NATURAL & NATURE-BASED SOLUTIONS FOR VULBERABILITY REDUCTION & RESILIENCE

The Nature Conservancy
Protecting nature. Preserving life.

OFFICE OF THE GOVERNOR
COMMONWEALTH OF MASSACHUSETTS
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CHARLES D. BAKER
GOVERNOR

KARYN E. POLITO
LIEUTENANT GOVERNO

By His Excellency
CHARLES D. BAKER
GOVERNOR

EXECUTIVE ORDER NO. 569

ESTABLISHING AN INTEGRATED CLIMATE CHANGE STRATEGY FOR THE COMMONWEALTH

WHEREAS, climate change presents a serious threat to the environment and the Commonwealth's residents, communities, and economy;

WHEREAS, extreme weather events associated with climate change present a serious threat to public safety, and the lives and property of our residents;

WHEREAS, the Global Warming Solutions Act (the "GWSA") directs the Secretary of Energy and Environmental Affairs and the Department of Environmental Protection to take certain steps to reduce greenhouse gas emissions and prepare for the impacts of climate change, including setting statewide greenhouse gas emissions limits for 2020, 2030, 2040 and 2050;

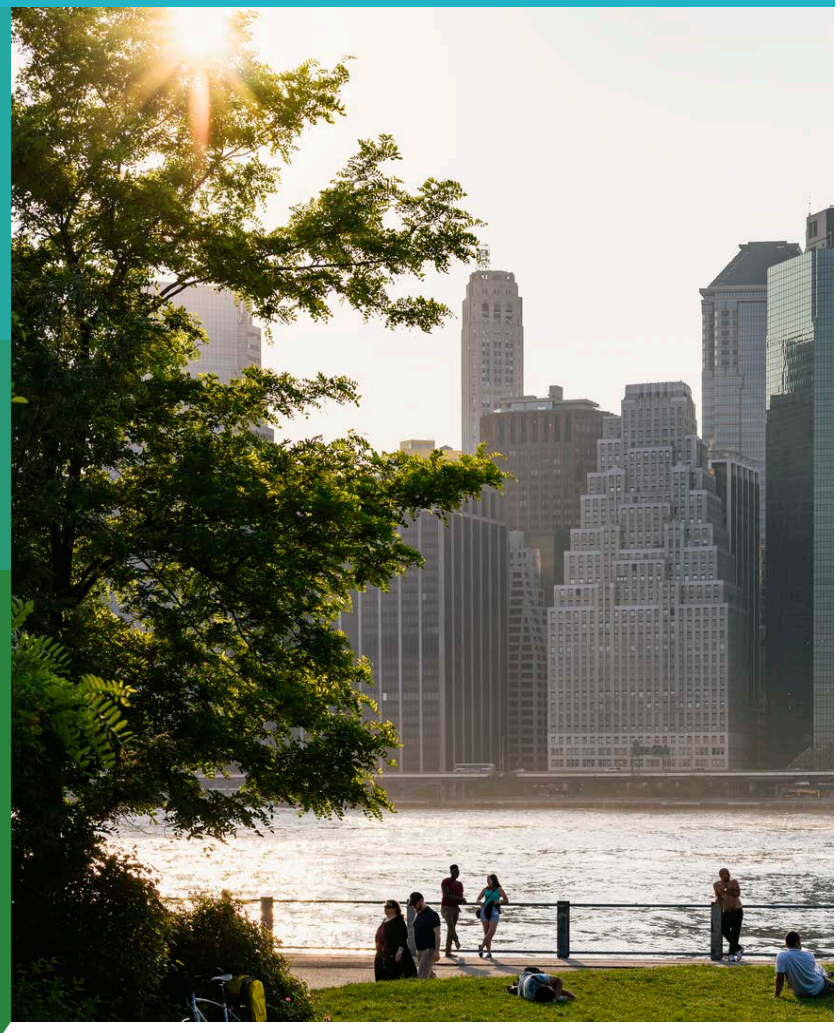
WHEREAS, the statewide greenhouse gas emissions limit for 2020 is 25% below the 1990 level of emissions and the corresponding limit for 2050 is 80% below the 1990 level of emissions, but no interim limits have yet been set for 2030 or 2040;

WHEREAS, the Commonwealth can provide leadership by reducing its own emissions from state operations, planning and preparing for impending climate change, and enhancing the resilience of government investments;

WHEREAS, the transportation sector continues to be a significant contributor to greenhouse gas emissions in the Commonwealth, and is the only sector identified through the GWSA with a volumetric increase in greenhouse gas emissions;

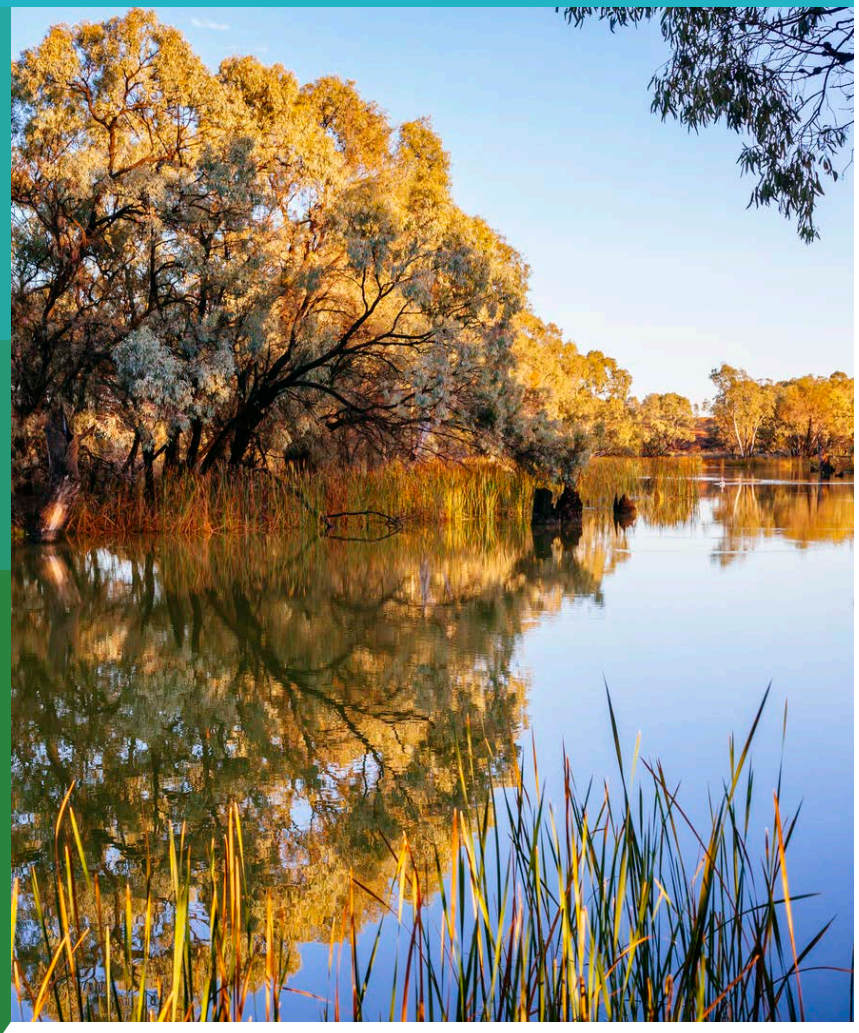
WHEREAS, the generation and consumption of energy continues to be a significant contributor to greenhouse gas emissions in the Commonwealth, and there is significant potential

The Order's Language



"...strategies that conserve and sustainably employ the natural resources of the Commonwealth to enhance climate adaptation, build resilience and mitigate climate change..."

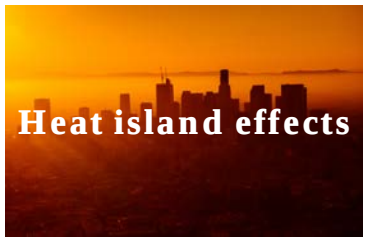
Nature-Based Solutions



Nature-Based Solutions *use* natural systems, *mimic* natural processes, or *work in tandem with* traditional approaches to address natural hazards like flooding, erosion, drought, and heat islands.

Incorporating nature-based solutions in local planning, zoning, regulations, and built projects can help communities reduce their exposure to these impacts, resulting in reduced costs, economic enhancement, and safer, more resilient communities.

Problems facing towns



Nature-based solutions

- Open space preservation
- Ecosystem restoration
- Low Impact Development

Additional benefits

Infrastructure benefits

Nature-based solutions can save $5 on every $1 spent, increase property value by up to $20, and create local jobs and capital inflows.

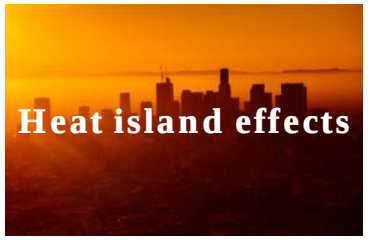
Societal benefits

Natural areas can reduce the likelihood of obesity by 40%, improve air and water, and draw people together to strengthen community ties.

Environmental benefits

Most natural systems rely on linkages with others. By prioritizing natural solutions, communities can provide restored links that augment biodiversity.

Problems facing towns



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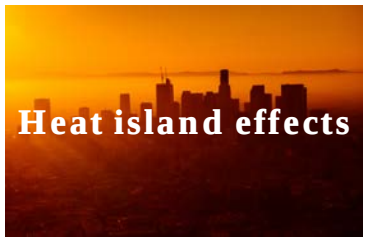

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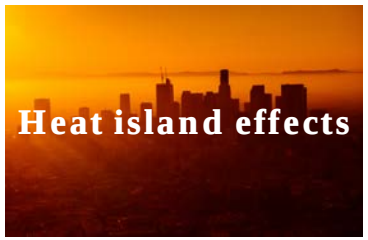

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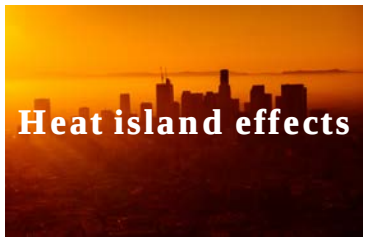

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Green Infrastructure

Green Infrastructure: A network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas that support native species, maintain natural ecological processes, sustain air and water resources and contribute to health and quality of life.

(McDonald, Benedict and O'Conner, 2005).

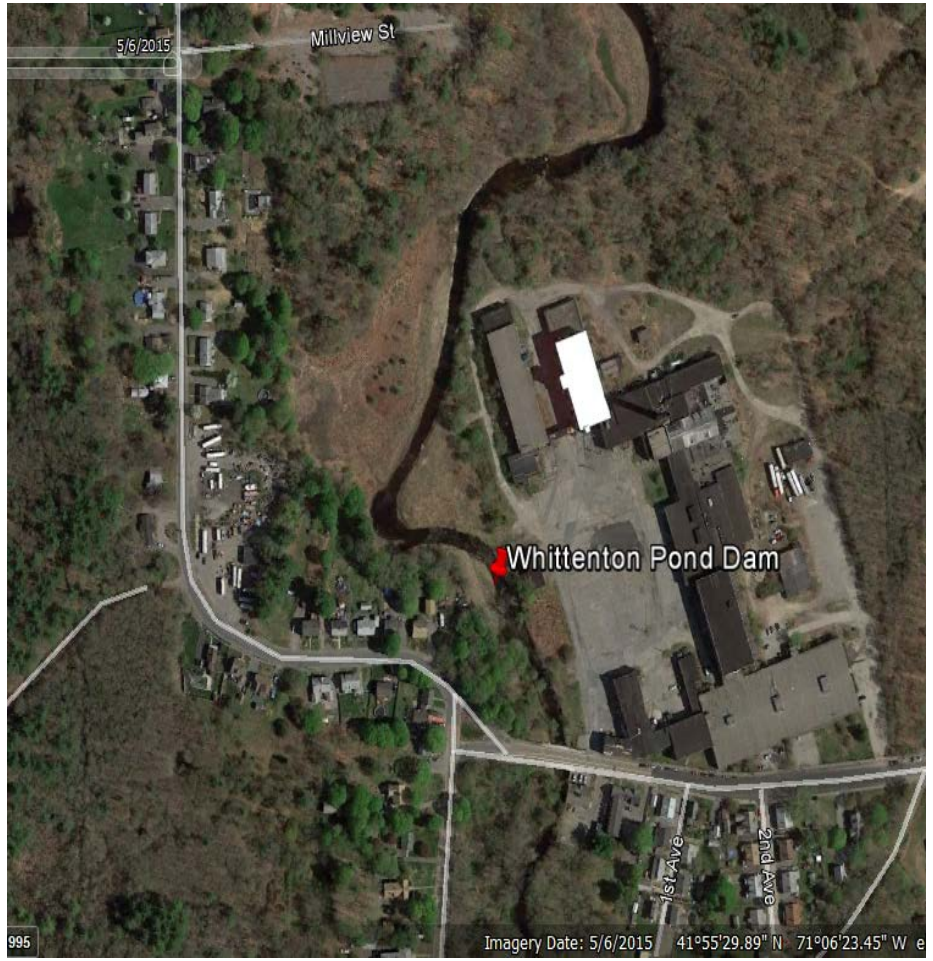
Low Impact Development (LID)

LID is a category of **Green** Infrastructure (GI):

- **Works *with* nature**
- **Manages stormwater** as close to the source as possible
- **Preserves natural landscape** (or creates recreating natural features).
- **Treats rain as a resource** rather than a waste product.

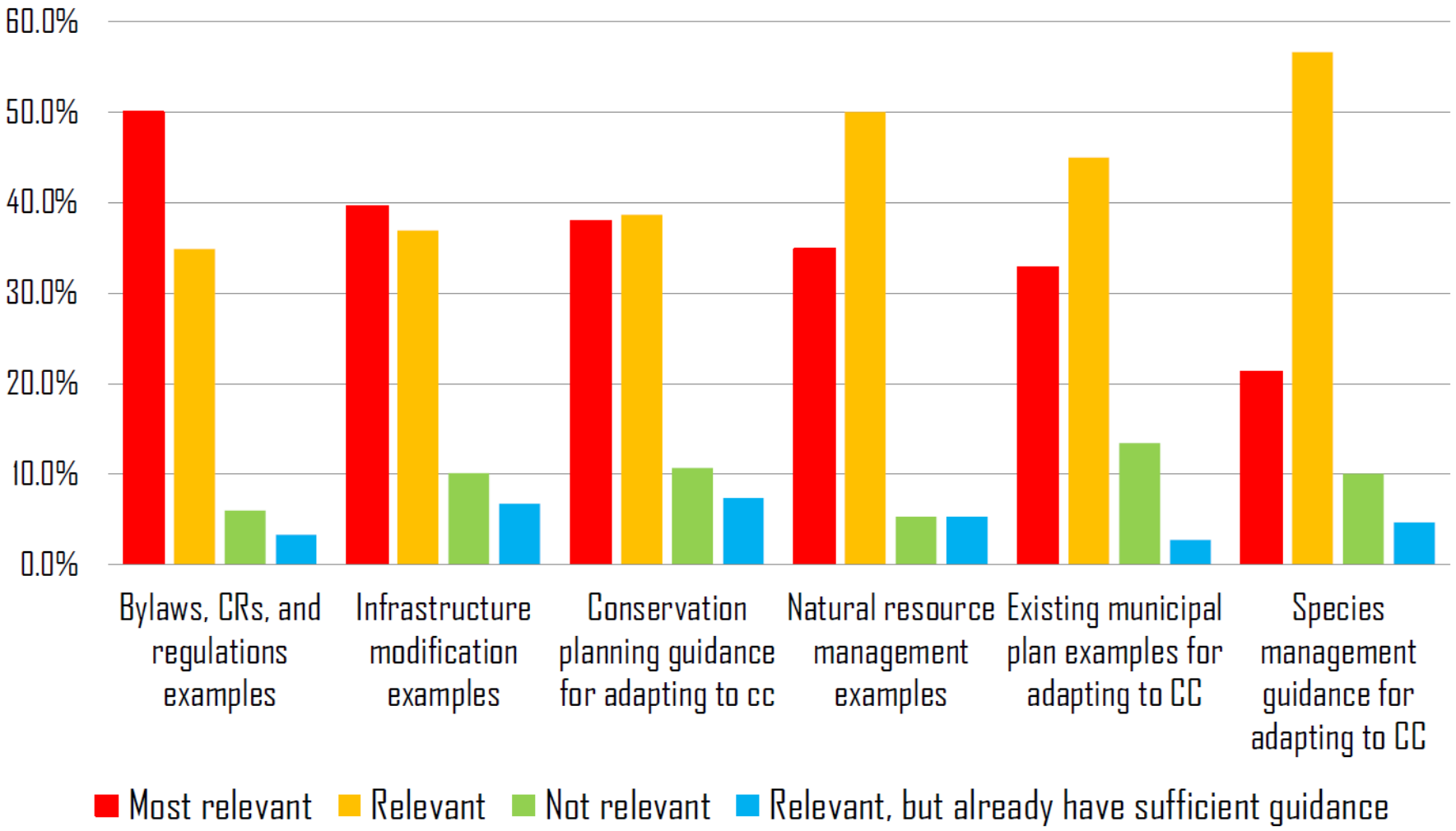
Resilience

A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.



Needs and Wants

From the Climate Action Tool survey, 2015



*Note! 70% of respondents were municipal professionals, but most already engaged in land conservation.

Needs and Wants

The most relevant needs across the board were for examples!

Needed Examples:

1. Bylaw, conservation restrictions, and regulation
2. Infrastructure Modification
3. Conservation and planning
4. Existing municipal climate change adaptation plans

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- Enhanced Safety by reducing risks from flooding and heat risks to vulnerable populations and community assets.
- Avoided infrastructure costs of unplanned repairs and improving safety due to flooding and failure from intense rain events.
- Securing the natural resource benefits of water quality, wildlife habitat and community resiliency.

Guidance/Case Studies

- **Naturally Resilient Communities** successful project case studies from across the country to help communities learn and identify nature-based solutions
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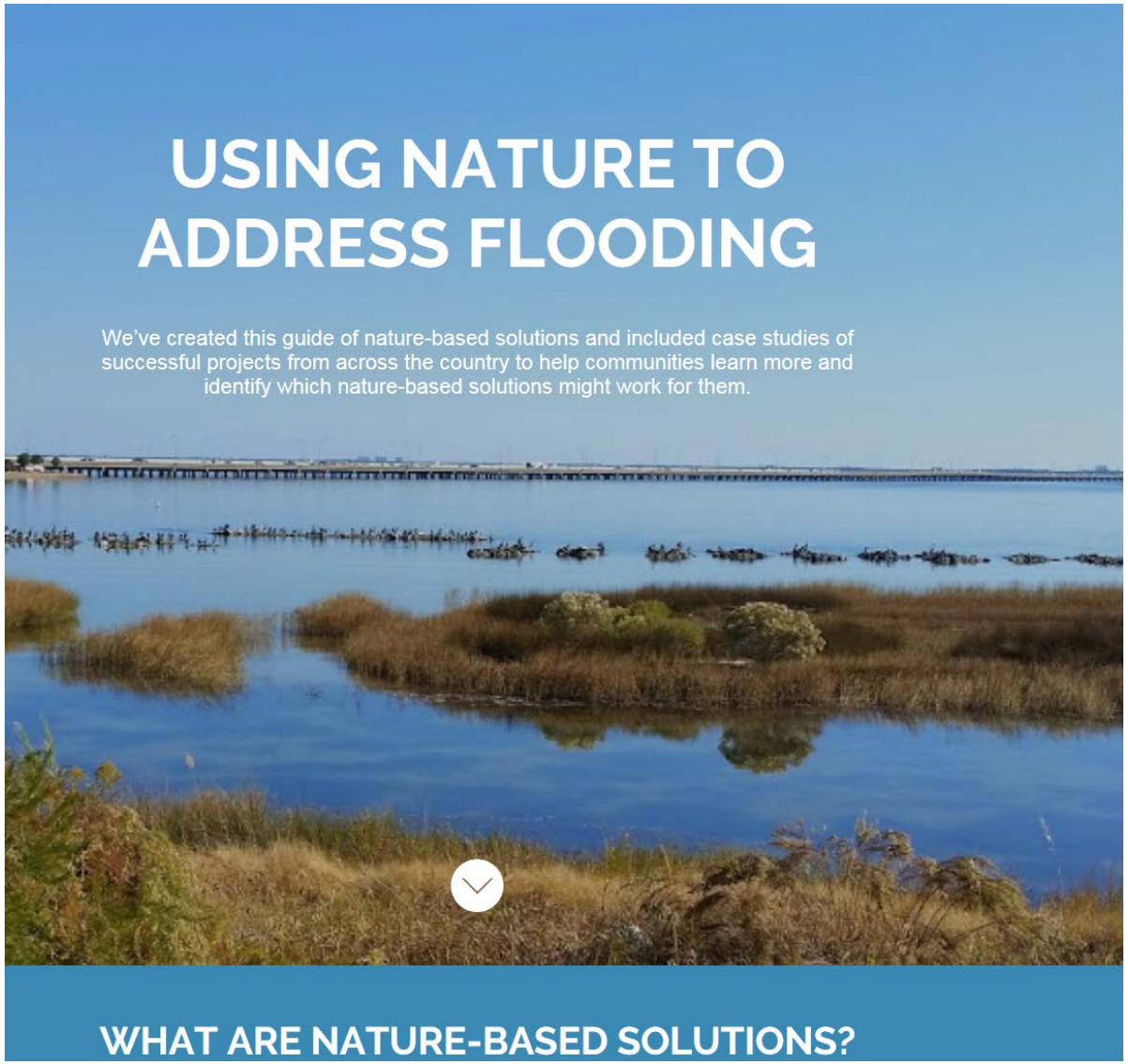
Naturally Resilient Communities

Yelp for Nature Based Solutions

You Choose:

1. Hazard Types
2. Region
3. Community type
4. Scale
5. Cost



HELP ME CHOOSE

Hazard Types

- [x] Coastal Erosion
- [ ] Tidal Flooding
- [ ] Coastal Flooding
- [ ] Riverine Erosion
- [ ] Riverine Flooding
- [ ] Stormwater Flooding

Region

- [ ] Coastal West
- [ ] Great Lakes
- [ ] Gulf of Mexico
- [ ] Mid-Atlantic
- [ ] Midwest
- [x] Northeast
- [ ] Pacific Northwest
- [ ] Rocky Mountain West
- [ ] Southeast
- [ ] Southwest

Community Type

- [ ] Rural
- [ ] Suburban
- [x] Urban

Scale

- [ ] Community
- [x] Neighborhood
- [ ] Site

Cost

- [ ] $
- [ ] $$
- [x] $$$
- [ ] $$$$

CLEAR ALL

DOWNLOAD PDF

Coastal Marshes

Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Coastal wetlands occur along marine, estuarine, and freshwater coastlines and may be…

Beaches and Dunes

Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Beaches and dunes occur in a variety of shapes, sizes, compositions, and…

Restoring Offshore Features

Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Restoration is the process of establishing or reestablishing a habitat that closely…

Restoring Coastal Features

Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Natural coastlines have evolved to absorb wave energy and provide a buffer…

Open Space Preservation through Land Acquisition

Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

This strategy focuses on the public acquisition of undeveloped land to lessen…

Moving People Out of Harm's Way: Property Buyouts

Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Property buyouts are a means by which communities can remove development from…

Horizontal Levees

Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

A horizontal levee consists of a hardened structure

Living Shorelines

Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Living shorelines are a suite of shoreline erosion

STRATEGIES	HAZARDS					
	Coastal Erosion	Tidal Flooding	Coastal Flooding	Riverine Erosion	Riverine Flooding	Stormwater Flooding
Naturally Resilient Communities						■
Building Rain Gardens						■
Green Parking Lots						■
Green Roofs						■
Green Streets						■
Urban Trees/Forests						■
Daylighting Rivers and Streams					■	■
Waterfront Parks		■			■	■
Setback Levees				■	■	
Flood Friendly Culverts/Bridges		■	■	■	■	
Horizontal Levees	■	■	■			
Living Breakwaters (Oyster And Coral Reefs)	■		■			
Living Shorelines	■					
Coastal Restoration	■		■			
Floodplain Restoration				■	■	
Offshore Restoration	■		■			
Coral Reef	■		■			
Oyster Reef	■		■			
Seagrass	■		■			
Mangroves	■		■			
Coastal Marshes	■		■			
Beaches and Dunes	■		■			
Floodplains				■	■	
Mapping	■	■	■	■	■	■
Planning and Zoning	■	■	■	■	■	■
Establishing Flood Bypasses					■	
Regulation	■	■	■	■	■	■
Open Space Acquisition		■	■		■	
Flood Water Detention Areas					■	■
Moving People Out of Harm's Way	■	■	■	■	■	■

Floodplain Buyout: Woloski Park, Middleborough, MA

- 10 homes in Woloski Park in a Flood Zone along the Taunton River flooded twice in 2010.
- Buyout funded by FEMA's Hazard Mitigation Grant Program (HMGP).
- Resilience benefits:
  - Avoided emergency evacuation and property recovery costs.
- Co-benefits
  - High quality habitat is restored, floodplain and ecosystem services recovered.

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Living Shorelines Introduction

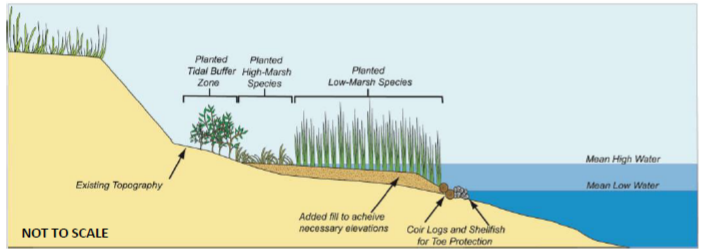
A detailed profile page was created for each of the eight (8) living shoreline types listed below. The purpose of these profile pages is to provide a comprehensive overview of the design recommendations, siting criteria and regulatory topics pertinent to a range of living shorelines designs that practitioners and regulators can use as a quick reference in the field or as an informational tool when educating home owners.

Living Shoreline Types

1. Dune – Natural
2. Dune – Engineered Core
3. Beach Nourishment
4. Coastal Bank – Natural
5. Coastal Bank – Engineered Core
6. Natural Marsh Creation/Enhancement
7. Marsh Creation/Enhancement w/Toe Protection
8. Living Breakwater

Design Schematics

The following living shoreline profile pages provide an example design schematic for each of the eight living shoreline types. Each schematic shows a generalized cross-section of the installed design. In addition, they illustrate each design's location relative to MHW and MLW, whether plantings are recommended, if fill is required, and any other major components of the design. It is important to note that these are not full engineering designs, and due to each sites unique conditions, a site specific plan, developed by an experienced practitioner is required for all living shoreline projects. Also note that these design schematics are meant to provide a general concept only, and are not drawn to scale.



Case Study

One example case study, with the following information, is provided for each living shoreline type.

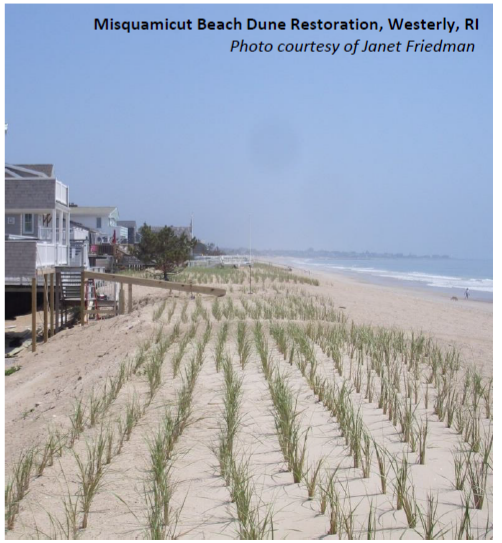
Project Proponent	The party responsible for the project.
Status	The status of the project (i.e. design stage, under construction, or completed) and completion date if appropriate.
Permitting Insights	This section notes any specific permitting hurdles that occurred, or any regulatory insights that might help facilitate similar projects in the future.
Construction Notes	This section identifies major construction methods or techniques, any unique materials that were used, or deviations from a traditional design to accommodate site specific conditions.
Maintenance Issues	If the project is complete and has entered the maintenance phase, this section will note whether the project has functioned correctly, if it is holding up, and/or if any specific maintenance needs have been required since construction.
Final Cost	This section provides costs for the project, broken down into permitting, construction, monitoring, etc. when possible.
Challenges	This sections highlights any unique challenges associated with a particular project and how th… handled.

Explanation of Design Overview Tables

Materials	A description of materials most commonly used to complete a living shoreline project of this type.
Habitat Components	A list of what types of coastal habitats are created or impacted by a living shoreline project of this type.
Durability and Maintenance	Although specific timelines are impossible to provide in this context, general guidelines and schedules for probable maintenance needs, and design durability are detailed here.
Design Life	Although specific design life timelines will vary by site for each living shoreline type, this section provides some insight into factors that could influence design life.
Ecological Services Provided	This section provides an overview of the ecological services that could be provided or improved through the installation of that particular type of living shoreline project.
Unique Adaptations to NE Challenges (e.g. ice, winter storms, cold temps)	This section provides any unique practices or design improvements that could be made to improve the performance of the design given New England climactic and tidal challenges.

Acronyms and Definitions

cy	Cubic yards; one cubic yard equal 27 cubic feet. Project materials are often measured in cubic yards.
MHW	Mean High Water: The average of all the high water (i.e. high tide) heights observed over a period of time.
MTL	Mean Tide Level: The average of mean high water and mean low water.
MLW	Mean Low Water: The average of all the low water (i.e. low tide) heights observed over a period of time.
SAV	Submerged aquatic vegetation, which includes seagrasses such as eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*).
…	Naturally occurring materials that have been broken down by weathering and erosion. Finer, small-grained … silts or clays. Slightly coarser sediments … larger materials are gravels or cobbles.



Misquamicut Beach Dune Restoration, Westerly, RI
Photo courtesy of Janet Friedman

Swansea Marsh and Habitat Preservation: Conservation

http://wildlandstrust.org/news/2016/3/1/publicprivate-partnership-saves-22-

- 37 Acres purchased and conserved by the Town of Swansea and Wildlands Trust in the Palmer River Corridor.
- Major storms in 2010 and 2012 damaged stormwater and transportation infrastructure.
- Benefits:
  - Conservation of green infrastructure that dissipates energy from storm, tide, and flood events
  - Avoided cost of infrastructure repair and replacement
- Co-Benefits:
  - Retention of stream connectivity and continuity
  - Protected water quality
  - Future marsh migration

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Green Infrastructure Cost-Benefit Resources

Green infrastructure can be a cost-effective approach to improve water quality and help communities stretch their infrastructure investments further by providing multiple environmental, economic, and community benefits. On this page, learn more about how other communities have realized cost savings through their green infrastructure programs as well as about tools you can use to inform your own cost-benefit analysis.

On this page:

Cost Analysis

Mill River: Whittenton Dam Removal, Taunton, MA

- Whittenton Mill Dam was removed in 2013 after a near failure in 2005 during which downtown Taunton, MA was evacuated at a cost of $1.5 million.

- Benefits:
  - Reduced flood risk to downtown Taunton.
  - Avoided costs: $2.2 Million
  - Increased property value

- Co-benefits
  - Migratory fish passage restored
    - Increased revenue from river based recreation
  - Water quality benefits

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How to Compare Local Land Use Regulations with Best Practices

Key Areas of Analysis

The following analysis framework is designed to assist communities in Massachusetts in applying cost-effective Low Impact Development (LID) techniques. Specifically, this template enables you to evaluate local land use regulations in relation to models and examples from the Commonwealth of Massachusetts' Smart Growth/Smart Energy Toolkit and other sources in relation to the use of LID and Green Infrastructure (GI) techniques. The focus is primarily on residential development, but the concepts are also applicable to other forms of development and redevelopment.

Best practices minimize the alteration of natural green infrastructure such as forests; reduce creation of impervious surfaces; support retention of naturally vegetated buffers along wetlands and waterways; minimize grading and alterations to natural flow patterns; and support the use of LID techniques as the preferred, most easily permitted methods for managing stormwater.

Get more details on LID's many cost-savings and other benefits, and our customizable bylaw review chart, at: www.massaudubon.org/LIDCost.

Local coordination across municipal boards and permits is also important for supporting LID. Application of these practices can result in significant savings in infrastructure maintenance costs, as well as improved water quality and protection of water supplies, while supporting property values and overall quality of life. Sustainable development

1 Introduction | 2 OSRD Overview | 3 Zoning Subdiv SPR SW Overview | 4 Other Considerations | 5

Review bylaws, ordinances, zoning, and other considerations for overall site design, LID project standards, and maintenance and operations considerations.

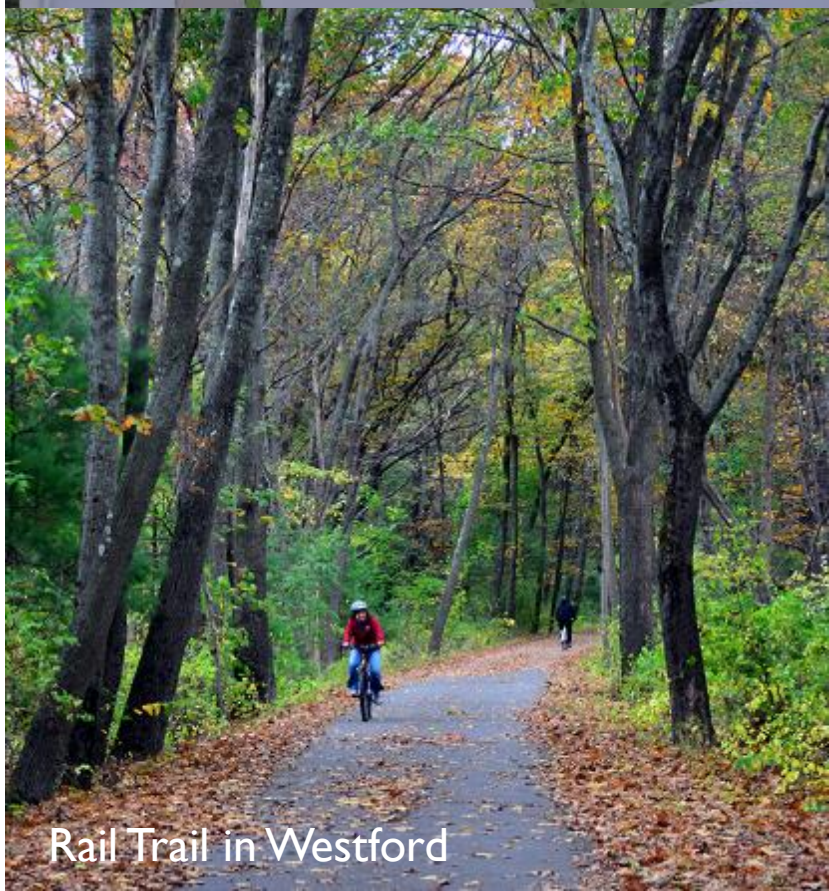
	A	B	C	D	E	F	G	H
1	**Factors**	**Conventional**	**Better**	**Best**	**Community's Zoning**	**Community's Subdivision Rules & Regulations**	**Community's Site Plan Review**	**Community's Stormwater/LID Bylaw/Regulations**
2	**GOAL 1: PROTECT NATURAL RESOURCES AND OPEN SPACE**							
3	Soils managed for revegetation	Not addressed	Limitations on removal from site, and/or requirements for stabilization and revegetation	Prohibit removal of topsoil from site. Require rototilling and other prep of soils compacted during construction	*(Not applicable)*			
4	Limit clearing, lawn size, require retention or planting of native vegetation/naturalized areas	Not addressed or general qualitative statement not tied to other design standards	Encourage minimization of clearing/ grubbing	Require minimization of clearing/grubbing with specific standards				
5	Require native vegetation and trees	Require or recommend invasives	Not addressed, or mixture of required plantings of native and nonnative	Require at least 75% native plantings				
6	**GOAL 2: PROMOTE EFFICIENT, COMPACT DEVELOPMENT PATTERNS AND INFILL**							
7	Lot size	Required minimum lot sizes	OSRD/NRPZ preferred. Special permit with incentives to utilize	Flexible with OSRD/NRPZ by right, preferred option		*(Not applicable)*	*(Not applicable)*	*(Not applicable)*
8	Setbacks	Required minimum front, side, and rear setbacks	Minimize, allow flexibility	Clear standards that minimize and in some instances eliminate setbacks		*(Not applicable)*	*(Not applicable)*	*(Not applicable)*
9	Frontage	Required minimum frontage for each lot/unit	Minimize especially on curved streets and cul-de-sacs	No minimums in some instances, tied into other standards like OSRD design and shared driveways.		*(Not applicable)*	*(Not applicable)*	*(Not applicable)*
10	Common driveways	Often not allowed, or strict limitations	Allow for 2-3 residential units	Allow for up to 4 residential units, preferrably constructed with permeable pavers or pavement				*(Not applicable)*

The power of a bylaw: Westford

- Adopted a Conservation Subdivision bylaw in 1978
- Requires conservation and conventional plans

<u>Benefits</u>

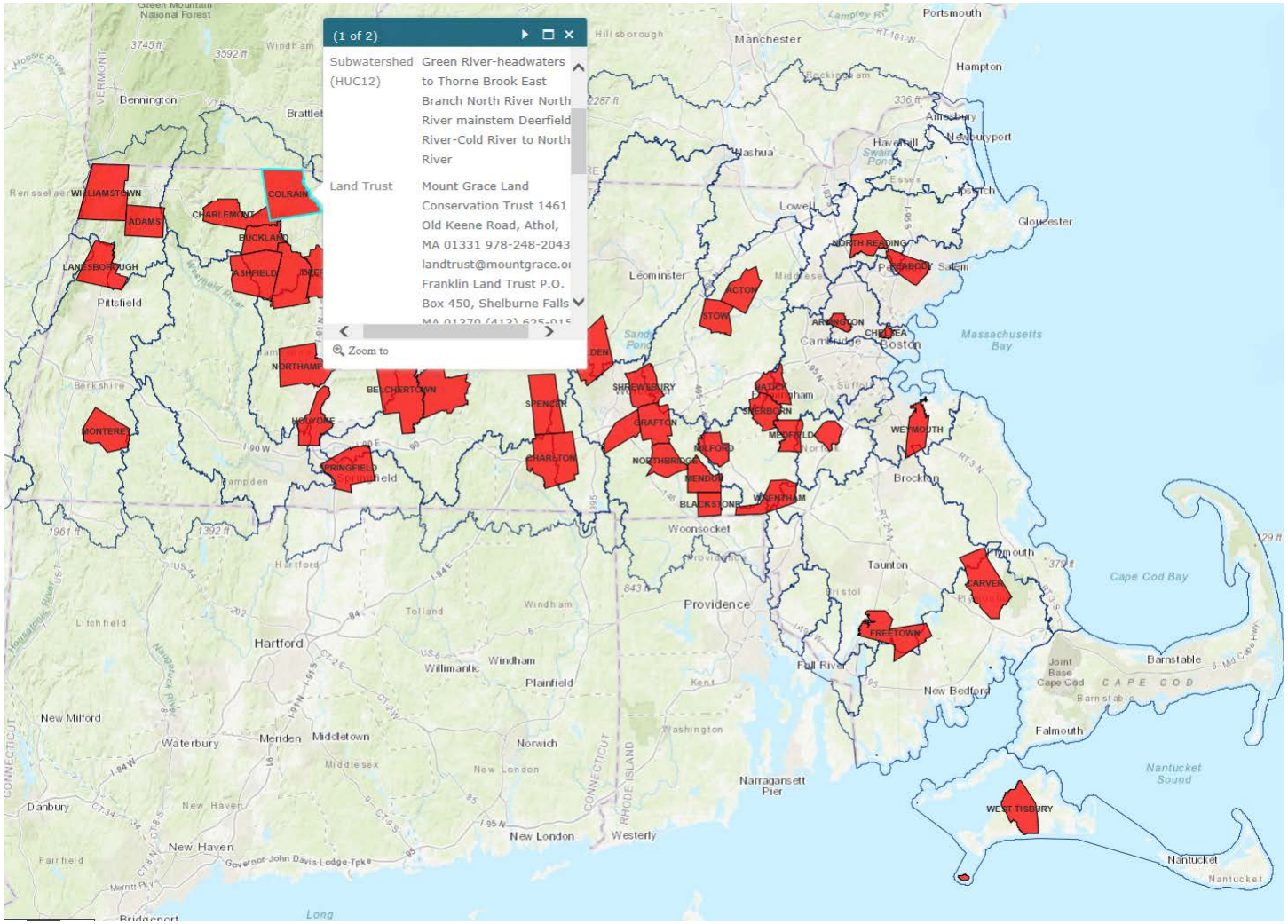
- 1,700 Acres of land Protected
- Preserved local habitat and water resources
- Created 13 miles of hiking trails & public recreation
- Town saved millions of dollars



Rail Trail in Westford

Potential Partners:

- Land Trust – Mass Land Trust Coalition
- Watershed Associations – Mass Rivers Alliance
- Climate Action Groups – Mass Climate Action Network



http://tnc.maps.arcgis.com/apps/View/index.html?appid=eb68b8f45e4548a59a1283b4d8c3a2e3

Thank You!