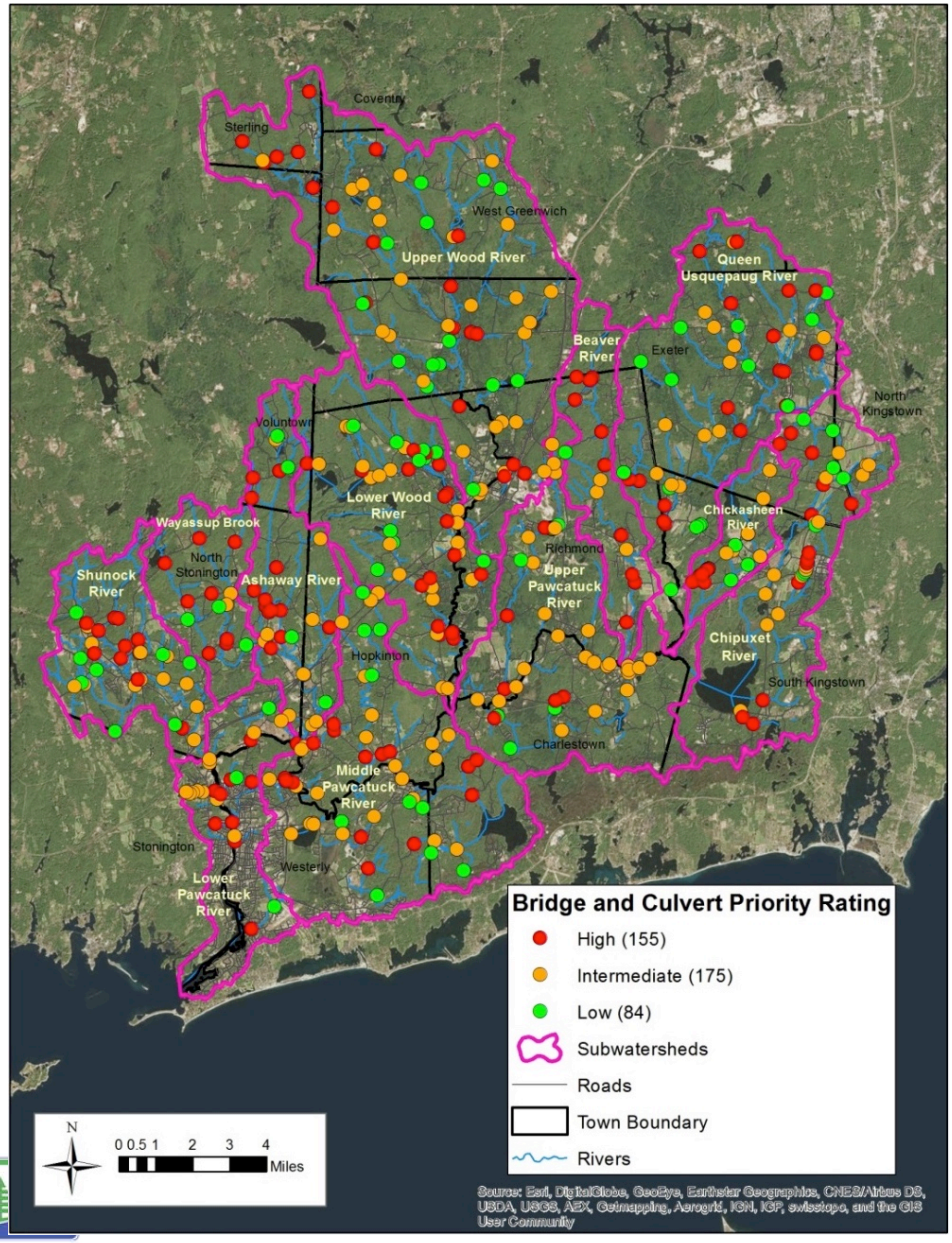
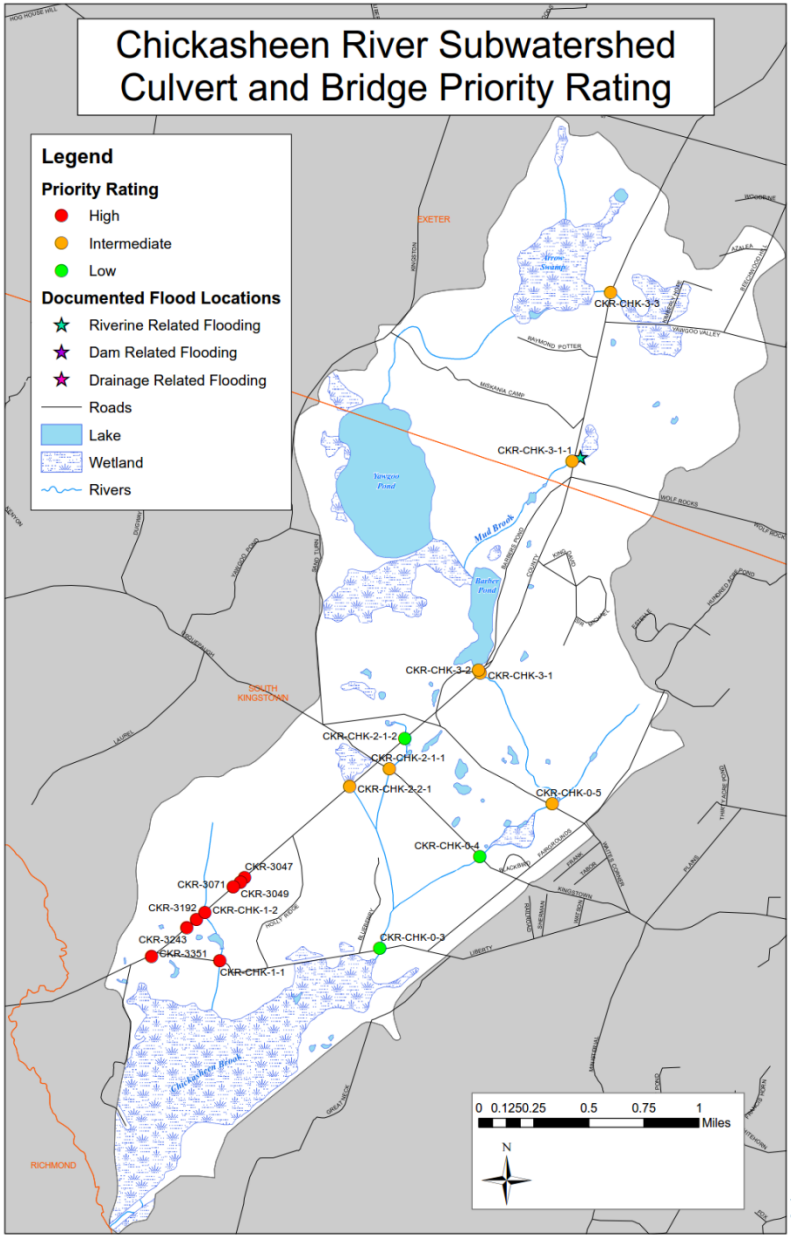
Road Stream Crossings – Priority Ratings





Stream and Flood Friendly Culverts

- **Stream crossing standards – MA, NH, NY, CT, VT, ME**
- **Well-designed crossings**
  - Span the stream and banks
  - Maintain comparable water velocities
  - Have a natural streambed
- **Can be more expensive short-term (50% to 100% more)**
- **Long-term costs are reduced due to longer life-span and less maintenance**

Scott Jackson photo

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Road Stream Crossings – Recommendations

- Incorporate priority stream crossings into local HMPs and CIPs
- Strategically upgrade vulnerable stream crossings
- Implement stream crossing standards in RI modeled after neighboring states
- Update design storm precipitation in local and state design standards
- Provide training to highway departments
- Implement ongoing inspection and maintenance program

Floodplains and River Corridors

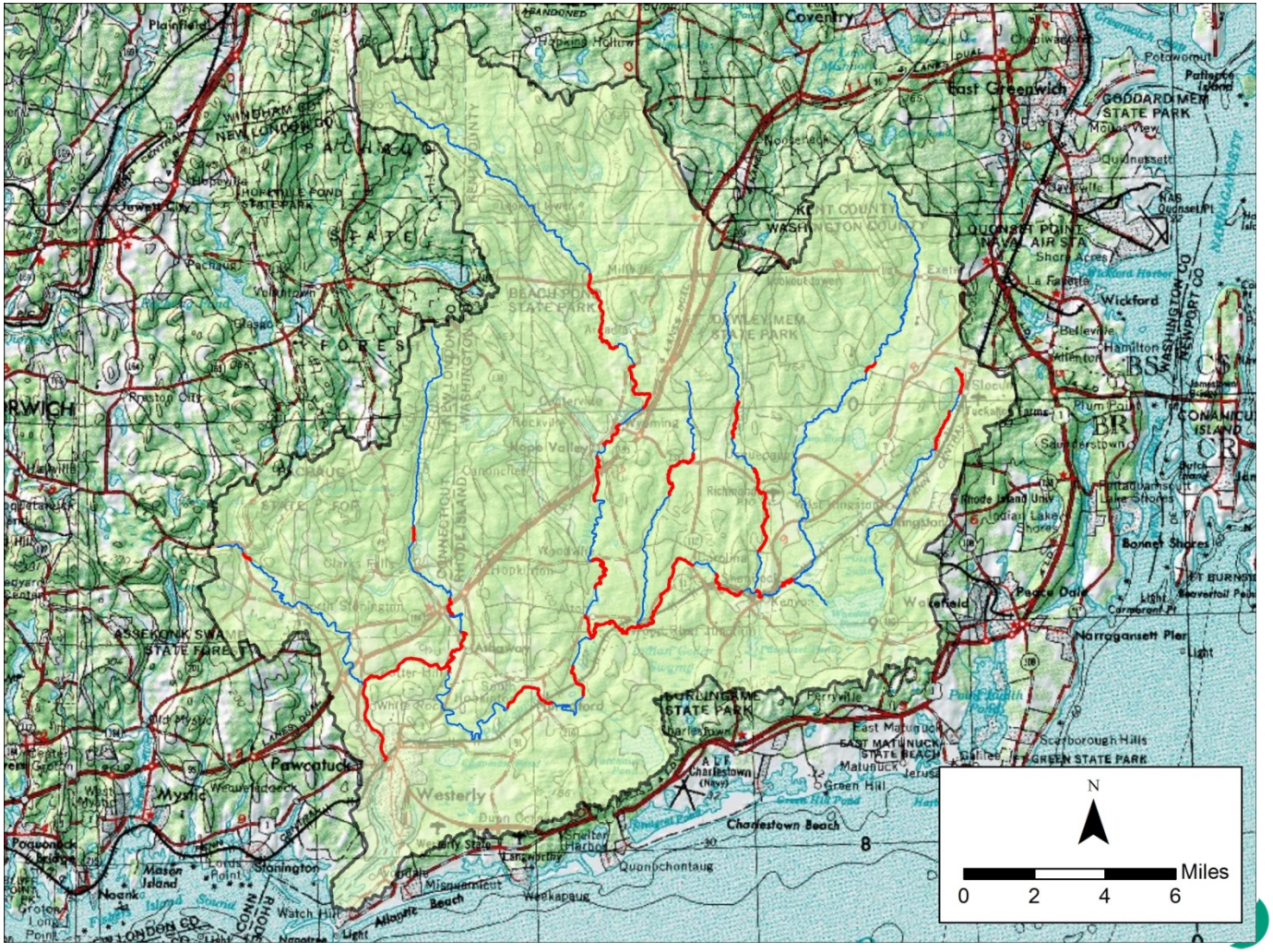
- **Areas along rivers and streams subject to flooding and erosion hazards**
- **Most stream reaches sensitive to change**
- **Channel straightening and bank armoring**
- **River corridor development**
- **Floodplain and channel restrictions**

Objective: *Conserve and restore floodplains and river corridors in a natural condition to mitigate flood and erosion hazards, attenuate sediment loads, and create and enhance habitat.*

Restore impacted stream channels to an equilibrium condition by addressing the underlying causes of channel instability.

Geomorphic Assessment

- **Phase 1 (desktop) – 111 stream miles**
- **Phase 2 (field) – 39 stream miles**



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Stream Restoration

a)

Marginal Log Jams

b)

Boulder and Log Deflectors

c)

Root Wad Revetments

d)

Willow Stakes above Root Wad Revetments

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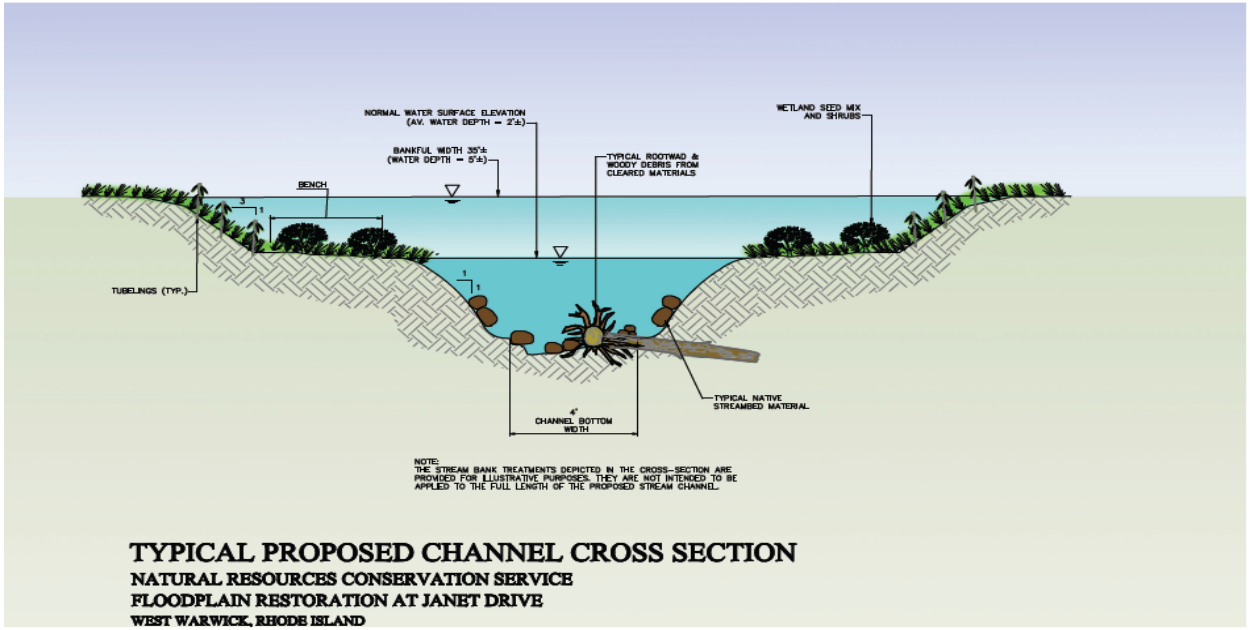
Floodplain Restoration



Creation of Floodplain Terrace for Incised Channels

Wood Addition

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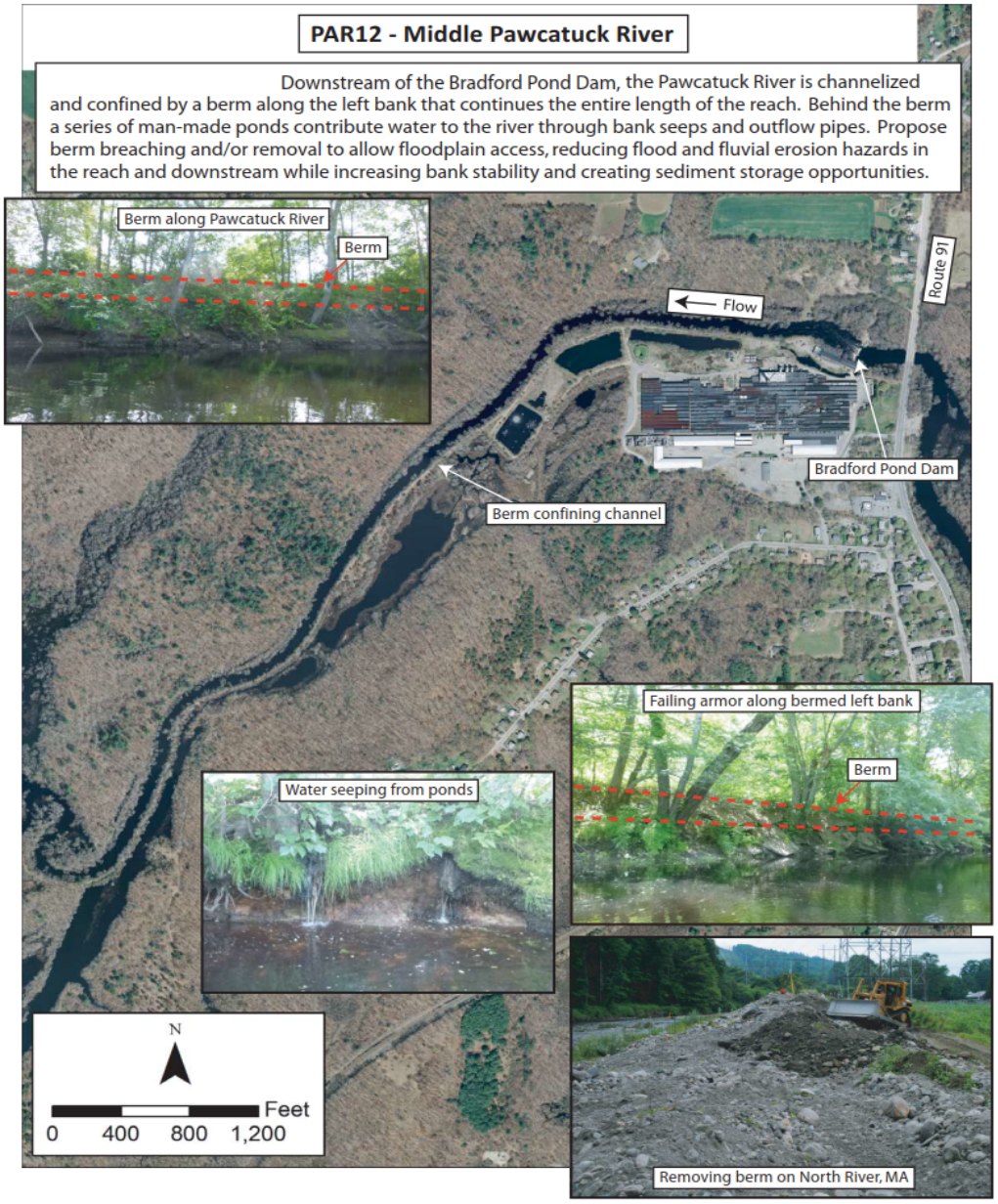
Floodplain & River Corridor – Recommendations

- **Implement stream and floodplain restoration projects identified in *River Corridor Plan***
- **Over 40 potential projects identified**
- **Costs – highly site specific**
  - $200 to $1,000 / LF
  - Recent projects ($300K - $800K)

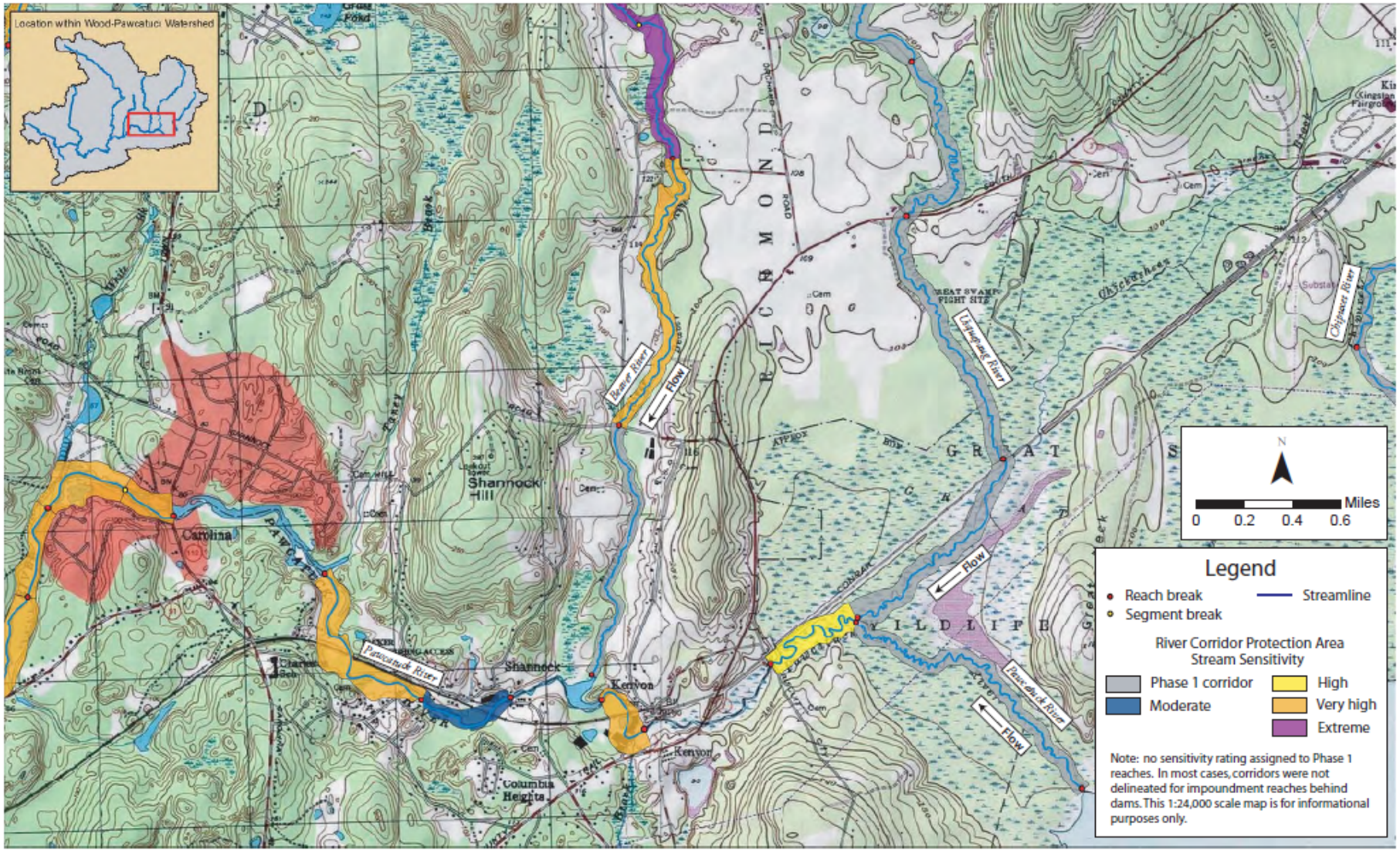


Floodplain & River Corridor – Recommendations

- **Purchase land or acquire conservation easements in floodplains and river corridor**
- **Consider Transfer of Development Rights (TDR) ordinance to discourage floodplain development**
- **Consider fluvial erosion hazard zoning, or less formal adoption in local hazard mitigation and comprehensive plans**

River Corridor Management Areas

Wood-Pawcatuck Watershed River Corridor Protection Area Map - Pawcatuck River (Map 1 of 4)



Basemap imagery: USA Topo Maps (http://services.arcgisonline.com/ArcGIS/rest/services/USA_Topo_Maps/MapServer)
GIS data: Field Geology Services 2015-2016
Map prepared February 2016

Map prepared by: Field Geology Services

With support from: FUSS & O'NEILL

Floodplain & River Corridor – Recommendations

- **Consider changes to zoning and subdivision ordinances/regulations to go beyond minimum NFIP standards**
  - Incorporate ASFPM "No Adverse Impact Floodplain Management" Policy
  - Increase participation in NFIP Community Rating System
  - Adopt more stringent flood management standards
- **See *Land Use Policy and Regulatory Review* (Appendix K) for more details**

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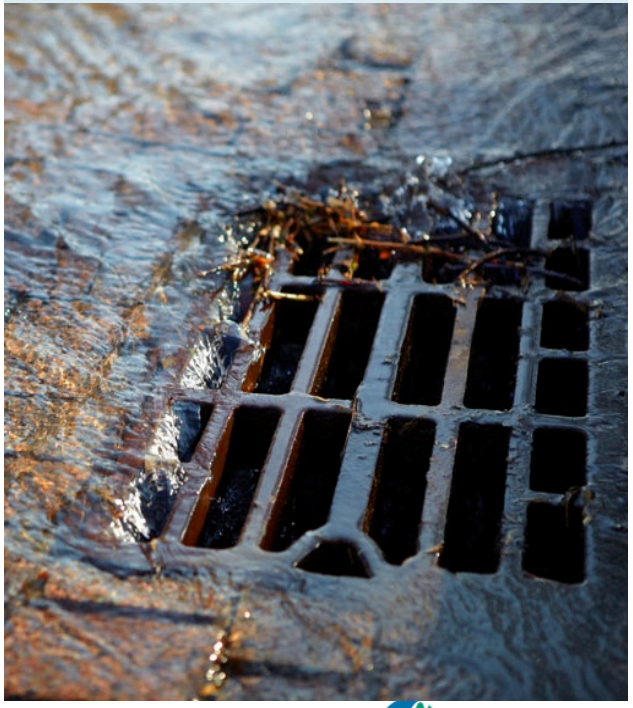
Stormwater

- **Stormwater runoff contributes to drainage-related and riverine flooding**
- **Source of water quality problems**
- **Communities using green stormwater infrastructure or LID to alleviate drainage-related flooding and improve water quality**

Objective: *Reduce runoff volumes, flooding, and water quality impacts through improved stormwater management and the use of green stormwater infrastructure throughout the watershed.*



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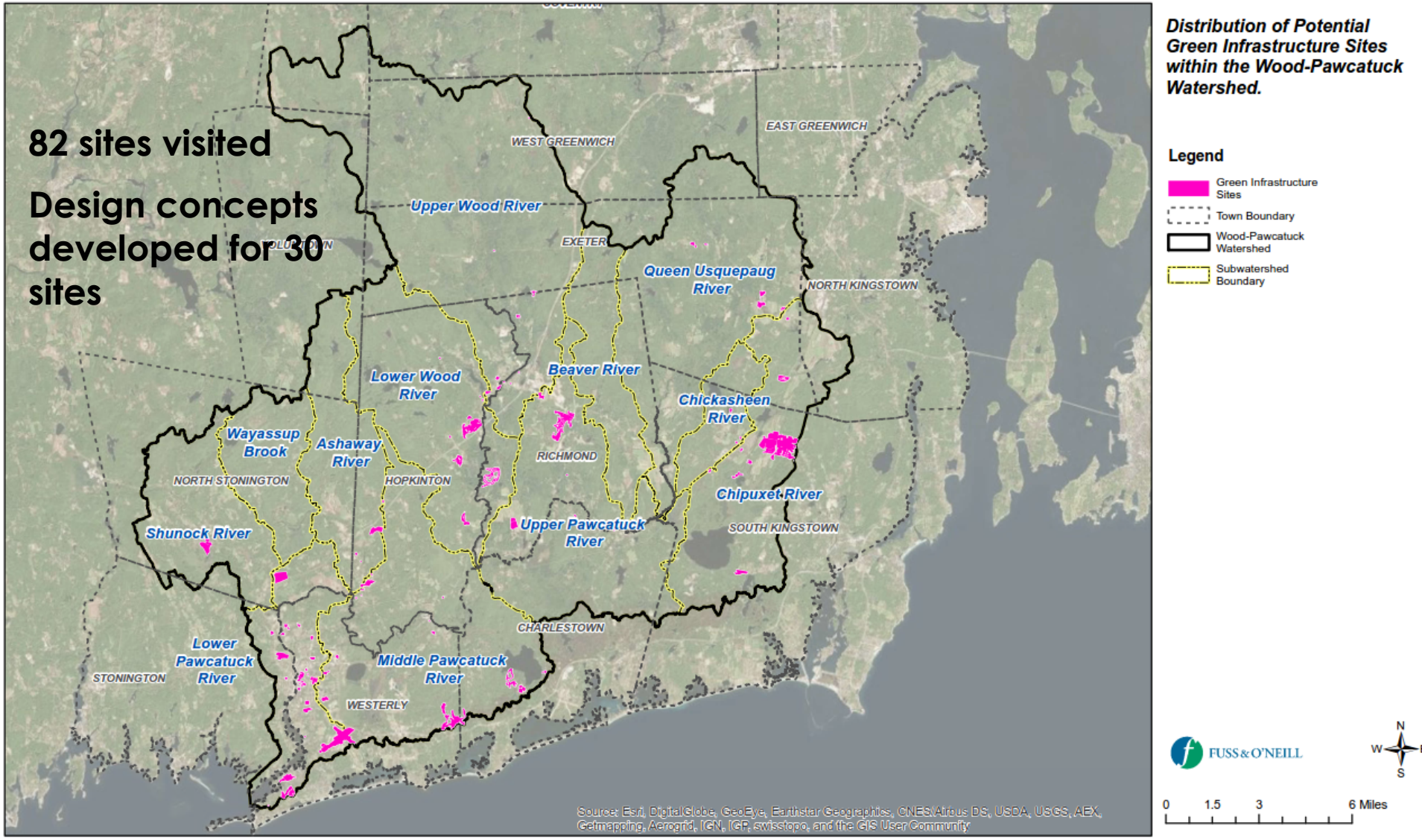
Potential GI Retrofit Sites



Retrofit Site 272A – Westerly Senior Center Bioretention

State Street, Westerly, Rhode Island

Site Description

The proposed retrofit concept is located at the Westerly Senior Center near the intersection of Westminster and State Streets in Westerly, RI. The site consists of an asphalt parking lot divided into multiple parking areas. There is a swale located between two sections of the parking lot, and some runoff is directed to the swale but no overflow or formal BMP exists, nor does the swale capture all of the runoff that could be directed to it.

Proposed Concept

Retrofit the current swale as a bioretention/infiltration practice. The practice would be designed to accept runoff from the surrounding parking lot and additional areas of the site and parking lot. If desired, an overflow structure could be incorporated into the design and connected to current stormwater drainage infrastructure located on Westminster Street.

Image 1: Close-up view of proposed bioretention/infiltration area.

Retrofit Concept Summary
Total Drainage Area: 1.2 acres
Total Impervious Area: 1.0 acres
Total Water Quality Volume: 3,794.0 ft^3
Runoff Reduction Volume: 379.4 ft^3

Estimated Pollutant Removal
Bioretention Area
Total Phosphorus ≈ **0.5 lbs/year**
Total Nitrogen ≈ **10.5 lbs/year**
Total Suspended Solids ≈ **410.2 lbs/year**
Bacteria (FC) ≈ **307.5 billion colonies/year**

Estimated Cost
Bioretention Area: $51,032

Image 2: Rendering of a typical bioretention area. (Image source: Johnson County Soil and Water District)

Image 3: View of proposed bioretention/infiltration area and some of the parking area that would drain to it.

Stormwater – Recommendations

- **Incorporate GI into municipal stormwater infrastructure planning and capital projects (see concepts in Appendix M)**
- **Update municipal land use policy and regulations to require GI/LID for new development and redevelopment and to meet MS4 Permit requirements**
- **Update design storm precipitation and stormwater BMP design considerations in coastal areas**

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Comments on Draft Plan

Draft plan and appendices available for download:

http://wpwa.org/flood_resiliency.html

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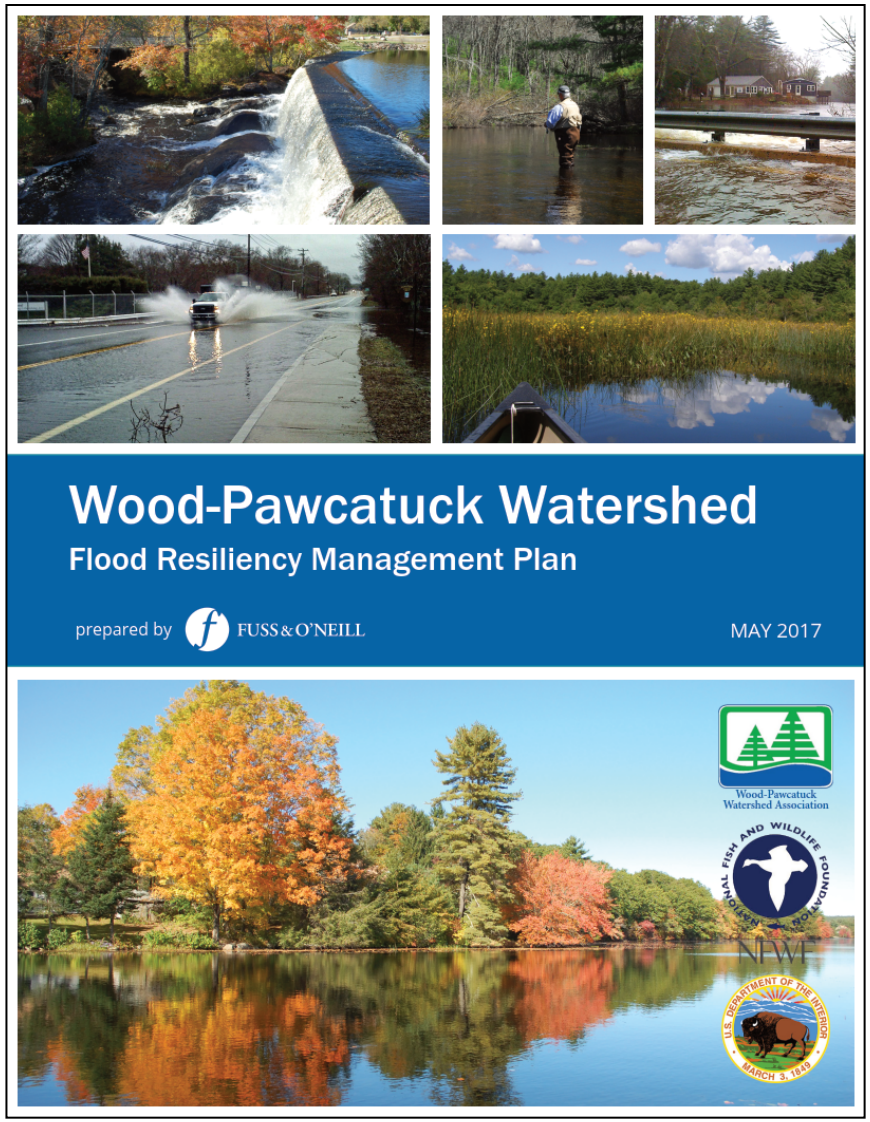
Plan to be finalized in August 2017



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