Photo #3: South side of Mystic River, Mystic River Parkway between Location #1 and River Street. Many fishing access points along riverbank are eroded. Note shallow depth of river extending several feet out.
(Location #2) (Photo Taken: 06/10/16)

Photo #4: South side of Mystic River, Mystic River Parkway between Location #1 and River Street. Unless armored, most banks along the river are eroded and undercut. Boat wakes likely cause the largest waves.
(Location #2) (Photo Taken: 06/10/16)

Photo #5: South side of Mystic River, Mystic River Parkway between Location #1 and River Street. Pipes discharge to river, and in a number of locations, contribute to riverbank erosion.
(Location #3) (Photo Taken: 06/10/16)

Photo #6: South side of Mystic River, Mystic River Parkway between Location #1 and River Street. Pipes discharge to river, and in a number of locations, contribute to riverbank erosion
(Location #3) (Photo Taken: 06/10/16)

Photo #7: Throughout much of the river corridor, sediment has accumulated in the channel, leading to shallow water depths across much of the riverbed profile.
(Representative of various locations) (Photo Taken: 06/10/16)

Photo #8: South side of Mystic River.
Pathways created by human traffic contribute to soil erosion.
(Representative of various locations) (Photo Taken: 06/10/16)

Photo #9: South side of Mystic River, Mystic River Parkway just west of Route 60 Bridge. Grassed and under-utilized area.
(Location #4) (Photo Taken: 06/10/16)

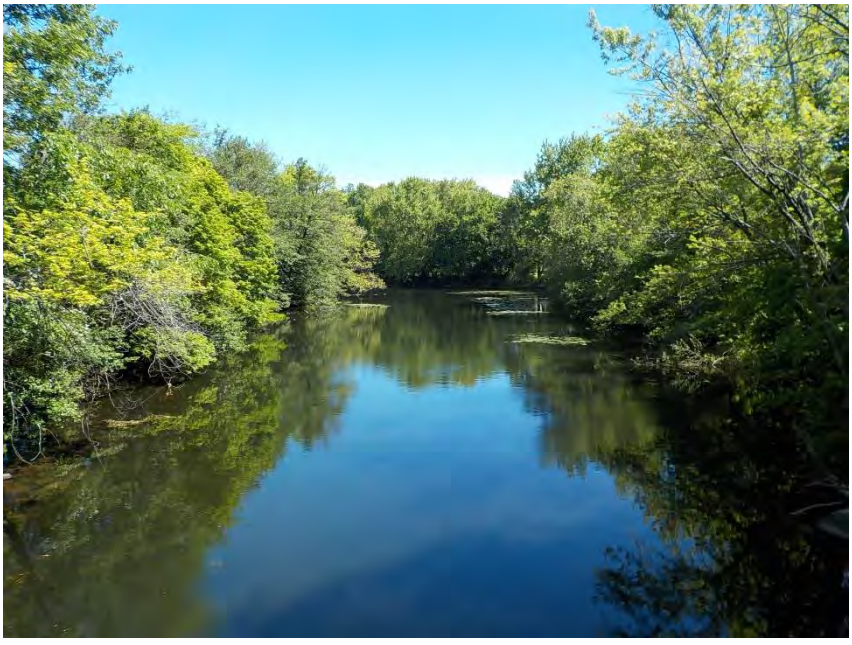

Photo #10: View of River from Route 60 Bridge.
(Photo Taken: 06/10/16)

Photo #11: North side of Mystic River, just west of Route 60 Bridge.
Grassed and under-utilized area.
(Location #5) (Photo Taken: 06/10/16)

Photo #12: Heavily used naturally vegetated area at mouth of Lower Mystic Lake, on north side of Mystic River.
(Location #6) (Photo Taken: 06/10/16)

Mystic River Photographs
Medford, MA
June 8 and 10, 2016

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Photo #13: Heavily utilized area at mouth of Lower Mystic Lake, on north side of Mystic River. **(Location #5) (Photo Taken: 06/10/16)**

Photo #14: North side of Mystic River, just east of Route 60 Bridge. Grassed and under-utilized area **(Location #7) (Photo Taken: 06/10/16)**

Photo #15: North side of Mystic River, west of Dugger Park Playground.
(Photo Taken: 06/10/16)

Photo #16: North side of Mystic River, Dugger Park. Eroded banks where humans access the river and pipe discharges.
(Location #9) (Photo Taken: 06/10/16)

Photo #17: North side of Mystic River, open grassed area at Dugger Park.
(Location #8)(Photo Taken: 06/10/16)

Photo #18: North side of Mystic River, east of River Street. Open grassed area.
(Location #10) (Photo Taken: 06/10/16)

Photo #19: North side of Mystic River, under-utilized open grassed area.
(Location #11)(Photo Taken: 06/10/16)

Photo #20: North side of Mystic River, at bend in river. Under-utilized open grassed area.
(Location #12) (Photo Taken: 06/10/16)

Photo #21: South side of Mystic River – Italian Gardens, under-utilized open grassed area.
(Location #13)(Photo Taken: 06/10/16)

Photo #22: South side of Mystic River – Italian Gardens. Eroded banks are common along the river.
(Location #13) (Photo Taken: 06/10/16)

Mystic River Photographs
Medford, MA
June 8 and 10, 2016

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Photo #21: North side of Mystic River – Undeveloped parcel north of Torbert McDonald Park.
(Location #17)(Photo Taken: 06/10/16)

Photo #22: North side of Mystic River – Undeveloped parcel north of Torbert McDonald Park.
(Location #17) (Photo Taken: 06/10/16)

Photo #21: North side of Mystic River – Waterside view of Torbert McDonald Park.
(Location #18)(Photo Taken: 06/10/16)

Photo #22: North side of Mystic River – Waterside view of Torbert McDonald Park.
(Location #18) (Photo Taken: 06/10/16)

Attachment D

Mystic River Watershed Association
Climate-Resilient Riverbank and Ecological Restoration Planning Project

Climate-Resilient Riverbank and Ecological Restoration Planning Report

ECOLOGICAL RESTORATION TABLES AND MEMORANDA

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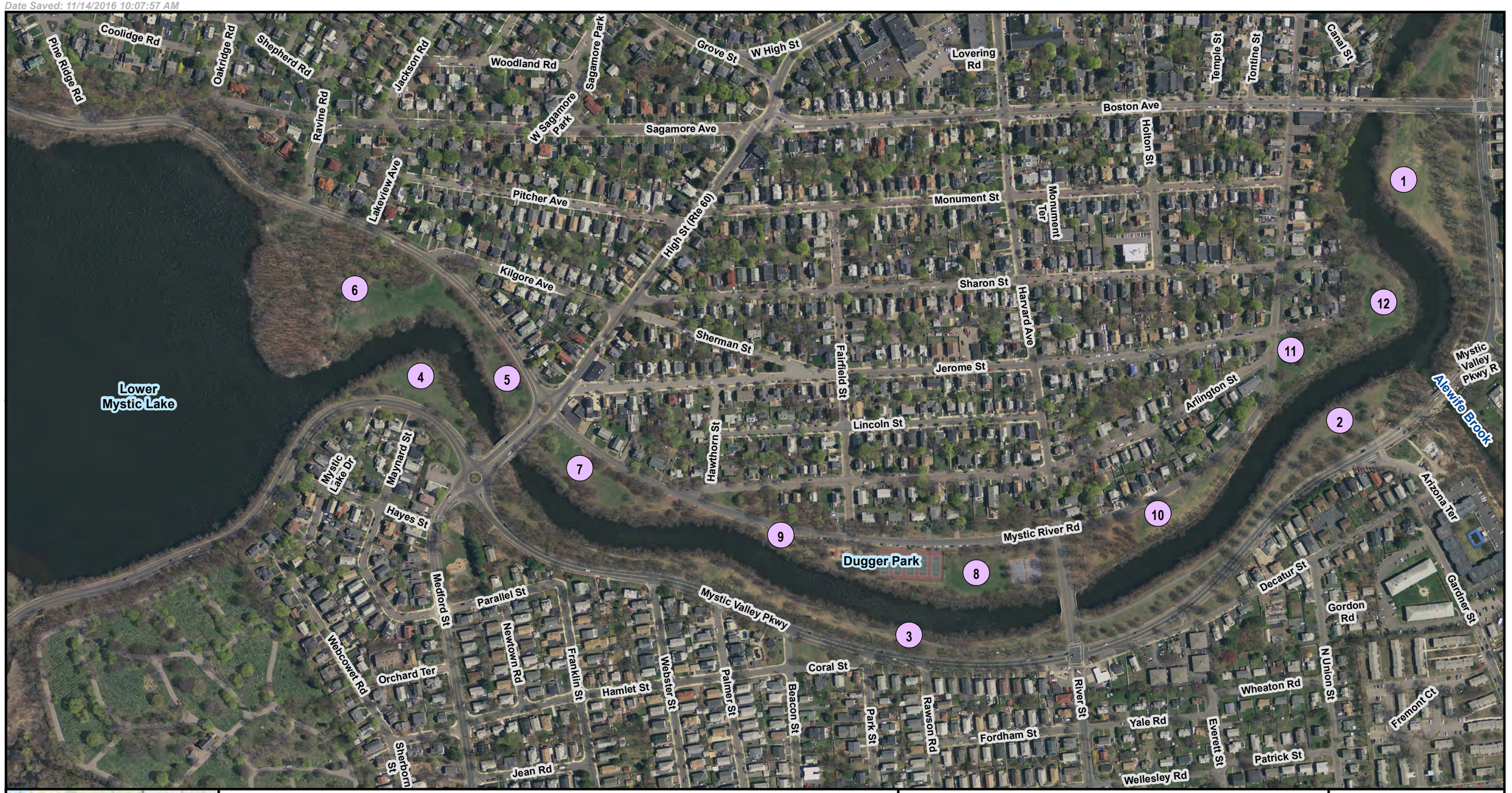

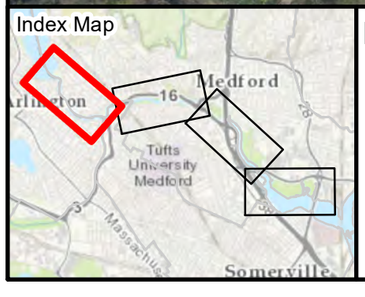

Legend

Potential Ecological and Riverbank Restoration Locations

N

1 inch = 350 feet

0 350 700

Feet

Source:
-MassGIS
Basemap & Environmental Data
-Aerial & Topo Imagery
ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community

MYSTIC RIVER ECOLOGICAL AND RIVERBANK RESTORATION OPPORTUNITY LOCATIONS PLAN

FIGURE 3

Somerville, Medford & Arlington, MA

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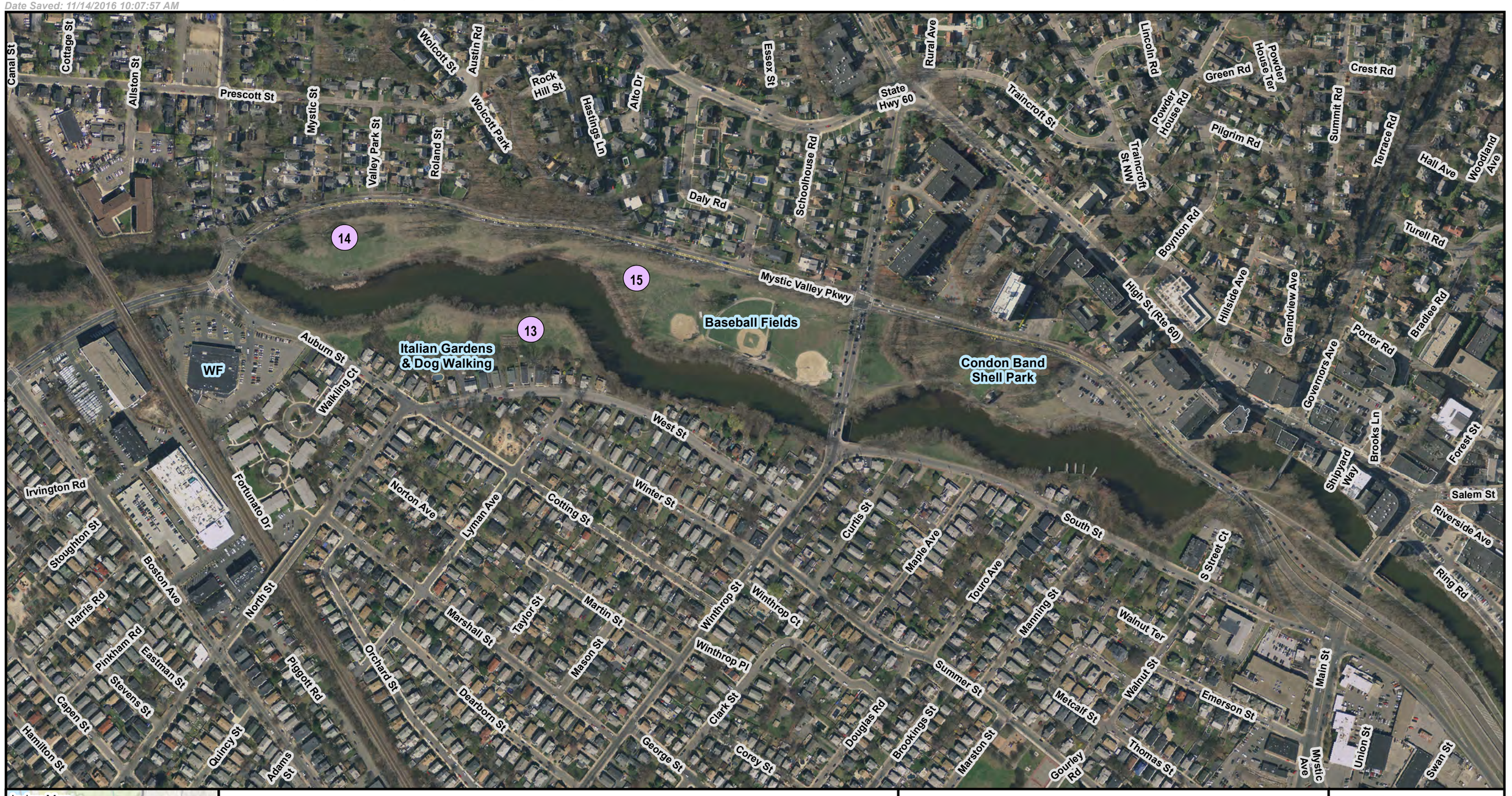

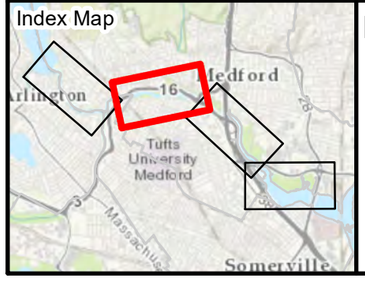

Legend

Potential Ecological and Riverbank Restoration Locations

N

1 inch = 350 feet

0 350 700

Feet

Source:
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ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community

MYSTIC RIVER ECOLOGICAL AND RIVERBANK RESTORATION OPPORTUNITY LOCATIONS PLAN

FIGURE 3

Somerville & Medford, MA

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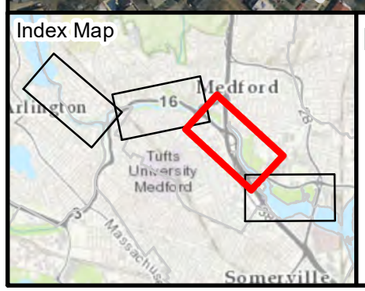

Legend

Potential Ecological and Riverbank Restoration Locations

1 inch = 350 feet

0 350 700

Feet

Source:
-MassGIS
Basemap & Environmental Data
-Aerial & Topo Imagery
ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community

MYSTIC RIVER ECOLOGICAL AND RIVERBANK RESTORATION OPPORTUNITY LOCATIONS PLAN

FIGURE 3

Medford, MA

Mystic River Watershed Association
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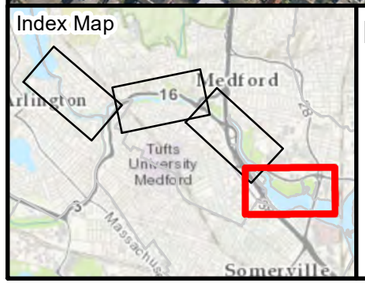

Legend

Potential Ecological and Riverbank Restoration Locations

N

1 inch = 350 feet

0 350 700

Feet

Source:
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Basemap & Environmental Data
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ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community

MYSTIC RIVER ECOLOGICAL AND RIVERBANK RESTORATION OPPORTUNITY LOCATIONS PLAN

FIGURE 3

Somerville & Medford, MA
Page 4 of 4

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MYSTIC RIVER ECOLOGICAL RESTORATION AND RESILIENCY OPPORTUNITIES TABLE

Key Value	GOOD	BETTER	BEST	(*= Priority location)
Feasibility	X	X	X	X = Feasible

LOCATION NUMBER

Prj #	RESTORATION/RESILIENCY OPPORTUNITY	1*	2	3	4	5	6*	7	8	9	10	11	12	13	14	15
	Direct action															
1	River bank restoration/ invasive control	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	Armored bank restoration/ invasive control															
3	Upland invasive control/ revegetation					X										
4	Woodland restoration/ invasive control					X	X	X		X						
5	Wetland invasive control/ revegetation															
6	Lawn to meadow transition	X			X		X	X				X	X	X	X	
7	Arboretum enhancement	X	X	X	X				X		X	X	X		X	X
8	Species inventory	X	X	X	X	X	X	X	X		X	X	X		X	X
	Intensive transformation															
9	New wetland construction	X	X		X	X	X	X			X	X	X		X	
10	New meadow construction wet/dry 'cultural grassland'	X			X			X				X	X		X	
11	New heath construction		X	X		X	X	X		X					X	
12	New savanna construction	X	X			X		X			X	X	X	X	X	
13	New woodland construction				X	X	X				X	X	X		X	
14	New marsh construction (High, Low)															
15	Bank modification	X	X	X												
16	Floodplain restoration/ modification	X	X		X	X		X				X	X		X	
	Ecological/ resilience Enhancement Projects															
17	Habitat enhancements				X	X	X								X	
18	Educational interpretation					X			X							X
19	Furnishings/ gathering space				X		X									
20	Stormwater treatment/incorporation	X	X	X	X	X	X	X			X	X	X	X	X	
21	Flood storage enhancement	X	X		X		X	X							X	
	Ecological Awareness & Access Projects															
22	Canoe Launch				X											X
23	Overlook deck															X
24	Boardwalk															
25	Bridge															
26	Soft trail															
27	Paved Trail	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
28	Parking Access				X											

MYSTIC RIVER ECOLOGICAL RESTORATION AND RESILIENCY OPPORTUNITIES TABLE

Prj #	RESTORATION/RESILIENCY OPPORTUNITY	16	17*	18*	18-1	18-2	18-3	18-4	18-5	18-6	18-7	18-8	18-8A*	18-9	18-10	18-11	18-12
	Direct action																
1	River bank restoration/ invasive control	X					X						X	X		X	
2	Armored bank restoration/ invasive control				X	X	X	X	X			X	X	X		X	X
3	Upland invasive control/ revegetation	X		X					X		X		X	X	X		X
4	Woodland restoration/ invasive control	X		X	X	X			X		X	X	X	X		X	X
5	Wetland invasive control/ revegetation	X	X	X	X	X	X	X	X				X	X			X
6	Lawn to meadow transition	X		X					X	X							
7	Arboretum enhancement	X		X	X	X	X	X	X		X	X	X	X	X	X	X
8	Species inventory	X		X	X	X	X		X	X	X	X	X	X	X	X	X
	Intensive transformation																
9	New wetland construction	X	X	X									X	X			X
10	New meadow construction wet/dry 'cultural grassland'			X									X				X
11	New heath construction	X		X			X					X	X			X	
12	New savanna construction	X		X							X		X				X
13	New woodland construction			X							X	X	X	X			
14	New marsh construction (High, Low)							X					X				X
15	Bank modification	X			X	X	X	X					X	X		X	X
16	Floodplain restoration/ modification		X		X	X	X	X					X	X		X	X
	Ecological/ resilience Enhancement Projects																
17	Habitat enhancements	X	X	X			X	X			X	X	X	X			X
18	Educational interpretation			X			X	X	X	X	X				X		
19	Furnishings/ gathering space			X	X		X	X	X		X		X		X		X
20	Stormwater treatment/incorporation		X		X	X		X						X	X		
21	Flood storage enhancement		X	X	X	X		X				X	X	X	X		X
	Ecological Awareness & Access Projects																
22	Canoe Launch	X					X									X	
23	Overlook deck				X	X		X	X							X	X
24	Boardwalk				X							X	X				X
25	Bridge				X												X
26	Soft trail		X	X								X		X			X
27	Paved Trail		X												X	X	
28	Parking Access	X													X		

MYSTIC RIVER ECOLOGICAL RESTORATION AND RESILIENCY OPPORTUNITIES TABLE

Prj #	RESTORATION/RESILIENCY OPPORTUNITY	18-13	19	20
	Direct action			
1	River bank restoration/ invasive control	X		
2	Armored bank restoration/ invasive control		X	X
3	Upland invasive control/ revegetation			
4	Woodland restoration/ invasive control	X		
5	Wetland invasive control/ revegetation	X		
6	Lawn to meadow transition			
7	Arboretum enhancement	X	X	
8	Species inventory	X	X	
	Intensive transformation			
9	New wetland construction	X		
10	New meadow construction wet/dry 'cultural grassland'			
11	New heath construction			
12	New savanna construction			
13	New woodland construction			
14	New marsh construction (High, Low)	X		
15	Bank modification	X		
16	Floodplain restoration/ modification	X		
	Ecological/ resilience Enhancement Projects			
17	Habitat enhancements			
18	Educational interpretation			
19	Furnishings/ gathering space			
20	Stormwater treatment/incorporation			
21	Flood storage enhancement			
	Ecological Awareness & Access Projects			
22	Canoe Launch			
23	Overlook deck		X	X
24	Boardwalk			
25	Bridge			
26	Soft trail			
27	Paved Trail			
28	Parking Access			

BSC GROUP

MEMORANDUM

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TEL 617-896-4300 - 800-288-8123

Notes on interpreting and using these memoranda for planning purposes

The following memoranda are prepared for use in planning projects prior to a complete analysis and design process for a specific site.

These are not to be used as a direct basis for design or construction budgets. They do not provide comprehensive scope for permitting, design, construction, or environmental monitoring. They represent an initial Designers opinion of limiting factors and opportunities based on the limited knowledge of each site.

They are organized by the following headings.

Project Number per matrix: **(#)**
Project Name: **Name**
This number and name refers back to the table providing a matrix of project types, and locations within the study area where we have determined sufficient feasibility for study and recommended a rating of overall value.

Budget Order of Magnitude: ($## - $##)
This number provides a rough order of magnitude cost for a given unit of the project named.
This report was issued in 2016 and is based on certain assumptions about project location, subsurface information, and observed conditions. For each year from that date consider including an escalation cost of 3% per year to the date of construction or appropriate inflation.

Unit: (Each, sy. square yard, lf. linear foot, etc.)
This provides a minimum practical unit for any project. The *Unit size* and *Budget Order of Magnitude* are affected by a number of factors such as full truckloads of material, an average amount of labor per unit, and practical limits of function or critical mass.
Provided for reference with this are a series of bullets further describing units of measure that drive the core of the *Budget Order of Magnitude*. These are intended to help understanding project costs and variables affecting them. These are also intended to allow for refinement of budgets for project sizes that fall between the units listed above.

Schedule: (#days) (# years establishment)
This describes the core construction schedule for a project *Unit*. Consider also design schedule, environmental testing, follow up monitoring, establishment of vegetation and maintenance constraints.

Prerequisites:
A number of conditions must be addressed before any project can be considered. This discussion point is intended to bring these factors to bear before significant investment of time and effort. These are notes for discussion to ensure limiting prerequisite factors are addressed before any project is considered or pursued. Any final limiting factors of an individual project will be discovered through analysis and design.

Description:
This section provides a simplified list of significant activities that will likely be part of the construction process and should be considered in relation to prerequisites, environmental impacts, volunteer opportunities, etc.

Recommendation:
This section provides an initial list of recommendations to spur discussion of the opportunities and constraints of a given project.

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MEMORANDUM

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To:	Mystic River Watershed Association (MyRWA)	**Date:**	July 24, 2016
From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **(1, 2)**
Project Name: **(1) River Bank Restoration/Invasive Control, (2) Armored Bank Restoration**

Budget Order of Magnitude: $1,000-$5,000
Square Yard Cost. Minimum Area 10 yd.

- Coordination costs 5%
- Design costs 1%
- Mobilization 5%
- Material costs $50-$100/yd.
- Labor Volunteer or $3000/day contractor team of Four: 1 Foreman & 3 Laborers.
- Licensed Herbicide applicator or machine operator. $1000/ day. Three (3) treatments prior to planting.
- For projects requiring Contract labor assume 20% Overhead and Profit.

Schedule:

- 1 day construction per unit.
- 2 years' establishment, permanent, once annual maintenance.

Prerequisites:

- Requires licensed herbicide applicator.
- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.

Description:

- Installation of erosion control measures where required.
- No intentional soil disruption or significant excavation beyond that necessary to install restoration plantings.
- Site preparation, herbicide or clear & grub, through DCR or private contractor. Site preparation to include invasive vegetation removal.
- Planting through Volunteer efforts or private contractor. Methods may include but are not limited to the following: live-stake of armored banks, live-stake of wetland, live fascines for bank stabilization/revegetation, plug/container planting, conservation seeding, seeded compost top-dress, seeded wattle, use of tree trunks and root masses.
- Follow up: maintenance period 60 days. Establishment period two (2) years. Maintenance period to include watering twice weekly, hand weeding & replacement of failed plantings. Establishment period to include biannual removal of invasive plants and weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.

Recommendation:

- Coordinate efforts to pair invasives control with public amenity features to ensure community investment, visibility, and assessment of best practices.
- Coordinate location of invasives control to achieve stability through critical mass.
- Assess bordering threats such as proximity of established invasive seed sources.
- Assess opportunities for coordinated habitat enhancement, educational resources.

- Ensure project budgets and contracts with private companies include sufficient retainage for maintenance and establishment period, and coordination costs for oversight.

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From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (3), (4)**
Project Name: **Upland Invasive Control/ Revegetation. Woodland Restoration/ Invasive Control.**

Budget Order of Magnitude: $2,000-$6000
Unit: Square Yard Cost. Minimum Area 10yd.

- Coordination costs 5%
- Design costs 5%
- Mobilization 5%
- Material costs $3-$30/yd.
- Labor cost Volunteer or $3000/day contractor team of four: 1 Foreman & 3 Laborers.
- Licensed Herbicide applicator. $1000/ day. Three (3) treatments prior to planting. (Cut & Brush Selective Treatment).
- For projects requiring Contract labor assume 20% Overhead and Profit.

Schedule:

- Preparation 1 year,
- construction 1 day/ unit,
- establishment 2 year,
- once-annual maintenance.

Prerequisites:

- Requires licensed herbicide applicator.
- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.

Description:

- Evaluation of existing native shrub/tree species for effective naturalization.
- Installation of erosion control measures where required.
- No intentional soil disruption or significant excavation beyond that necessary to install restoration plantings.
- Site preparation to include selective invasive vegetation removal.
- Planting of select native species, soil amendment, mulching, watering, and weeding during maintenance period.
- Follow up: Establishment period two (2) years. Establishment period to include biannual removal of invasive plants and weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.

Recommendation:

- Assess safety and perceived safety considerations.
- Maintain stability through critical mass, and coordinated invasive control.
- Assess bordering threats such as proximity of established invasive seed sources.
- Assess opportunities for coordinated habitat enhancement, educational resources.
- Ensure clear communication and understanding of maintenance personnel.

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TEL 617-896-4300 - 800-288-8123

To:	Mystic River Watershed Association (MyRWA)	**Date:**	July 24, 2016
From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (5)**
Project Name: **Wetland Invasive Control/ Revegetation. Woodland Restoration/ Invasive Control.**

Budget Order of Magnitude: $1,500-$6,000
Unit: Square Yard Cost. Minimum Area 10yd.

- Coordination costs 5%
- Design costs 8%
- Material costs $10-$30/yd.
- Labor cost Volunteer or $3000/day contractor team of four: 1 Foreman & 3 Laborers.
- Licensed Herbicide applicator. $1000/ day. Three (3) treatments prior to planting. (Cut & Brush Selective Treatment).
- Access controls: swamp mats & erosion control barrier. 10%
- For projects requiring Contract labor assume 20% Overhead and Profit.

Schedule:

- 1 year preparation,
- 1 day/ unit construction,
- 2 years' establishment,
- permanent once-annual maintenance.

Prerequisites:

- Requires licensed herbicide applicator.
- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.

Description:

- Evaluation of existing native shrub/tree species for effective naturalization.
- Installation of erosion control measures where required.
- Limited soil disruption or significant excavation beyond that necessary to install restoration plantings.
- Site preparation to include selective invasive vegetation removal.
- Planting of select native species, mulching, watering, and weeding during maintenance period.
- Follow up: Establishment period two (2) years. Establishment period to include biannual removal of invasive plants and weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.

Recommendation:

- Assess potential erosion or habitat disruption impacts.
- Maintain stability through critical mass, and coordinated invasive control.
- Assess bordering threats such as proximity of established invasive seed sources.
- Assess opportunities for coordinated habitat enhancement, flood storage and storm water controls.
- Ensure clear communication and understanding of maintenance personnel.

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TEL 617-896-4300 - 800-288-8123

To:	Mystic River Watershed Association (MyRWA)	**Date:**	July 24, 2016
From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **(6)**
Project Name: **Lawn To Meadow Conversion.**

Budget Order of Magnitude: $500-$1000
Square Yard Cost. Minimum Area 30 yd.

- Coordination costs 5%
- Design & testing costs 5%
- Mobilization 5%
- Material costs $3-$10/yd.
- Labor Volunteer or $3000/day contractor team of four: 1 Foreman & 3 Laborers.
- Licensed Herbicide applicator. $1000/ day. Three (3) treatments prior to planting.
- For projects requiring Contract labor add 20% Overhead and Profit.

Schedule:

- Change to maintenance methods. One (1) day per year, modification, twice-annual establishment.
- Permanent biannual maintenance.
- annual assessment & modification.

Prerequisites:

- Requires licensed herbicide applicator.
- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Soils assessment & amendment.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.

Description:

- Evaluation of existing turf species for effective naturalization with soil test and amendment.
- Installation of erosion control measures where required.
- No intentional soil disruption or significant excavation beyond that necessary to install restoration plantings.
- Site preparation to include selective invasive vegetation removal, assessment of solar aspect, & threats.
- Reduction of mowing to twice annually, modification of mowing practice to allow meadow species 10” mow height. Planting of key meadow species through volunteer efforts or private contractor. Methods may include but are not limited to the following: compost top-dress, conservation seeding, plug/container planting of forbes. See details and specifications.
- Follow up: Establishment period two (2) years. Establishment period to include biannual removal of invasive plants and weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.
- Perpetual maintenance program as coordinated with DCR.

Recommendations:

- Include mowed turf borders and signage for control of encroaching woody vegetation, clear boundary of intentional meadow, visibility, and value as a passive recreation feature.
- Maintain stability through critical mass, solar exposure, soil assessment and amendment, and coordinated invasive control.

- Assess bordering threats such as proximity of established invasive seed sources.
- Assess opportunities for coordinated habitat enhancement, educational resources.
- Ensure clear communication and understanding of maintenance personnel.

BSC GROUP

MEMORANDUM

803 SUMMER STREET, BOSTON, MA 02127 - www.bscgroup.com
TEL 617-896-4300 - 800-288-8123

To:	Mystic River Watershed Association (MyRWA)	**Date:**	July 24, 2016
From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (7)**
Project Name: **Arboretum Enhancement**

Budget Order of Magnitude: $2000. to $15,000
Unit: 10 trees per day

- Coordination costs 5%
- Design costs 5%
- Mobilization 5%
- Material costs $100-$1300 per tree with soil & amendments.
- Labor Volunteer or $2000/day contractor team of three 1 Foreman & 2 Laborers.
- Machine operator. $1000/ day.
- For projects requiring Contract labor add 20% Overhead and Profit.

Schedule:

- 1 day/unit construction,
- 1 years' establishment,
- permanent once annual maintenance.

Prerequisites:

- Inventory of species, coordinated tree selection.
- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.

Description:

- No intentional soil disruption or significant excavation beyond that necessary to install trees.
- Site preparation to include invasive vegetation removal.
- Planting through Volunteer efforts or private contractor.
- Soil assessment and amendments.
- Staking of large material in exposed locations.
- Follow up: maintenance period 60 days. Establishment period one (1) year. Maintenance period to include watering twice weekly, hand weeding & replacement of failed plantings. Establishment period to include biannual pruning, removal of weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.
- Permanent markers and mapping of arboretum species.

Recommendation:

- Ensure project budgets and contracts with private companies include sufficient retainage for maintenance and establishment period, and coordination costs for oversight.
- Consider bare root tree plantings when possible. These limit transportation constraints and allow for more volunteer labor. Properly installed, they have a higher success rate than B&B-balled & burlap plantings. Note these are limited seasonally and schedule must be carefully coordinated with nursery source.

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MEMORANDUM

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Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (8)**
Project Name: **Species Assesment**

Budget Order of Magnitude: $1000. to $2,000
Unit: 100 trees per day

- Coordination costs 5%
- Planning costs 5%
- Materials $500, 30 trees tagged (signs $15 each)
- Labor Volunteer and or $1000/day Arborist/ horticulturalist.
- For projects requiring Contract labor add 20% Overhead and Profit.

Schedule:

- 1 day/ unit construction,

Prerequisites:

- None.

Description:

- No intentional soil disruption or impact to existing species trees.
- Permanent markers and mapping of arboretum species.

Recommendation:

- Coordinate Species assessment with planning documents.
- Select species to be identified by location and value.

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MEMORANDUM

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From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (9)**
Project Name: **New Wetland Construction - Conversion From Adjacent Uplands/Potential Floodplain Restoration.**

Budget Order of Magnitude: $15,000-$20,000
Unit: Minimum Area 10yd.

- Coordination costs 5%
- Design costs 10%
- Mobilization 5%
- Plant material costs $5-$50/yd.
- Labor cost volunteer labor for planting/ seeding and or $3000/day-unit contractor team of four 1 Foreman & 3 Laborers.
- Machine operator $1000/ day-unit.
- Access controls swamp mats & erosion control barrier $500-$1000
- Excavation: $25/cy. = $25/sy.
- Material disposal: on site $50/cy. offsite $70/cy., Contaminated soils disposal offsite $300/cy.
- Placement of wetland soils $80/cy. = $20/sy.
- Seed establishment $5/yd.
- Groundwater Monitoring well $1200 ea.,
- For projects requiring Contract labor add 20% Overhead and Profit.
- Construction and post-construction environmental monitoring: Variable costs

Schedule: Pre-construction monitoring of groundwater table (minimum 1 growing season, preferably multiple growing seasons), 2-day construction, 2 years' establishment.

Prerequisites:

- Requires permitted excavation adjacent to wetlands.
- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.
- Soil testing for contamination.
- LSP (Licensed Site Professional) available for unexpected hazards.

Description:

- Evaluation of water table & soil profile for effective wetland establishment, groundwater monitoring well(s).
- Evaluation of existing native shrub/tree species for effective naturalization.
- Installation of access control measures where required.
- Significant soil disruption.
- Site preparation to include erosion control & stock pile/mobilization staging area.
- Planting of select native species, mulching, watering, and weeding during maintenance period.
- Plan for construction period and post-construction period environmental monitoring.
- Volunteers could design, build and install signage explaining ecological and climate resiliency value of

restoration effort.

- Follow up: Establishment period (2) two years. Establishment period to include biannual removal of invasive plants and weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.

Recommendation:

- Assess potential erosion contamination impacts.
- Maintain stability through critical mass, and coordinated invasive control.
- Assess invasive soil seed bank & root stock.
- Assess bordering threats such as proximity of established invasive seed sources.
- Assess opportunities for coordinated habitat enhancement flood storage and storm water controls.
- Ensure clear communication and understanding of maintenance personnel.

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MEMORANDUM

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From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (10)**
Project Name: **New Meadow Establishment.**

Budget Order of Magnitude: $10,000
Square Yard Cost. Minimum Area 30 yd.

- Coordination costs 5%
- Design costs 5%
- Mobilization 5%
- Material costs $3-$30/yd.
- Labor cost Volunteer planting and Seeding and or $3000/day contractor team of four 1 Foreman & 3 Laborers per 30 yd. unit.
- Licensed Herbicide applicator. $1000/ day. (3) treatments prior to planting. 30 yd. unit.
- Construction and post-construction environmental monitoring: Variable costs.
- For projects requiring Contract labor add 20% Overhead and Profit.

Schedule:

- 1 year preparation
- 1 month construction
- 2 years' establishment
- permanent biannual maintenance

Prerequisites:

- Requires licensed herbicide applicator.
- Requires contracted labor & heavy equipment.
- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.
- Soils assessment.

Description:

- Soil test and amendment.
- Evaluation of existing turf species for effective naturalization.
- Installation of erosion control measures where required.
- Site preparation to include clear & grub of invasive species, follow-up herbicide treatment of germinated seed bank, assessment of solar aspect, & threats.
- Specialized mowing twice annually, modification of mowing practice to allow meadow species 10" mow height.
- Planting of key meadow species through volunteer efforts or private contractor. Methods may include but are not limited to the following: compost top-dress, conservation seeding, plug/container planting of forbes. See details and specifications.
- Follow up: Establishment period (2) two years. Establishment period to include biannual removal of invasive plants and weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.

- Perpetual maintenance program as coordinated with DCR.

Recommendation:

- Include mowed turf borders and signage for control of encroaching woody vegetation, clear boundary of intentional meadow, visibility, and value as a passive recreation and ecological feature. Volunteers could create, build and install signage.
- Maintain stability through critical mass, solar exposure, soil assessment and amendment, and coordinated invasive control.
- Install flowering plants and forbes separately after grasses have been established through mowing.
- Assess bordering threats such as proximity of established invasive seed sources.
- Assess opportunities for coordinated habitat enhancement, educational resources.
- Ensure clear communication and understanding of maintenance personnel.

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MEMORANDUM

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From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (11), (12), (13)**
Project Name: **New Upland Habitat Construction: Heath, Savanah, Cultural Grassland**

Budget Order of Magnitude: $20,000-$unlimited
Unit: Square Yard Cost. Minimum Area 100yd. three-day minimum.

- Coordination costs 5%
- Design costs 5%
- Mobilization 5%
- Material costs $3-$30/yd.
- Labor cost Partial Volunteer and/ or $3000/day contractor team of four: 1 Foreman & 3 Laborers.
- Machine operator $1000/ day-unit.
- Access controls & erosion control barrier $500
- Material disposal: on site $50/cy. offsite $70/cy., Contaminated soils disposal offsite $300/cy.
- Amendment of soils $10/yd.
- Seed establishment/ mulch $5/yd.
- Interpretive/ recreational features extra.
- For projects requiring Contract labor add 20% Overhead and Profit.

Schedule:

- Preparation 1 year
- construction 3 days
- establishment 1 year
- once-annual maintenance

Prerequisites:

- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.

Description:

- Evaluation of microclimate and abutting conditions for effective naturalization.
- Installation of erosion control and access measures where required.
- Amendment of soil necessary to install restoration plantings.
- Site preparation to include grading connection of foot paths and selective clearing of adjacent vegetation.
- Planting of select native species, soil amendment, mulching, watering, and weeding during maintenance period.
- Follow up: Establishment period two (2) years. Establishment period to include biannual removal of invasive plants and weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.

Recommendation:

- Assess safety and perceived safety considerations.
- Maintain stability through critical mass, and coordinated invasive control.
- Assess bordering threats such as proximity of established invasive seed sources.
- Assess opportunities for coordinated habitat enhancement, educational resources.

- Ensure clear communication and understanding of maintenance personnel.

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From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (14)**
Project Name: **New Salt Marsh Construction.**

Budget Order of Magnitude: $15,000-$unlimited
Unit: Minimum Area 10yd.

- Coordination costs 5%
- Design costs 10%
- Mobilization 5%
- Plant material costs $10-$25/yd.
- Labor cost Volunteer planting and $3000/ day contractor team of four: 1 Foreman & 3 Laborers.
- Machine operator $1000/ day.
- Access controls swamp mats & erosion control barrier, coffer-dams $2000-$4000
- Material disposal: on site $50/cy. offsite $70/cy., Contaminated soils disposal offsite $300/cy.
- Placement of wetland soils $80/cy.
- Seed establishment $5/yd.
- Groundwater Monitoring well installation $1200 ea. 2/area,
- Construction and post-construction environmental monitoring: Variable depending on project specifics.
- For projects requiring Contract labor assume 20% Overhead and Profit.

Schedule:

- Pre-construction monitoring of groundwater table (minimum 1 growing season, preferably multiple growing seasons), 2-day construction per unit.
- 2 years' establishment period.

Prerequisites:

- Effective overall salination program has been performed to achieve sufficient salinity.
- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.

Description:

- Evaluation of water table & soil profile for effective marsh establishment, groundwater monitoring well(s).
- Installation of access control measures where required.
- Significant soil disruption.
- Site preparation to include erosion control & stock pile/mobilization staging area.
- Planting of select species, mulching, watering, and weeding during maintenance period.
- Plan for construction period and post-construction period environmental monitoring.
- Volunteers could design, build and install signage explaining ecological and climate resiliency value of restoration effort.
- Follow up: Establishment period (2) two years. Establishment period to include biannual removal of invasive plants and weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.

Recommendation:

- Assess potential erosion contamination impacts.
- Maintain stability through critical mass, and coordinated invasive control.
- Assess invasive soil seed bank & root stock.
- Assess bordering threats such as proximity of established invasive seed sources.
- Assess opportunities for coordinated habitat enhancement flood storage and storm water controls.
- Ensure clear communication and understanding of maintenance personnel.

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From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (15, 16)**
Project Name: **15 New Wetland Construction - Conversion From Adjacent Uplands/ 16 Potential Floodplain Restoration.**

Budget Order of Magnitude: $25,000-$unlimited
Unit: Minimum Area 50yd. three-day construction period.

- Coordination costs 5%
- Design costs 10%
- Mobilization 5%
- Plant material costs $5-$50/yd.
- Labor cost Volunteer planting and $3000/ day contractor team of four: 1 Foreman & 3 Laborers.
- Machine operator $1000/ day.
- Access controls swamp mats & erosion control barrier, coffer-dams $500-$2000
- Material disposal: on site $50/cy. offsite $70/cy., Contaminated soils disposal offsite $300/cy.
- Placement of wetland soils $80/cy.
- Seed establishment $5/yd.
- Groundwater Monitoring well installation $1200 ea. 2/area,
- Construction and post-construction environmental monitoring: Variable depending on project specifics.
- For projects requiring Contract labor assume 20% Overhead and Profit.

Schedule:

- Pre-construction monitoring of groundwater table (minimum 1 growing season, preferably multiple growing seasons),
- 3-day construction per unit.
- 2 years' establishment period.

Prerequisites:

- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.

Description:

- Evaluation of water table & soil profile for effective wetland establishment, groundwater monitoring well(s).
- Evaluation of existing native vegetation species & terrain for effective naturalization.
- Installation of access control measures where required.
- Significant soil disruption.
- Site preparation to include erosion control & stock pile/mobilization staging area.
- Planting of select species, mulching, watering, and weeding during maintenance period.
- Plan for construction period and post-construction period environmental monitoring.
- Volunteers could design, build and install signage explaining ecological and climate resiliency value of restoration effort.
- Follow up: Establishment period (2) two years. Establishment period to include biannual removal of invasive

plants and weeds, annual replacement of failed plantings, and watering as needed to naturalize plantings.

Recommendation:

- Assess potential erosion contamination impacts.
- Maintain stability through critical mass, and coordinated invasive control.
- Assess invasive soil seed bank & root stock.
- Assess bordering threats such as proximity of established invasive seed sources.
- Assess opportunities for coordinated habitat enhancement flood storage and storm water controls.
- Ensure clear communication and understanding of maintenance personnel.

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From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Name: **(17) Habitat Enhancement**

Budget Order of Magnitude: $1,000-$5,000
Square Yard Cost. Minimum Area 10 yd.

- Coordination costs 5%
- Design costs 1%
- Mobilization 5%
- Material costs $5-$100/yd.
- Labor Volunteer and or $3000/day contractor team of four: 1 Foreman & 3 Laborers.
- Machine operator. $1000/ day.
- For projects requiring Contract labor assume 20% Overhead and Profit.

Schedule:

- 1 day construction per unit.

Prerequisites:

- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.

Description:

- Installation of erosion control measures where required.
- Installation of snag trees, brush piles, stone cairns, logs, nesting boxes, nesting terrain, forage plantings, habitat plantings, and or interpretation features.
- No intentional soil disruption or significant excavation beyond that necessary to install enhancements.
- Site preparation, or clear & grub, through DCR or private contractor. Site preparation to include invasive vegetation removal.
- Installation through Volunteer efforts or private contractor.
- Follow up: general annual maintenance for constructed features and standard maintenance and establishment practices for plantings, replacement of failed plantings, and watering as needed to naturalize plantings.

Recommendation:

- Coordinate efforts to support or retain species that are present but threatened.
- Select locations based on connections to necessary species resources.
- Assess bordering threats such as human interference, predators, and microclimate, or vegetation constraints
- Use materials found on site to the extent feasible.
- Assess opportunities for coordinated habitat enhancement, educational resources.
- Ensure project budgets and contracts with private companies include sufficient retainage for maintenance and establishment period, and coordination costs for oversight.

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From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix **(18,19)**
Project Name: **(18) Educational or Interpretive features (19) Furnishings, Gathering Space**

Budget Order of Magnitude: $3,000-$unlimited
Per unit cost each.

- Coordination costs 5%
- Design costs 20%
- Mobilization 5%
- Material costs $500-$2,500/yd.
  $1500/day contractor team of two: 1 Foreman & 1 Laborers.
- Machine operator. $1000/ day.
- For projects requiring Contract labor assume 20% Overhead and Profit.

Schedule:

- 1 day construction per unit.

Prerequisites:

- Restoration is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.

Description:

- Installation of erosion control measures where required.
- Installation of benches, furnishings, interpretive signage, display bulletin case, kiosk, art works, view finders, or other interpretation features and their associated footings.
- No intentional soil disruption or significant excavation beyond that necessary to install enhancements.
- Installation through Volunteer efforts may be possible but typically requiring private contractors for footings.
- Follow up: general annual maintenance for constructed features.

Recommendation:

- Coordinate furnishings interpretive features with specific context or associated conservation efforts.
- Ensure project budgets and contracts with private companies include sufficient retainage for coordination costs and oversight.

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Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (20, 21)**
Project Name: **20 Stormwater Treatment Feature: Rain Gardens, Bio Swales, Detention/ Retention Ponds, 21 Flood Storage Enhancement**

Budget Order of Magnitude: $15,000-$30,000
Unit: Minimum Area 10yd.

- Coordination costs 5%
- Design costs 10%
- Mobilization 5%
- Labor cost $3000/day-unit contractor team of four: 1 Foreman & 3 Laborers.
- Machine operator $1000/ day-unit.
- Access controls & erosion control barrier $500-$1000
- Excavation: $25/cy. = $25/sy.
- Material disposal: on site $50/cy. offsite $70/cy., Contaminated soils disposal offsite $300/cy.
- Installation of liners $5-15/sy.
- Drainage structures new $5000
- Drainage structures modified $350
- Piping & associated connections $3600
- Placement of bio-infiltration soils $80/cy. $30/sy.
- Placement of drainage stone.$50/cy. = $20sy.
- Seed establishment $5/yd.Plug establishment $50-100/yd.
- For projects requiring Contract labor add 20% Overhead and Profit.
- Construction and post-construction environmental monitoring: Variable costs

Schedule:

- 4-day construction, 1 year seed establishment.

Prerequisites:

- Requires permitted excavation typically adjacent to wetlands.
- Development is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.
- Soil testing for contamination.
- LSP (Licensed Site Professional) available for unexpected hazards.

Description:

- Evaluation of water table & soil profile for effective infiltration.
- Installation of access control measures where required.
- Significant soil disruption.
- Site preparation to include erosion control & stock pile/mobilization staging area.

Recommendation:

- Assess potential erosion contamination impacts.
- Assess opportunities for coordinated habitat enhancement wetland connections.

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Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (22)**
Project Name: **Canoe Launch**

Budget Order of Magnitude: $45,000-$60,000
Unit: 10'x10' ramp + stone access road 30'

- Coordination costs 10%
- Design costs 10%
- Mobilization 5%
- Labor cost $3000/day-unit contractor team of four: 1 Foreman & 3 Laborers.
- Machine operator $1000/ day-unit.
- Access controls & erosion control barriers $20/lf.
- Aquatic silt barrier $10-50/lf.
- Excavation & grading $25/sy.
- Material disposal: on site $50/cy. offsite $75/cy., Contaminated soils disposal offsite $300/cy.
- Concrete Ramp $200/sy. 10x10
- Asphalt path for accessible route.
- Signage $200 ea.
- Placement of crushed stone access $35sy.
- For projects requiring Contract labor add 20% Overhead and Profit.
- Construction and post-construction environmental monitoring: Variable costs

Schedule:

- 5-day construction plus mobilization.

Prerequisites:

- Vehicle access & parking must be in place.
- Requires permitted disturbance excavation within riverfront area.
- Development is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.
- Soil testing for contamination.
- LSP (Licensed Site Professional) available for unexpected hazards.

Description:

- Installation of access control measures where required.
- Site preparation to include erosion control & stock pile/mobilization staging area.
- Significant soil disruption and permanent impervious surface.
- Installation of cast in place or precast reinforced concrete, signage stone access road.

Recommendation:

- Assess potential erosion contamination impacts.

- Assess opportunities for pedestrian connections and educational opportunities.
- Target underutilized high visibility and easy access sites.

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From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (23, 24)**
Project Name: **23 Boardwalk, 24 Overlook Deck**

Budget Order of Magnitude: $35,000-$45,000
Unit: Each. Per 6x12 section minimum 2 sections.

- Coordination costs 10%
- Design costs 10%
- Mobilization 5%
- Vegetation clearing Volunteer labor or $500 contract labor.
- Labor cost $3000/day-unit contractor team of four: 1 Foreman & 3 Laborers.
- Machine operator $1000/ day-unit.
- Access controls & erosion control barrier $20/lf.
- Coffer Dam $500-$2,000
- Excavation and grading: $25/cy. = $25/sy.
- Prefabricated metal deck with rail $2,250/ section.
- Footings, 2 per section spread footing $500 ea., driven or helical pile $1,000 ea.
- Cross bracing required for elevated decks add $300/footing.
- For projects requiring Contract labor add 20% Overhead and Profit.
- Construction and post-construction environmental monitoring: Variable costs.

Schedule:

- 4-day construction

Prerequisites:

- Requires permitted clearing and excavation typically adjacent to wetlands.
- Development is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.
- Soil testing for contamination. (This guides footing selection) LSP (Licensed Site Professional) available for unexpected hazards.

Description:

- Installation of access control measures where required.
- Minor soil disruption.
- Site preparation to include erosion control & stock pile/mobilization staging area.
- Modular sections steel or aluminum frame. Stick built is possible but added labor and maintenance costs are prohibitive.

Recommendation:

- Assess potential erosion contamination impacts.
- Select strong pedestrian connections & view shed opportunities.

BSC GROUP

MEMORANDUM

803 SUMMER STREET, BOSTON, MA 02127 - www.bscgroup.com
TEL 617-896-4300 - 800-288-8123

To:	Mystic River Watershed Association (MyRWA)	**Date:**	July 24, 2016
From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (25)**
Project Name: **25 Pedestrian Bridge**

Budget Order of Magnitude: $100,000-$200,000
Unit: Each. Per 6'x50' bridge.

- Coordination costs 10%
- Design costs 10%
- Mobilization 10%
- Vegetation clearing Volunteer labor and or $20/yd. contract labor.
- Access controls & erosion control barrier $20/lf.
- Excavation and grading: $25/cy. = +/-$25/sy.
- Material disposal: on site $50/cy. offsite $70/cy., Contaminated soils disposal offsite $300/cy.
- 6'x50' Prefabricated metal Bridge with Rails $50,000.
- Footings, 2 per Bridge $10,000-$15000.
- Construction environmental monitoring: Variable costs.

Schedule:

- 15-day construction

Prerequisites:

- Requires permitted clearing and excavation adjacent to wetlands.
- Development is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report. Note Chapter 91 license for crossing of navigable waters.
- Soil testing for contamination. (This guides footing selection) LSP (Licensed Site Professional) available for unexpected hazards.

Description:

- Installation of access control measures where required.
- Major soil/ riverbank disruption.
- Site preparation to include erosion control & stock pile/mobilization staging area.
- Modular steel, wood or aluminum prefabricated bridge complete to be mounted on bridge abutments.
- Bridge supports may include full depth excavation and placement of concrete footings where feasible, where soft or contaminated soils are prohibitive consider helical pile supports.
- Connective pathways or deck transition ramp's not included in order of magnitude.

Recommendation:

- Select strong pedestrian connections & view shed opportunities.
- Consider flood elevations and debris flow in relation to elevation and position of any pedestrian bridge.

BSC GROUP

MEMORANDUM

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TEL 617-896-4300 - 800-288-8123

To:	Mystic River Watershed Association (MyRWA)	**Date:**	July 24, 2016
From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (26)**
Project Name: **Soft Trail**

Budget Order of Magnitude: $1,000-5,000$
Unit: Minimum Area 30yd. average 5' wide 55' long

- Coordination costs 5%
- Design costs 5%
- Mobilization 5%
- Labor cost Volunteer clearing/ grading and or $3000/ day contractor team of four 1 Foreman & 3 Laborers.
- Machine operator $1000/ day. Chipper rental $200/day
- Erosion control barrier, 10/lf.
- Excavation and grading $15/sy.
- Material disposal: on site $50/cy. offsite $70/cy, contaminated soils disposal offsite $300/cy.
- Low end surface: compaction of soils placement of woodchip granular pavement. $10/sy.
- High end surface: placement of stabilized inorganic granular pavement. $60/sy.
- Seed establishment $5/yd.
- Construction monitoring: variable depending on project specifics.
- For projects requiring contract labor assume 20% overhead and profit.

Schedule:

- 1-2-day construction per unit.

Prerequisites:

- Trail is coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.
- Grades are meet MAAB trail requirements.

Description:

- Installation of access control measures where required.
- Moderate soil disruption.
- Site preparation to include erosion control & stock pile/mobilization staging area.
- Volunteers could perform preliminary layout and clearing, significant grubbing or excavation will require machinery/ professional labor. Recommendation:
- Asses visibility and safety concerns.
- Choose trail locations based on existing wear tracks and desire lines.
- Assess bordering threats such as proximity of aggressive vegetation, soil and erosion issues.
- Assess opportunities for coordinated education and recreation features.
- Ensure clear communication and understanding of maintenance personnel to maintain access.

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MEMORANDUM

803 SUMMER STREET, BOSTON, MA 02127 - www.bscgroup.com
TEL 617-896-4300 - 800-288-8123

To:	Mystic River Watershed Association (MyRWA)	**Date:**	July 24, 2016
From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (27)**
Project Name: **Hard Trail**

Budget Order of Magnitude: $15,000-$25,000
Unit: Minimum Area 50yd. average 8' wide 60' long

- Coordination costs 5%
- Design costs 10%
- Mobilization 5%
- Labor cost $2000/ day contractor team of four 1 Foreman & 2 Laborers.
- Machine operator $1000/ day.
- Erosion control barrier, 10/lf.
- Excavation and grading $15/sy.
- Material disposal: on site $50/cy. offsite $70/cy., Contaminated soils disposal offsite $300/cy.
- Low end surface: Asphalt/ Chip-seal, $40/sy. complete in place with base.
- High end surface: Pervious pavers, Bricks. $235/sy. complete in place with base.
- Seed establishment $5/yd.
- For projects requiring contract labor assume 20% overhead and profit.

Schedule:

- 4-day construction per unit.

Prerequisites:

- Trails coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.
- Accessible surface to meet ADA/ trails requirements.
- Connection to drainage systems structures where necessary.

Description:

- Installation of access control measures where required.
- Moderate soil disruption.
- Site preparation to include erosion control & stock pile/mobilization staging area.
- Installation of pavement and related improvements.

Recommendation:

- Asses visibility and safety concerns.
- Consider volume of regular visitors and of event visitors.
- Consider pervious surface alternatives and benefits.
- Asses potential risks to water quality and contingency for controls.

BSC GROUP

MEMORANDUM

803 SUMMER STREET, BOSTON, MA 02127 - www.bscgroup.com
TEL 617-896-4300 - 800-288-8123

To:	Mystic River Watershed Association (MyRWA)	**Date:**	July 24, 2016
From:	BSC Group Inc. -Ecological & Landscape	**Proj. No.**	89561.01
Re:	**Mystic River Climate-Resilient Riverbank and Ecological Restoration Planning Project**		

Project Number per matrix: **Project (28)**
Project Name: **Parking Lot**

Budget Order of Magnitude: $15,000-$45,000
Unit: Minimum Area 5 Spaces. 200 sy.

- Coordination costs 5%
- Design costs 10%
- Mobilization 5%
- Labor cost $3000/ day contractor team of four 1 Foreman & 3 Laborers.
- Machine operator $1000/ day.
- Erosion control barrier, 10/lf.
- Excavation and grading $15/sy.
- Material disposal: on site $50/cy. offsite $70/cy., Contaminated soils disposal offsite $300/cy.
- Low end surface: crushed stone, $25/sy. complete in place.
- High end surface: Asphalt or chip/seal pavement. $45/sy. complete in place with base & marking.
- Curbed with vertical granite & drainage structures. $55/lf. Plus drainage structures.
- Curbless with swales & BMP's see project 20.
- Seed establishment $5/yd.
- For projects requiring contract labor assume 20% overhead and profit.

Schedule:

- 5-day construction per unit.

Prerequisites:

- Parking coordinated with Mystic River Master Plan, if located within Master Plan project area.
- DCR/land owner approval.
- Appropriate permits are obtained. See discussion in Section 2.1.1 of report.
- Accessible spaces and access routes to meet ADA/ MAAB.
- Connection to drainage systems structures where necessary.
- Traffic impact analysis.

Description:

- Installation of access control measures where required.
- Moderate soil disruption.
- Site preparation to include erosion control & stock pile/mobilization staging area.
- Installation of improvements.

Recommendation:

- Asses visibility and safety concerns for curb cut roadway access.
- Consider volume of regular visitors and of event visitors.
- Consider wayfinding and access to river amenities.
- Asses potential risks to water quality and contingency for controls.

Attachment E

Mystic River Watershed Association
Climate-Resilient Riverbank and Ecological Restoration Planning Project

Climate-Resilient Riverbank and Ecological Restoration Planning Report

ECOLOGICAL CLIMATE RESILIENCY MAPS

BSC GROUP

Resilient Sites for Conservation in the Eastern United States

The Nature Conservancy
Protecting nature. Preserving life.

Strongholds for Nature in a Changing Climate

Conserving the Stage: Climate change is creating an increasingly dynamic natural world by shifting species distributions and rearranging habitats. Consequently, conservationists need a way to identify important areas for protection that does not assume that the locations of existing plants and animals will stay the same. Rather than trying to protect diversity one species at a time, the key is to protect the different "stages" upon which the drama of nature unfolds. In the Eastern United States, these stages are based strongly on geology and consist of recognizable geophysical settings such as coastal sands, limestone valleys, granite summits, or silt floodplains, that each support a distinct set of species. Conserving a range of physical environments offers an approach to conservation that protects a diversity of plants and animals under both current and future climates.

Settings and Stages: The number of plants and animals in each state across the East is correlated with the number of geology types, the amount of limestone, the latitude, and range of elevation in the state. These geophysical factors form ecological regions across the landscape that support different species.

High Elevation Granite | High Elev. Limestone | High Elev. Mafic

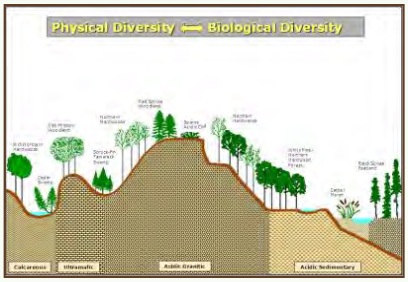
Low Elev. Sand | Low Elev. Sedimentary | Low Elev. Silt

Typical **geophysical settings** of the Eastern United States

Natural Strongholds: Lasting conservation depends on identifying and protecting places where the effects of climate change are buffered by the natural properties of the site. Conserving these places is vital to maintaining a diversity of species and natural processes regardless of changes in the climate.

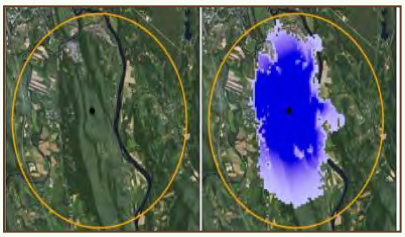
Natural strongholds are places where the direct effects of climate change are moderated by **complex** topography and **connected** natural cover, and where the current landscape contains **high quality biodiversity** features. Natural Strongholds can serve as a bridge to grant safe passage into the future for thousands of species.

In these sites, species can find areas of suitable moisture and temperature within their local neighborhood. This allows resident species populations to remain strong and helps ensure that changes in the composition and structure of the communities will be more gradual.



GEOPHYSICAL SETTINGS
are unique combinations of geology, elevation, and landforms.

COMPLEX LANDSCAPES
create "micro-climates" that buffer change by providing species with a variety of local climates.



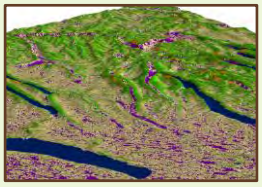
CONNECTED LANDSCAPES
offset the development, roads, and agriculture that can inhibit natural movements. Maintaining a connected area (BLUE REGION above) in which species can move ensures that the area can adapt to climate change.

Underlying data developed by The Nature Conservancy's Eastern Science Office with support from the Doris Duke Charitable Foundation and the Northeast Association of Fish and Wildlife Agencies.

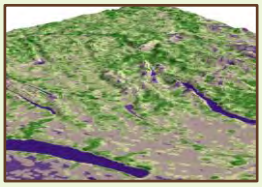
View the report, papers, and full-sized maps at:

http://www.nature.ly/TNCResilience

A Complex and Connected Landscape

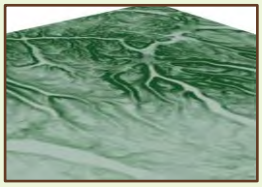


Landforms

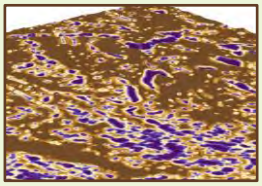


Landform Variety

Complex Landscapes: are places that have an assortment of small, connected, local climates creating a range of temperature and moisture options for the resident species. In essence, complex topography and elevation gradients break the regional climate into a wide array of micro-climates.



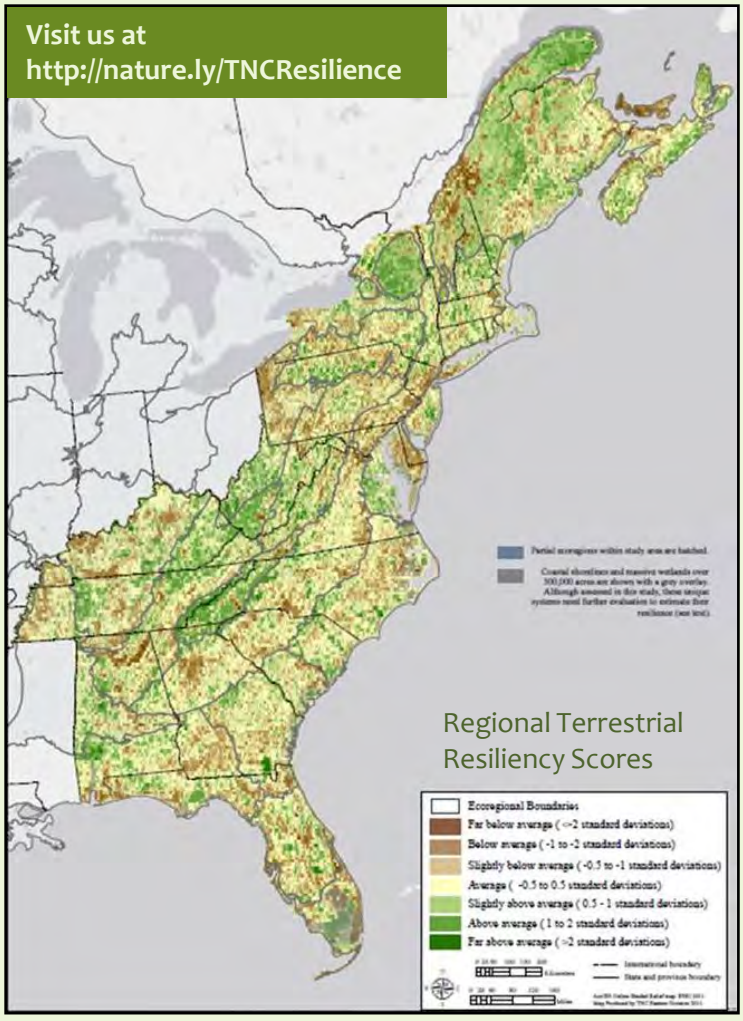
Elevation Range



Wetland Density

Connected Landscapes: are places that allow species to move and disperse, and processes like fire or water movement can occur unimpeded. This facilitates the adjustments necessary for the natural world to stay balanced with the climate. Permeable landscapes have an abundance of connected natural cover.

Visit us at http://nature.ly/TNCResilience



Regional Terrestrial Resiliency Scores

Resilient Sites: With a changing climate, many places may become degraded and lose species, but some places will retain high quality habitat and continue to support a diverse array of plants and animals. Sites that have both **complex** topography and **connected** land cover are places where conservation action is most likely to succeed in the long term.

Permanent conservation of the resilient areas should be prioritized to ensure they can continue to provide habitat for species.

Securing resilient sites safeguards natural benefits such as fresh drinking water and clean air for local communities now and into the future.

Resiliency Scores: The map shows areas that offer the greatest potential for species to adapt as the climate changes. A dark green color indicates that the area has high estimated resilience. Brown indicates areas vulnerable to climate change. The analysis estimates resiliency scores by each ecological region (gray lines) in the East.

Coastal shorelines and wetlands over 300,000 acres need further analysis.

For more information and full-sized maps, see the complete report: **http://nature.ly/TNCResilience**

Terrestrial Resilience Core Concepts

Resilient Site: An area of land with sufficient variability and microclimate options to enable species and ecosystems to persist in the face of climate change and which will maintain this ability over time.

Geophysical Settings: Broadly defined landscape types that contain a variety of plants, animals and natural habitats that occur in similar geologic environment (e.g. similar bedrock, soils and elevation zone). If conservation succeeds, each geophysical setting will support species and communities that thrive in conditions defined by its physical properties, although the species in the future may differ from those currently present. In this study, we defined geophysical settings by mapping and classifying combinations of geology and elevation.

Natural Stronghold: a resilient site that currently supports exemplary habitats, wildlife, or rare species, and may provide refuge for these elements as the climate changes.

Two Example Settings:

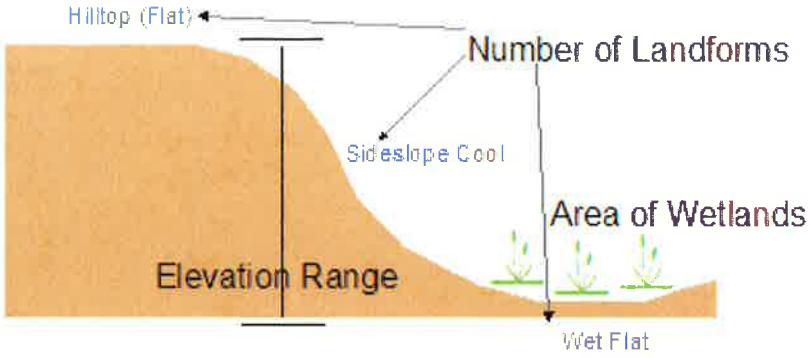
Coarse sand: Longleaf pine in Weymouth Woods SP, © Albert Herring.

Sedimentary: Sandstone at the Altamaha Rocks, © Alan Cressler.

Resilience Score: A site's Resilience Score estimates its capacity to maintain species diversity and ecological function as the climate changes. The score is relative to all other sites with the same geophysical setting and is described on a relative basis as above or below average. For example, granite mountains were compared with other granite mountains, and coastal plain sands were compared with other coastal plain sands. Our goal was to identify the places most resilient to climate change for each type of setting. A site's final resilience score was determined by evaluating physical characteristics that foster resilience, particularly the site's landscape diversity and local connectedness.

Characteristics that Foster Resilience: A resilient site is one that offers many options to species and ecosystems. Such options, include topographic and elevation diversity that provide a range of habitat types and microclimates (landscape diversity), and minimal barriers that restrict adaptive movement of species or ecosystems (local connectedness).

Landscape Diversity: Refers to the microhabitats and climatic gradients available in one's immediate neighborhood. Topographic diversity buffers against climatic effects because the persistence of species in an area increases in landscapes with a wide variety of microclimates. In this study, we measure microclimates by counting the variety of landforms, measuring elevation range, and the density of wetlands in a 100 acre neighborhood around every point on the landscape.



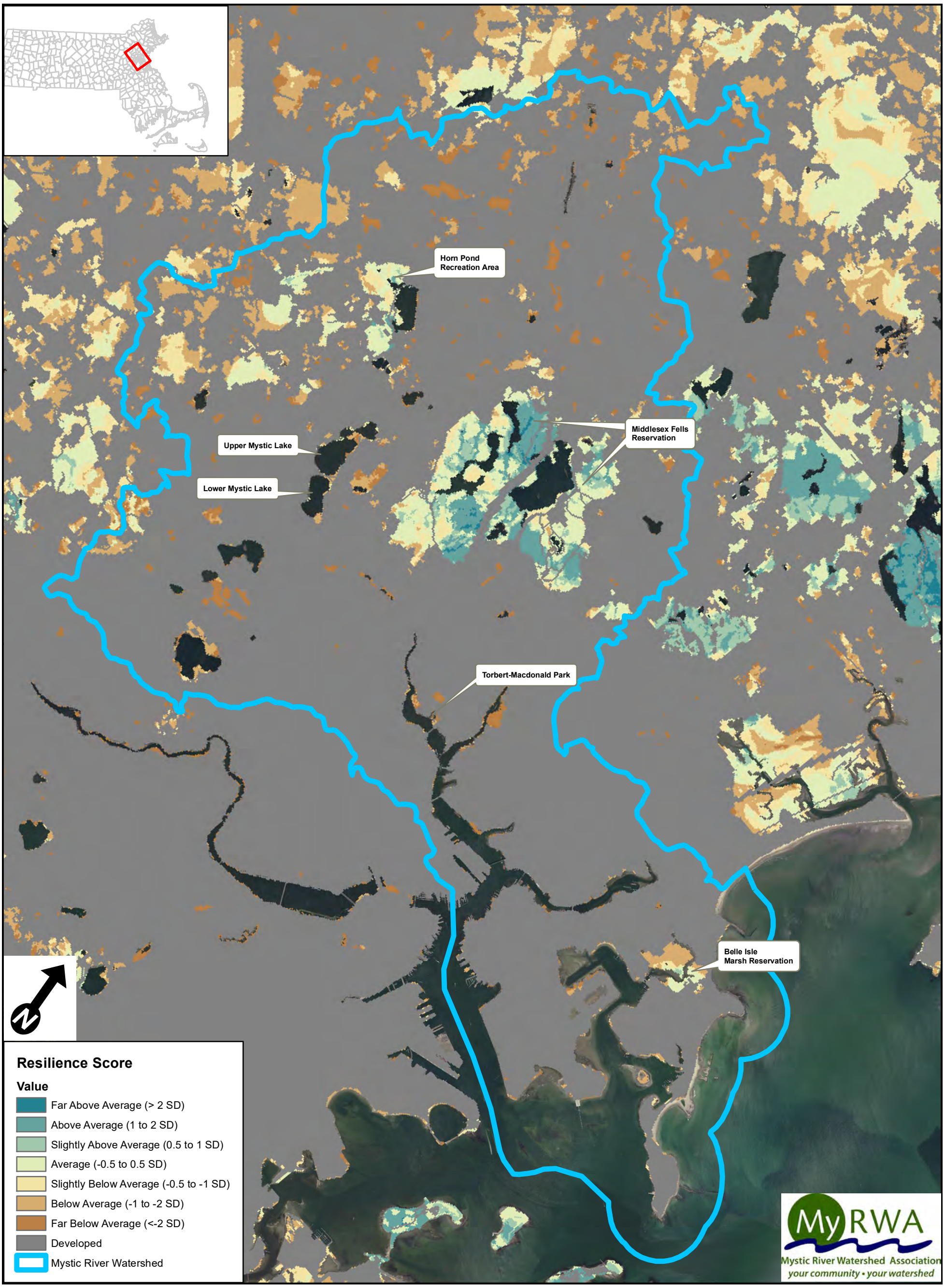
Local Connectedness: refers to the number of barriers and the degree of fragmentation within a landscape. A highly connected landscape promotes resilience by allowing species to move around the landscape and find suitable microclimates where they can persist. In this study, we measure local connectedness by measuring the amount of natural land cover and configuration of human-created barriers like major roads, developments, and agricultural land.

Many barriers. Low Local Connectivty

No barriers. High Local Connectivty

Riparian Climate Corridors: Riparian areas are the floodplains and zones along water bodies that serve as interfaces between terrestrial and aquatic ecosystems. With respect to climate change, riparian areas feature micro-climate refugia that are significantly cooler and more humid than immediately surrounding areas. Our objective was to identify intact riparian floodplain areas that serve as natural corridors to facilitate movement of plants and wildlife linearly, taking advantage of the cooler moister environment within these areas.

1. **High Flow Riparian Corridors, largely within resilient land:** These riparian corridors have high regional terrestrial permeability flow and have >75% of their land area within resilient land. They have a minimum size of 1,000 acres and are considered highly intact and resilient.
2. **High Flow Riparian Corridors, largely outside resilient land:** These riparian corridors have high regional terrestrial permeability flow, but are <75% within resilient land. They have a minimum size of 5,000 acres and touch at least 3 prioritized diversity features. They are considered more vulnerable given a significant portion of their area falls on non-resilient land.



Scale:

1 inch = 7,000 feet

0 6,500 13,000

Feet

MYSTIC RIVER WATERSHED

Figure 4
Ecological Climate Change Resiliency Score Map

Massachusetts

Source:
-MassGIS: Basemap & Environmental Data
-Aerial & Topo Imagery: ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community, Resilient and Connected Landscapes for Terrestrial Conservation - 2016 (The Nature Conservancy)

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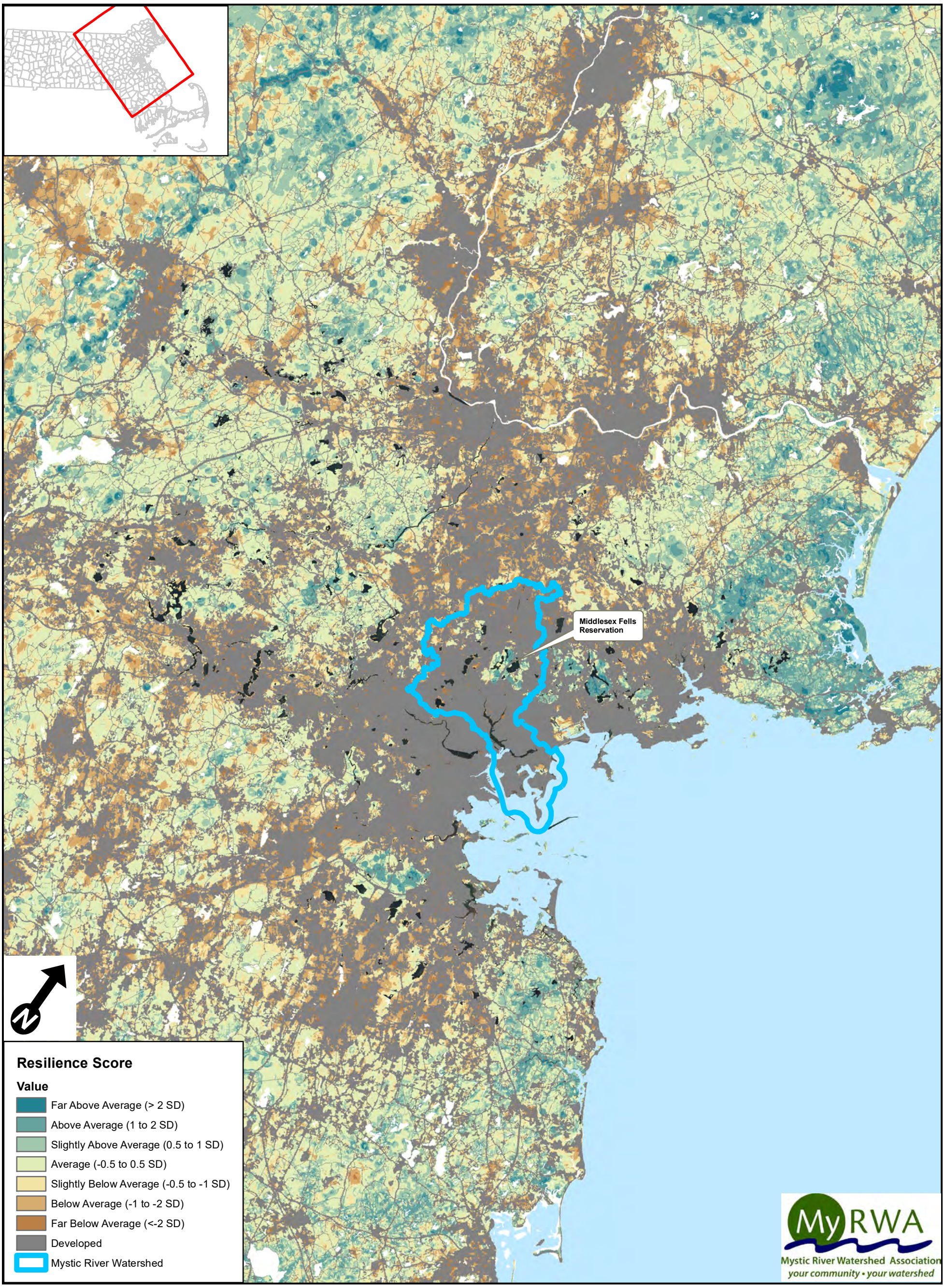

Scale:

1 inch = 33,000 feet

0 31,000 62,000

Feet

MYSTIC RIVER WATERSHED

Figure 4A
Ecological Climate Change Resiliency Score Map

Massachusetts

Source:
-MassGIS: Basemap & Environmental Data
-Aerial & Topo Imagery: ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community, Resilient and Connected Landscapes for Terrestrial Conservation - 2016 (The Nature Conservancy)

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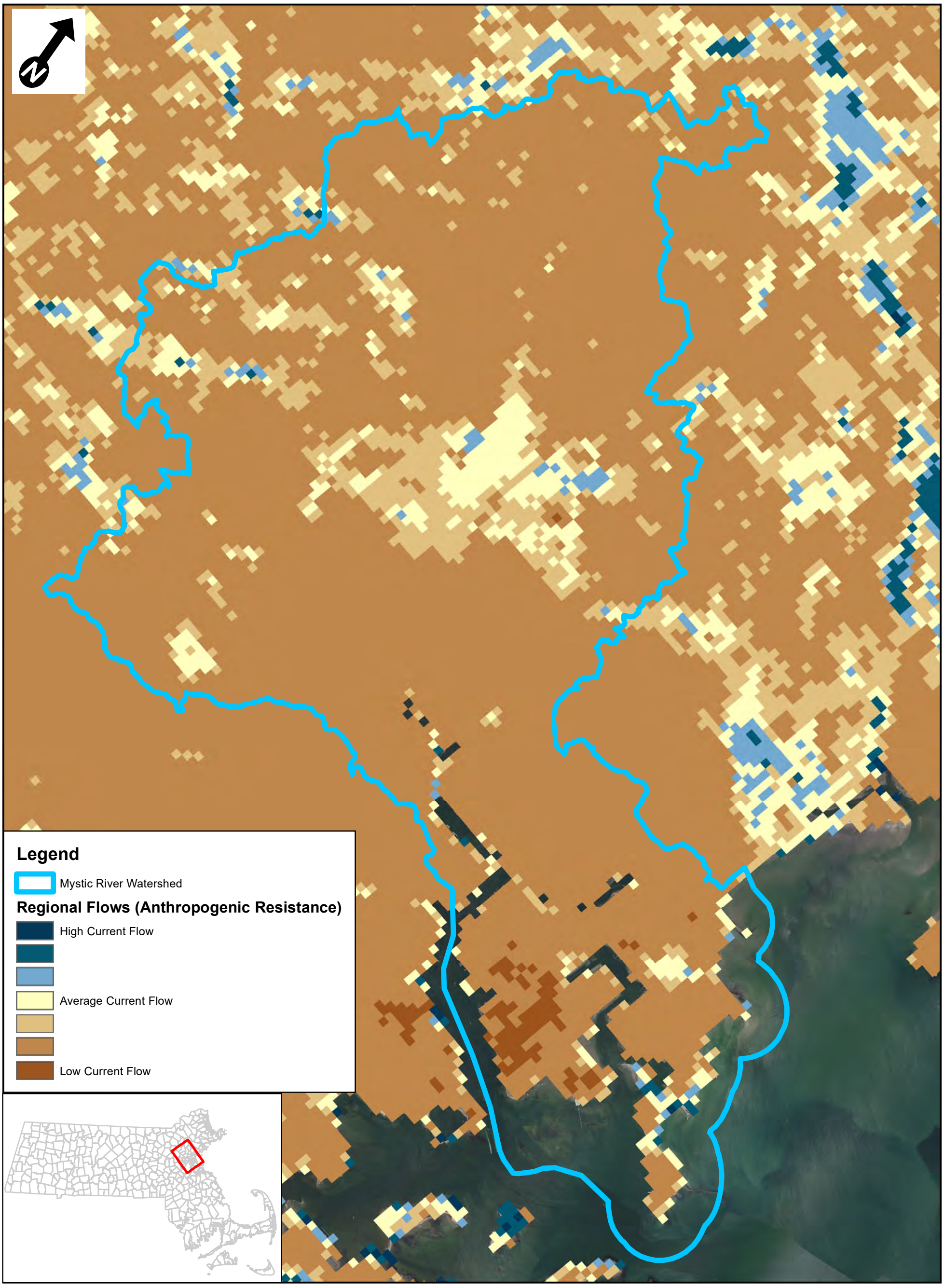

Scale:

1 inch = 7,000 feet

0 6,500 13,000

Feet

Massachusetts

MYSTIC RIVER WATERSHED

Figure 5
Regional Flows (Anthropogenic Resistance) Map

Regional Flow represents the ability, or lack thereof, for species to move across the landscape, and is a measure of landscape connectivity.

Source:
-MassGIS: Basemap & Environmental Data
-Aerial & Topo Imagery: ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community, Resilient and Connected Landscapes for Terrestrial Conservation - 2016 (The Nature Conservancy)

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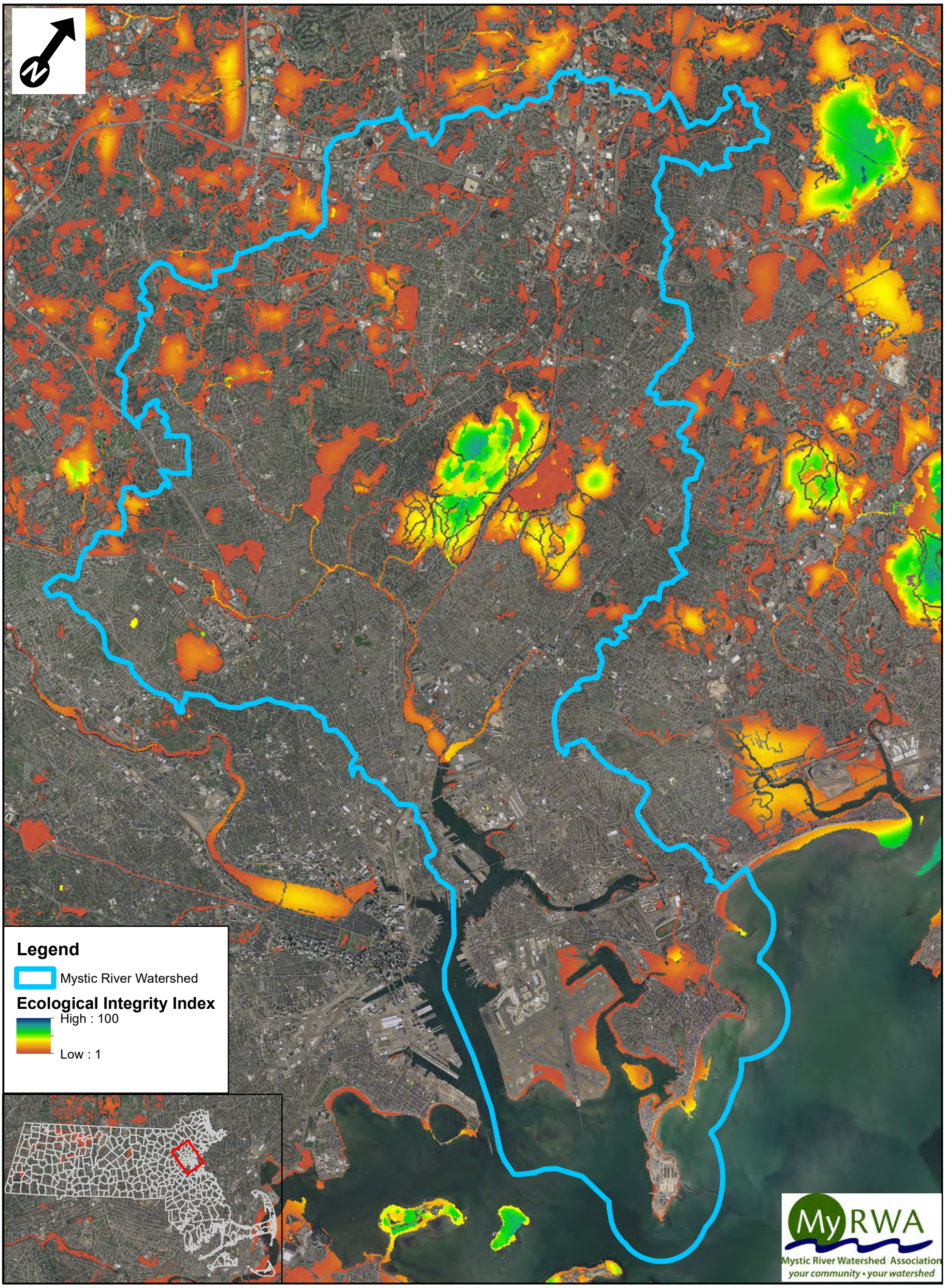

Scale:

1 inch = 7,000 feet

0 6,500 13,000

Feet

MYSTIC RIVER WATERSHED

Figure 6
Ecological Integrity Index Map

Massachusetts

Source:
-MassGIS: Basemap & Environmental Data
-Aerial & Topo Imagery: ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community, Resilient and Connected Landscapes for Terrestrial Conservation - 2016 (The Nature Conservancy)

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Legend

Mystic River Watershed

Co-Occurrence Level

1

2

3

Scale:

1 inch = 7,000 feet

0 6,500 13,000

Feet

MYSTIC RIVER WATERSHED

Figure 7
Climate Resiliency Co-Occurrence Map

Average or Greater Values of:
Regional Flow Dataset, Index of Ecological Integrity 3.1 Dataset, Resilience Score Dataset

Massachusetts

Source:
-MassGIS: Basemap & Environmental Data
-Aerial & Topo Imagery: ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community, Resilient and Connected Landscapes for Terrestrial Conservation - 2016 (The Nature Conservancy)

MyRWA
Mystic River Watershed Association
your community • your watershed

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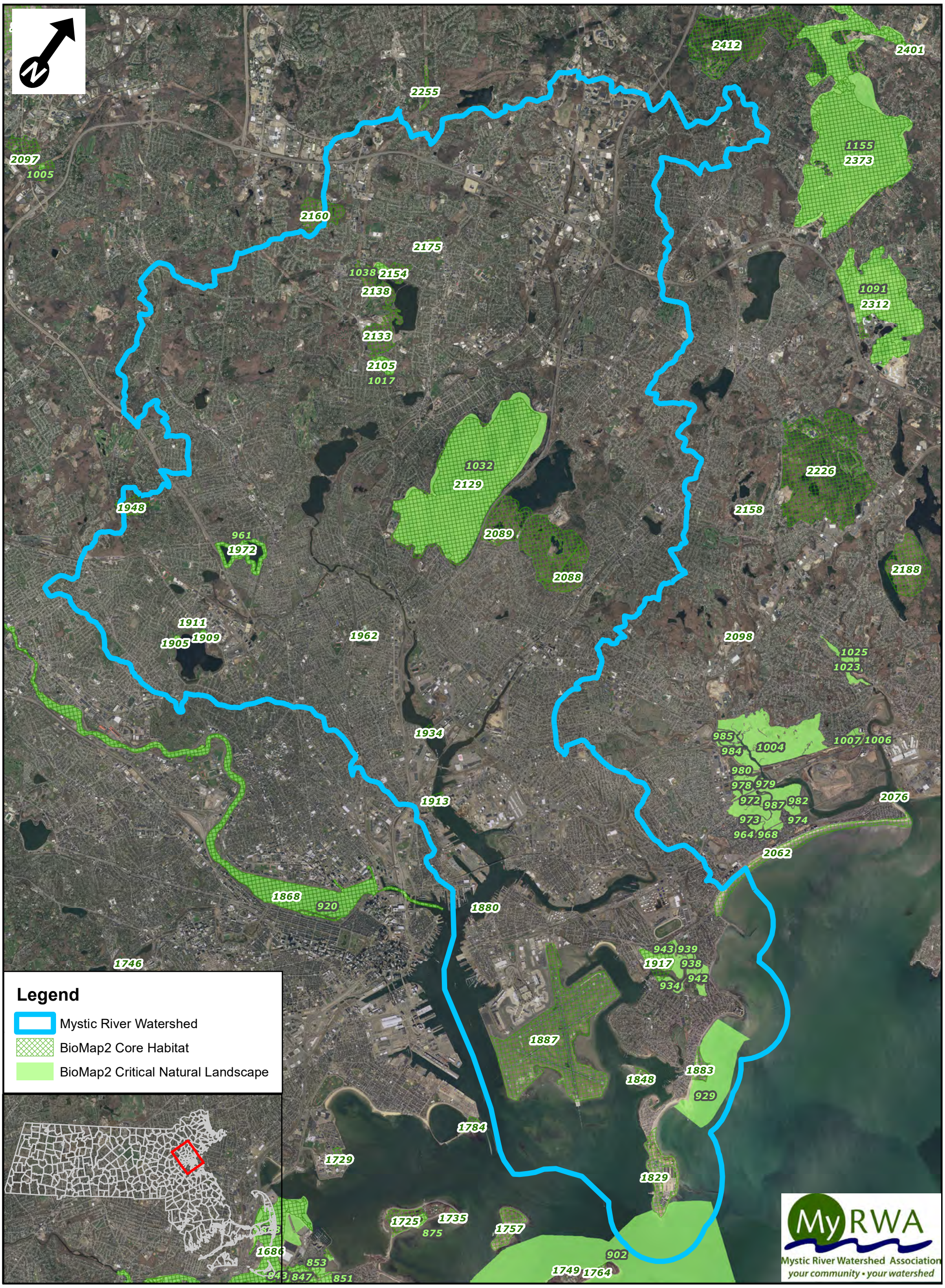

Legend

- Mystic River Watershed
- BioMap2 Core Habitat
- BioMap2 Critical Natural Landscape

MyRWA
Mystic River Watershed Association
your community • your watershed

Scale:

1 inch = 7,000 feet

0 6,500 13,000

Feet

MYSTIC RIVER WATERSHED

Figure 8
BioMap2 Data Map

Massachusetts

Source:
-MassGIS: Basemap & Environmental Data
-Aerial & Topo Imagery: ESRI, DigitalGlobe, GeoEye, i-cubed, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., AEX, GEBCO, USDA, USGS, FAO, NPS, NRCAN, GeoBase, Getmapping, Aerogrid, IGP, IGN, Kadaster NL, Ordnance Survey, ESRI japan, METI, ESRI China (Hong Kong), swisstopo, & the GIS User Community, Resilient and Connected Landscapes for Terrestrial Conservation - 2016 (The Nature Conservancy)

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