

SOUTHERN CONNECTICUT
for
**REGIONAL FRAMEWORK
COASTAL
RESILIENCE**

**Community Resilience Building Design Portfolio
Edges and Slopes**

JUNE 2017



ACKNOWLEDGEMENTS:

The Core Team – South Central Regional Council of Governments, The Nature Conservancy, and the Connecticut Metropolitan Council of Governments - sincerely thanks those individuals and organizations that contributed to the success of the Southern Connecticut Regional Framework for Coastal Resilience. Central to the completion of this Community Resilience Building Design Portfolio was the leadership and staff from the ten municipalities (Fairfield, Bridgeport, Stratford, Milford, West Haven, New Haven, East Haven, Branford, Guilford, and Madison). In addition, we would like to recognize the design prowess on display herein of Milone & MacBroom, GEI Consultants, and Yale University’s School of Architecture and Urban Ecology and Design Lab.

Many of the conceptual designs presented in this Design Portfolio were supported by a Hurricane Sandy Coastal Resiliency Competitive Grant, which was funded by the Hurricane Sandy disaster relief appropriation through the U.S. Department of the Interior and administered by the National Fish and Wildlife Foundation (grant ID: 44271). Several of the conceptual designs provided herein were funded through a grant award from The Nature Conservancy in Connecticut.

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TABLE OF CONTENTS

INTRODUCTION - i

ICON GUIDE - 1

DUNE RESTORATION – ENHANCEMENT • [Natural] - 2

DUNE RESTORATION – ENHANCEMENT • [Urban – Flexible] - 3

DUNE RESTORATION – ENHANCEMENT • [Urban – Fixed] - 4

DUNE RESTORATION – ENHANCEMENT • [Urban – Fixed] - 5

URBAN STREAM RESTORATION • [Daylighting] - 6

URBAN STREAM RESTORATION • [Floodplain Expansion] - 7

RESILIENT LIVING EDGE • [Natural] - 8

RESILIENT LIVING EDGE • [Urban – Flexible] - 9

RESILIENT LIVING EDGE • [Natural – Hybrid] - 10

RESILIENT LIVING EDGE • [Suburban – Hybrid] - 11

SLOPE ENHANCEMENT • [Natural] - 12

SLOPE ENHANCEMENT • [Urban – Fixed] - 13

UNIMPROVED SPACE • [Urban – Flexible] - 14

INTRODUCTION:

The Southern Connecticut Regional Framework for Coastal Resilience, encompassing ten municipalities, was conceived and launched to stimulate community engagement, proactive risk assessment, and conceptual designs in hopes of minimizing the consequences of extreme weather and climate change while strengthening existing and future ecosystems. The principal guiding question used to foster this Regional Resilience Framework for the ten municipalities served - Fairfield, Bridgeport, Stratford, Milford, West Haven, New Haven, East Haven, Branford, Guilford, and Madison – was: “how do we create collaborative actions across and between municipalities to ensure a regional integration of resilience via strong and growing partnerships”. This guiding question was advanced through a carefully devised fluid, yet functional, project team structure that integrated representation from all ten municipalities alongside a diverse array of community and regional-based stakeholders. This Regional Resilience Framework comprehensively catalogued resilience-related projects, facilitated community workshops and site visits, developed geospatial databases and applications, and created conceptual designs for high priority projects. Many of those projects are presented herein. This collective endeavor represents the first time a Regional Resilience Framework process and approach has been conceived and advanced in the state of Connecticut.

Across the conceptual designs presented herein are a few common “gradients of concern” as informed by the challenges of extreme weather and climate change and the promise of resilient solutions in vulnerable locations. The first “resilient gradient” common to most stretches of coastline around the world is urban, suburban, and rural development. The designs selected reflect development challenges in urban centers like Bridgeport and New Haven as well as less developed coastlines from suburban (West Haven, East Haven, Fairfield, Stratford, Milford) to more rural (Branford, Guilford, Madison). A second resilient gradient reflected in these designs is the transition from coastal areas to inland locations up into the watersheds – salt to fresh water flooding challenges. A third resilient gradient presented is one of socio-economic advantages and disadvantages or the immediate context amongst the neighborhood and community being served by the design. This recognition of these very real gradients - urban to rural, coastal to inland, wealth disparity - is fundamental to designing projects that truly enhance resilience in a diversity of forms. Visible throughout this portfolio is an additional adherence to a “resilient triple bottom line” where each project strives to reduce risk from hazards, enhance the amenity or quality of life for the residents, and increase the ecological viability and function.

Presented here are a sequential array of designs that highlight alternative conceptals to help achieve resilience across coastal dunes, urban streams, lower energy coastlines, and urban embankments – categorized simply as Edges and Slopes. The hope is that this material will inspire “net positive” projects that truly foster collaborative and creative approaches to community resilience building.

Additional Resources

Additional resources about this project can be found at:

- <http://www.ctmetro.org/coastal-resilience>
- <http://scrcog.org/regional-planning/coastal-resilience>

ICON GUIDE



DUNE RESTORATION – ENHANCEMENT

Naturally or maintained dune systems with unrestricted to limited space for expansion horizontally, laterally, and vertically.



URBAN STREAM RESTORATION

Excavate and/or restore tidal and freshwater wetlands as well as install green infrastructure to capture adjoining stormwater runoff.



RESILIENT LIVING EDGE

Installation of break water and sill to reduce wave energy, enhance accretion, and stimulate expansion of tidal wetlands.



SLOPE ENHANCEMENT

Contouring and installation of sill, vegetation, and green infrastructure features to stabilize slope and protect adjoining resources.



UNIMPROVED SPACE

Multi-function revitalization as public amenity and flood protection for adjoining critical facilities.

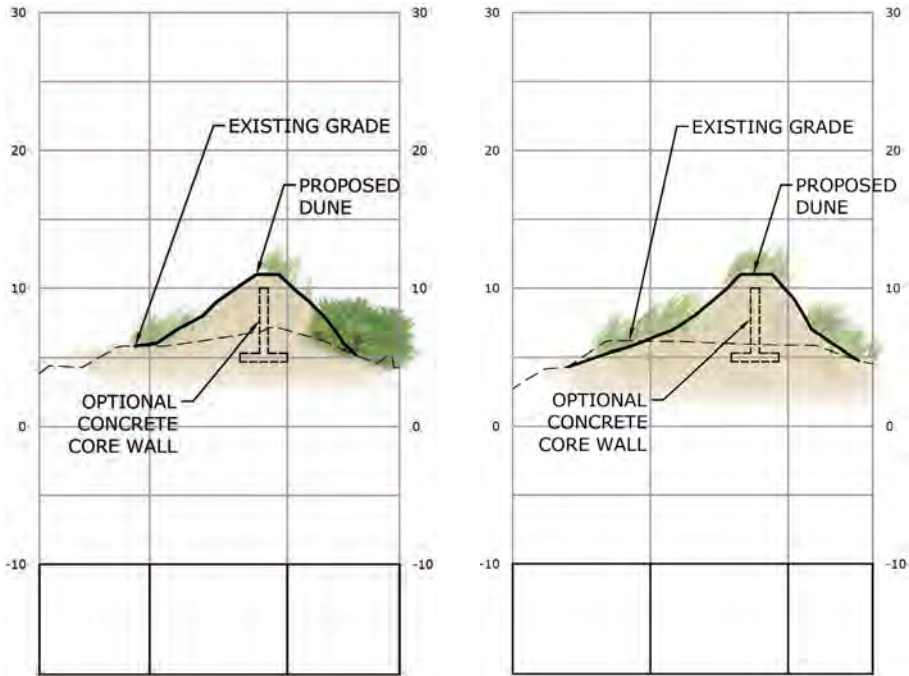
DUNE RESTORATION – ENHANCEMENT • [Natural]

Naturally occurring dune system
with unrestricted space for expansion horizontally, laterally, and vertically.



DESIGN ELEMENTS

- THIS SEGMENT OF COASTLINE A PUBLIC BEACH
- DUNES AND PATCHES OF VEGETATION ARE STILL PRESENT, BUT NOT CONTINUOUS
- THE MUNICIPALITY CONSIDERS THIS IS A PRIORITY AREA FOR FLOOD PROTECTION
- THE FEMA BASE FLOOD ELEVATION IS 14 (VE ZONE)
- THE CALCULATED STORM LEVELS ARE 9.4 TO 10.5 FEET IN THE 50 TO 100-YEAR RI RANGE
- RESTORATION OF A DUNE RIDGE AT ELEVATION 11 FEET WOULD PROVIDE INCREASED PROTECTION AND ALLOW FOR INCREASED DENSITY AND TYPES OF VEGETATION
- THE BEACH WIDTH LIKELY DOES NOT NEED TO BE INCREASED TO ACCOMMODATE THE RESTORATION
- MINIMAL BUILT STRUCTURES PROXIMATE TO DESIGN SITE



EXISTING



PROPOSED



DUNE RESTORATION – ENHANCEMENT • [Urban – Flexible]

Managed dune system with relatively restricted ability to expand laterally and horizontally.
Opportunities for vertical movement and adjoining beach nourishment.



DESIGN ELEMENTS

- THIS SEGMENT OF COASTLINE IS AN EXEMPLARY EXAMPLE OF COASTAL PUBLIC ACCESS
- LOW PROFILE DUNES AND PATCHES OF VEGETATION ARE FOUND AMONG WIDE SANDY EXPANSES
- THE MUNICIPALITY CONSIDERS THIS IS A PRIORITY AREA FOR FLOOD PROTECTION
- THE FEMA BASE FLOOD ELEVATION IS 12 (VE ZONE)
- THE CALCULATED STORM LEVELS ARE 10.3 TO 11.4 FEET IN THE 50 TO 100-YEAR RI RANGE
- CREATION OF A DUNE RIDGE AT ELEVATION 13 FEET WOULD PROVIDE INCREASED PROTECTION
- A DUNE RIDGE WOULD INCREASE THE DENSITY AND TYPES OF VEGETATION AT THIS BEACH
- THE BEACH WIDTH MUST BE INCREASED IN SOME PLACES TO ACCOMMODATE THE DUNE RIDGE
- WITH SEA LEVEL RISE OF ONE FOOT, THE DUNE RIDGE SHOULD STILL PROVIDE SIGNIFICANT PROTECTION
- RESIDENTIAL DEVELOPMENT AND PAVED PUBLIC PROMINADE IMMEDIATELY ADJACENT



DUNE RESTORATION – ENHANCEMENT • [Urban – Fixed]

Managed dune system with restricted ability to expand horizontally due to built environment.
Opportunities for lateral and vertical movement.



DESIGN ELEMENTS

- COASTLINE SEGMENT COMBINATION OF RESIDENTIAL, ROADS, AND PUBLIC BEACH
- LOW PROFILE DUNES AND PATCHES OF VEGETATION ARE FOUND AMONG WIDE SANDY EXPANSES
- HEAVILY USED THROUGHOUT THREE SEASONS AS PRINCIPAL PUBLIC AMMENITY IN MUNICIPALITY
- FOCUS ON AUGMENTING BEACH PROFILE AND CREATING DUNE RIDGE TO INCREASE PROTECTION OF ADJOINING ROAD AND RESIDENTIAL
- RAISING OF ROAD AND SUPPORTING WALL TO MINIMIZE EXTREME WEATHER FLOODING AND INUNDATION FROM SEA LEVEL RISE
- ROAD AND SUPPORTING WALL DESIGNED TO WORK IN ALIGNMENT WITH DUNE RESTORATION AS INTEGRATED RISK MANAGEMENT FOR THE MUNICIPALITY

PROPOSED



EXISTING

Yale

EAST HAVEN, CONNECTICUT

DUNE RESTORATION – ENHANCEMENT • [Urban – Fixed]

Managed dune system with restricted ability to expand horizontally, laterally, and vertically.



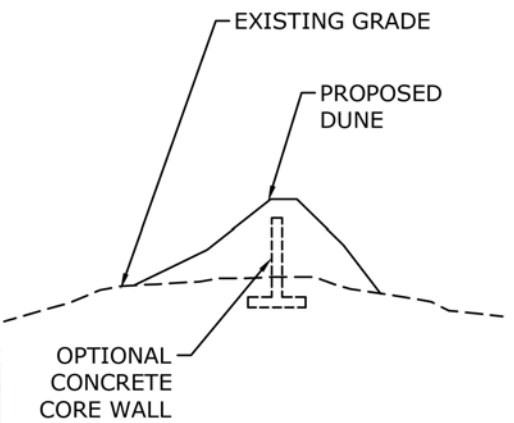
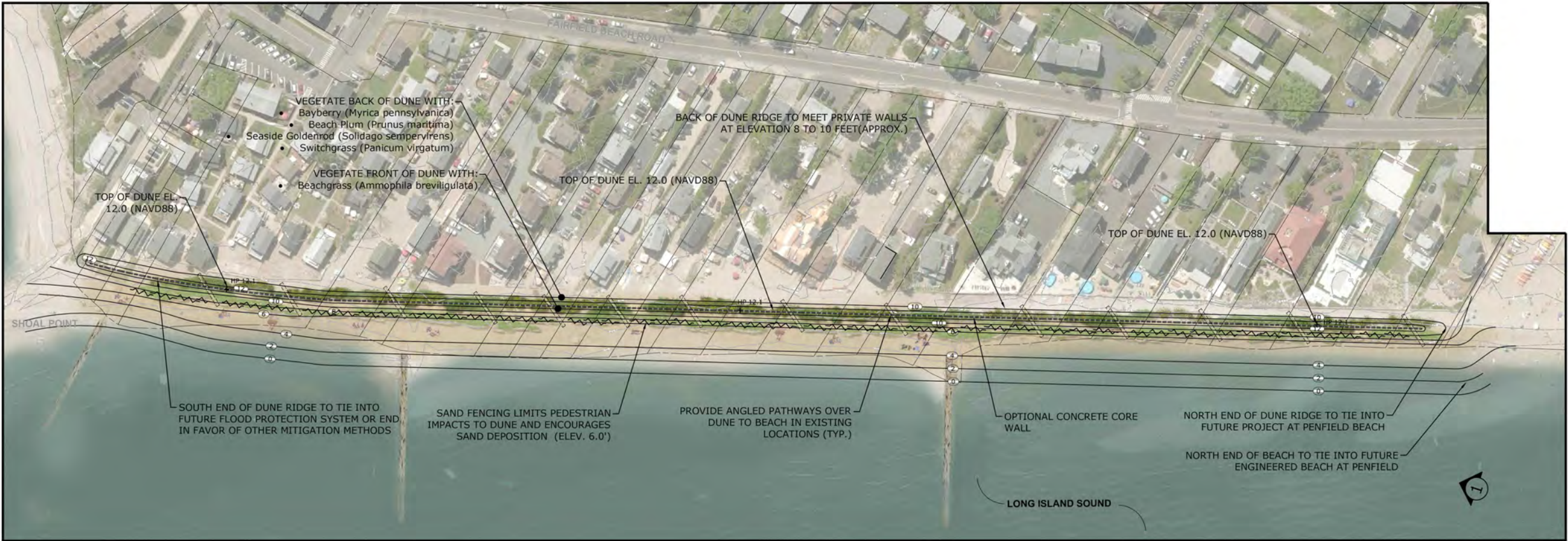
EXISTING



PROPOSED

DESIGN ELEMENTS

- THIS SEGMENT OF COASTLINE IS A PATHWAY FOR STORM SURGES TO REACH THE COASTAL FLOODPLAIN
- THE LOCAL FLOOD AND EROSION CONTROL BOARD CONSIDERS THIS IS A PRIORITY AREA FOR MITIGATION
- PRIVATE SEAWALLS ARE AT ELEVATION 8 TO 10 FEET
- THE FEMA BASE FLOOD ELEVATION IS 13 (VE ZONE)
- THE CALCULATED STORM LEVELS ARE 10.5 TO 11.5 FEET IN THE 50 TO 100-YEAR RI RANGE
- CREATION OF A DUNE RIDGE AT ELEVATION 12 FEET WOULD PROVIDE INCREASED PROTECTION
- THE ELEVATION 12 FEET IS SUFFICIENTLY LOW TO AVOID OBSTRUCTING VIEWS FOR ADJOINING RESIDENTIAL PROPERTIES
- A DUNE RIDGE WOULD INTRODUCE VEGETATION TO THIS BEACH
- DIAGONAL PUBLIC ACCESS PATHS WOULD INCREASE VEGETATIVE COVER OVER TIME
- THE BEACH WIDTH MUST BE INCREASED TO ACCOMMODATE THE DUNE RIDGE
- WITH SEA LEVEL RISE OF ONE FOOT, THE DUNE RIDGE SHOULD STILL PROVIDE SIGNIFICANT PROTECTION
- OPTIONAL CONCRETE CORE WALL WOULD HELP STABILIZE DUNE PROFILE
- RESIDENTIAL DEVELOPMENT IMMEDIATELY ADJACENT WITH ONGOING NEED FOR PUBLIC ACCESS



MILONE & MACBROOM

GEI Consultants

FAIRFIELD, CONNECTICUT

URBAN STREAM RESTORATION • [Daylighting]

Excavate and restore tidal and freshwater wetlands as well as install green infrastructure to capture adjoining stormwater runoff.



DESIGN ELEMENTS

- THE PROXIMATE FACILITY IS AN IMPORTANT COMMUNITY ASSET
- A SMALL TIDAL CREEK WAS LONG AGO PLACED IN A CULVERT BENEATH THE SITE
- DAYLIGHTING THE STREAM WOULD PROVIDE OPPORTUNITIES TO RESTORE TIDAL AND NON-TIDAL WETLAND VEGETATION
- A RAIN GARDEN MAY BE INCORPORATED INTO THE PROJECT TO FILTER STORMWATER FROM THE COMMUNITY CENTER PARKING AREA
- AS SEA LEVELS RISE, TIDAL CONDITIONS WILL MIGRATE UPSTREAM FROM THE ADJACENT MARSH INTO THE DAYLIGHTED PART OF THE STREAM
- TIDAL WETLANDS COULD ADVANCE INTO THE STREAMBANK AREAS -THIS IS NOT POSSIBLE UNDER CURRENT CONDITIONS
- PARKING LOT IMMEDIATELY ADJACENT WITH MUNICIPAL BRIDGE IMMEDIATELY DOWNSTREAM



MILONE & MACBROOM

GEI Consultants



URBAN STREAM RESTORATION • [Floodplain Expansion]

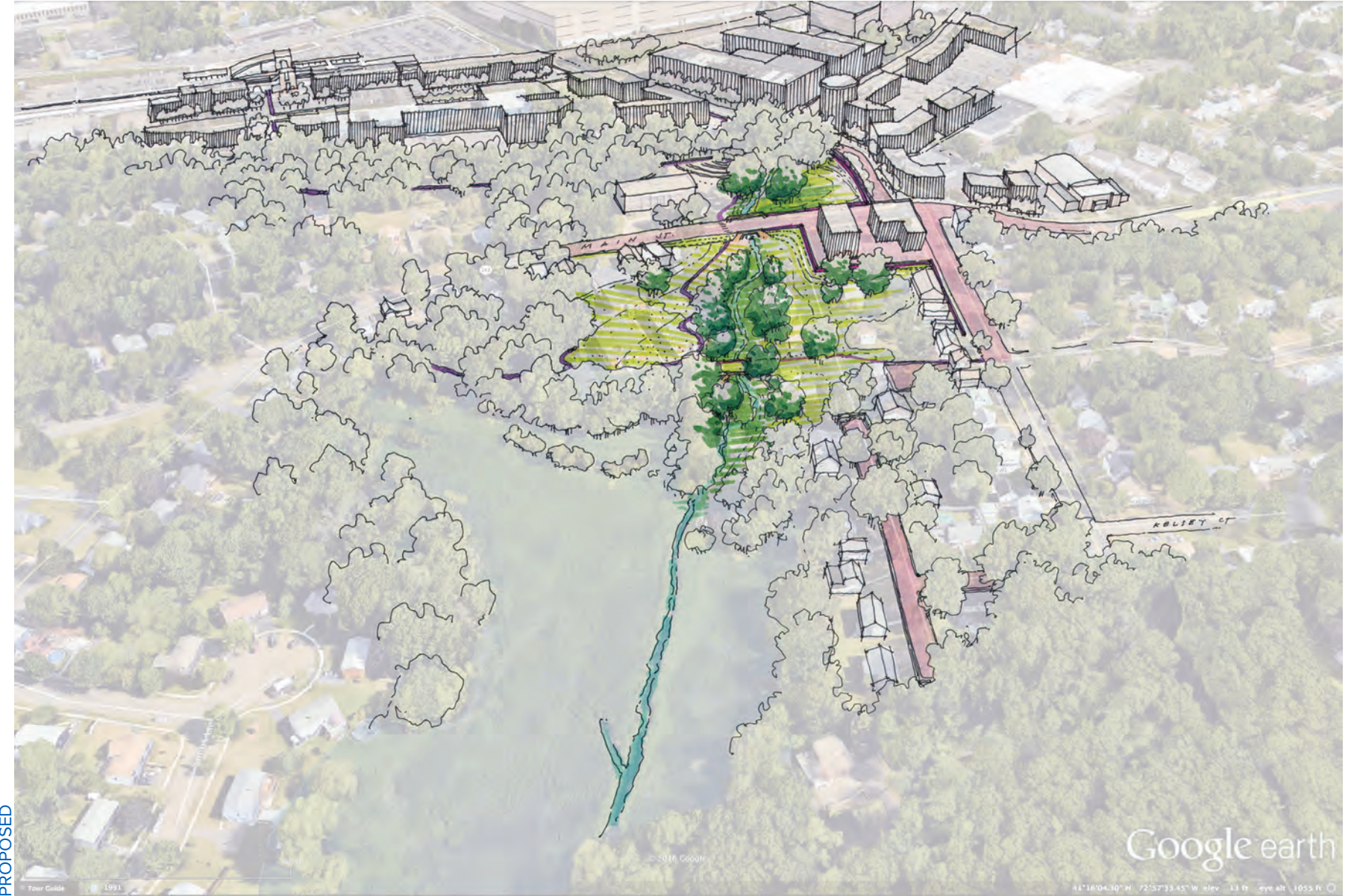
Reconfigure built environment for expanded floodplain with increased storage and public access.



EXISTING

DESIGN ELEMENTS

- THE PROXIMATE FACILITY IS AN IMPORTANT COMMUNITY ASSET
- A SMALL TIDAL CREEK WAS LONG AGO PLACED IN A CULVERT BENEATH THE SITE
- DAYLIGHTING THE STREAM WOULD PROVIDE OPPORTUNITIES TO RESTORE TIDAL AND NON-TIDAL WETLAND VEGETATION
- A RAIN GARDEN MAY BE INCORPORATED INTO THE PROJECT TO FILTER STORMWATER FROM THE COMMUNITY CENTER PARKING AREA
- AS SEA LEVELS RISE, TIDAL CONDITIONS WILL MIGRATE UPSTREAM FROM THE ADJACENT MARSH INTO THE DAYLIGHTED PART OF THE STREAM
- TIDAL WETLANDS COULD ADVANCE INTO THE STREAMBANK AREAS - THIS IS NOT POSSIBLE UNDER CURRENT CONDITIONS
- PARKING LOT IMMEDIATELY ADJACENT WITH MUNICIPAL BRIDGE IMMEDIATELY DOWNSTREAM

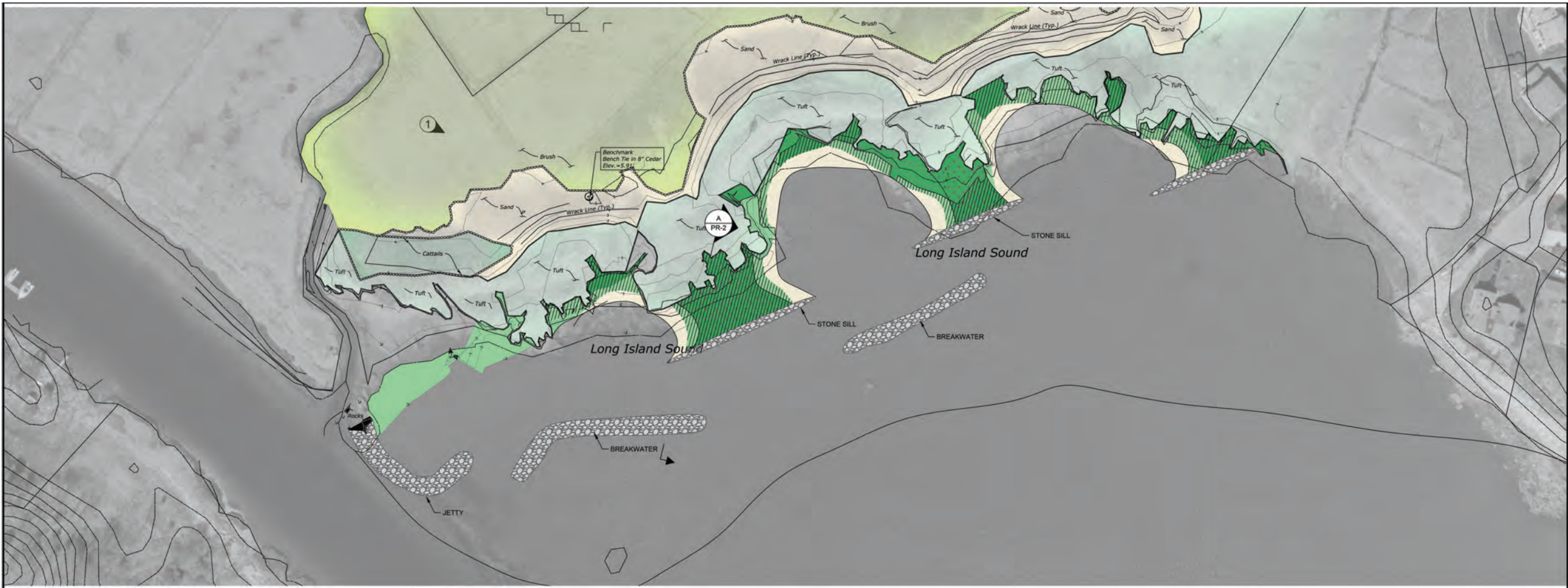


PROPOSED

Yale 

RESILIENT LIVING EDGE • [Natural]

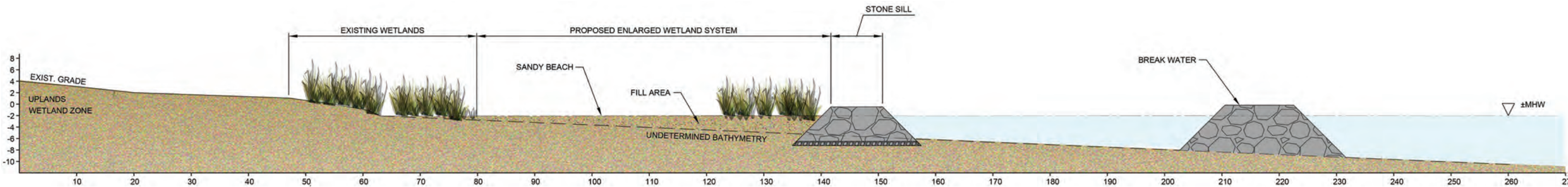
Installation of break water and sill to reduce wave energy, enhance accretion, and stimulate expansion of tidal wetlands.



LEGEND:

- PROVIDE INITIAL SAND FILL
- WETLAND VE SHRUBS

- DESIGN ELEMENTS**
- NATURAL COASTLINE WITH ONGOING EROSION WITH MOVEMENT OF MATERIALS INLAND
 - FOCUS ON INSTALLING SERIES OF NEARSHORE BREAKWATERS AND ONSHORE SILLS TO STIMULATE ESTABLISHMENT OF TIDAL WETLANDS AND STRENGTHEN COASTLINE
 - DESIGN PROVIDES INCREASED STABILITY AND DECREASED EROSION TO COASTLINE SEGMENT, INCREASES ECOLOGICAL FUNCTION OF IMPORTANT ESTUARY, SECURES PUBLIC ACCESS, AND PROTECTION OF ADJOINING RECREATIONAL FIELDS



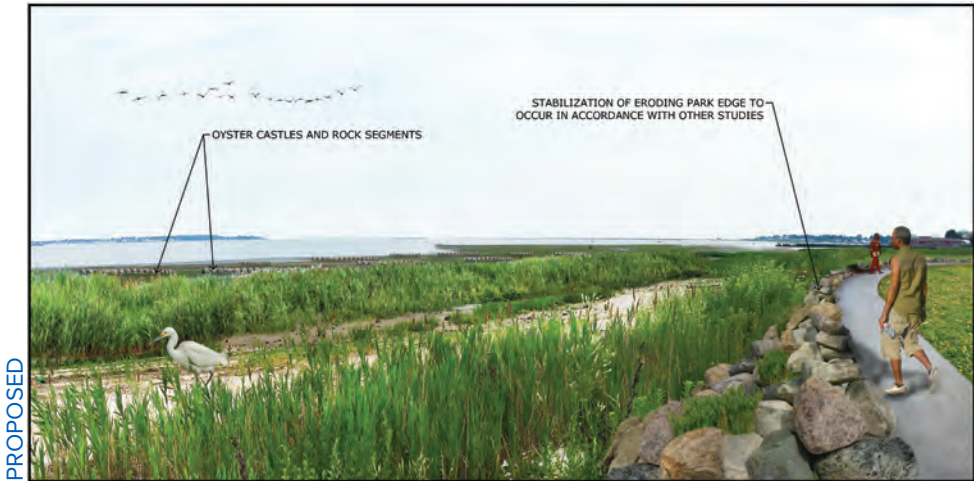
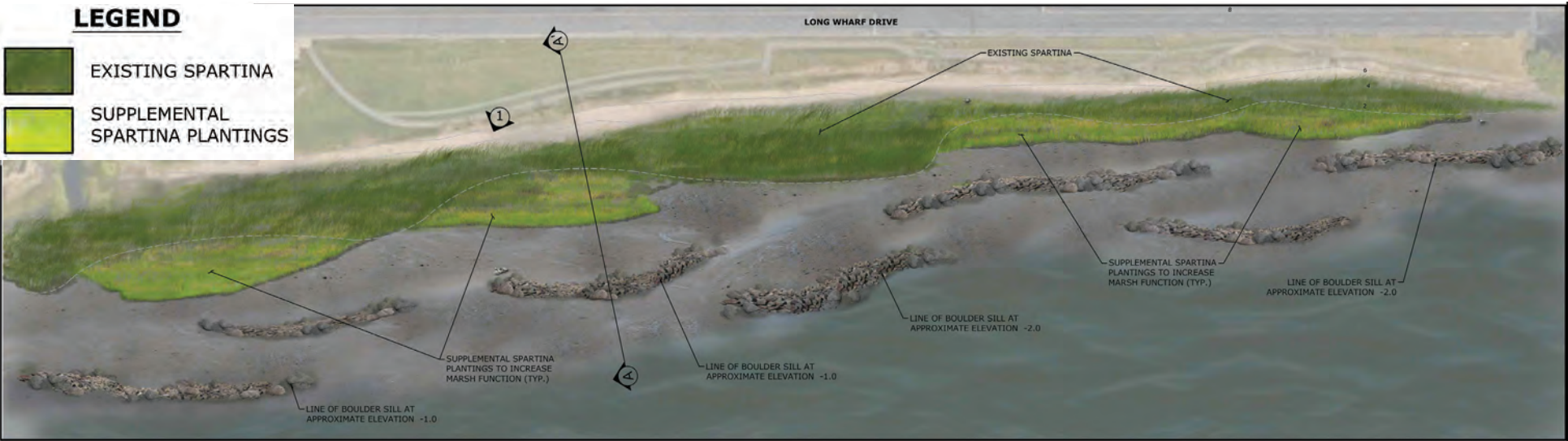
RESILIENT LIVING EDGE • [Urban – Flexible]

Installation of sill and artificial structures to stabilize shoreline, reduce erosion, enhance public access, and protect built environment.



DESIGN ELEMENTS

- SIGNIFICANT EROSION OF THE PARK EDGE HAS OCCURRED IN THE LAST FEW YEARS
- OPPORTUNITY FOR PROJECT IN THE INTERTIDAL ZONE TO RETAIN SEDIMENT AND INCREASE THE AREA OF VEGETATION VIA USE OF ROCK/BOULDER SILLS AND ARTIFICIAL HABITAT STRUCTURES – OYSTER CASTLES
- OYSTER CASTLES SET WITH BASES ABOVE THE MLW (-3.3 FEET) AT ELEVATIONS -1.0 FEET
- ROCK SEGMENTS SET WITH BASES ABOVE THE MLW (-3.3 FEET) AT ELEVATIONS -2.0 FEET
- WITH SEA LEVEL RISE OF 1-2 FEET, THE BOULDER SILLS SHOULD REMAIN EFFECTIVE
- LINEAR PUBLIC PARK WITH HIGH LEVEL OF PUBLIC ACCESS ADJOINING A CRITICAL TRANSPORTATION CORRIDOR



NEW HAVEN, CONNECTICUT

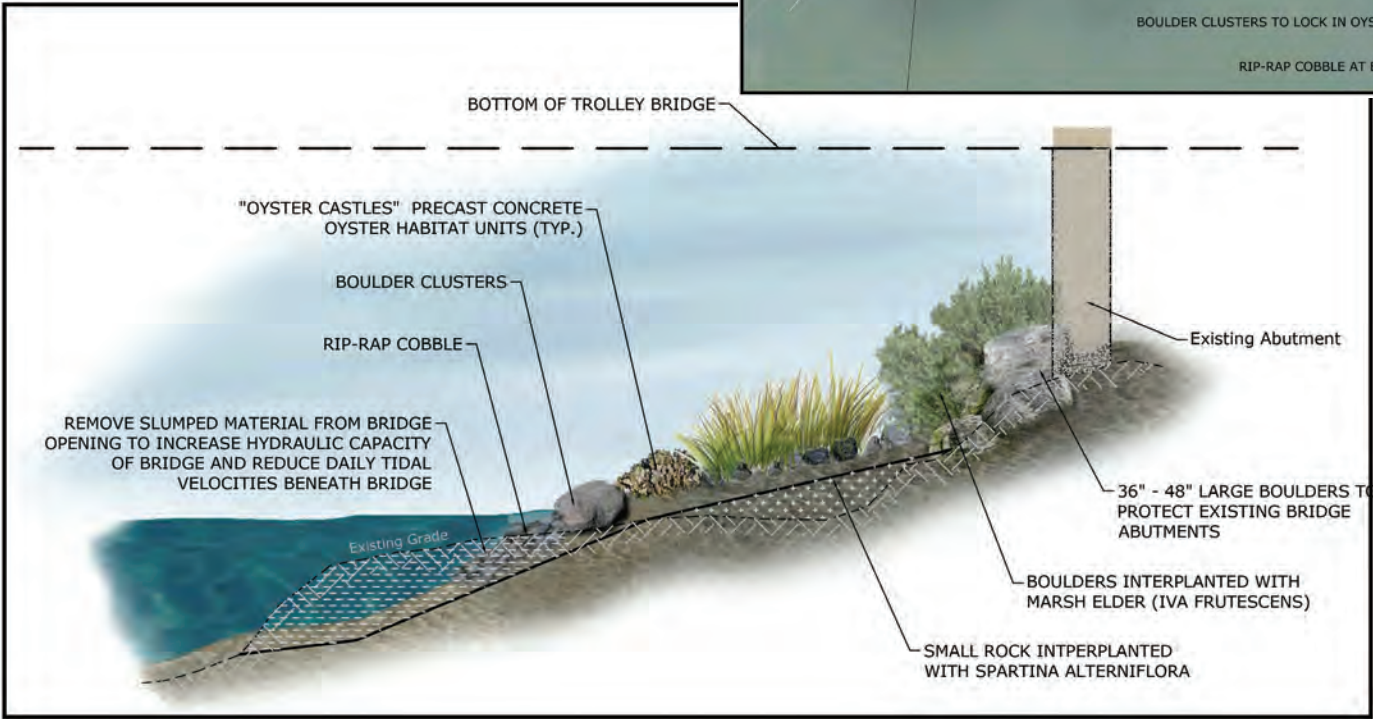
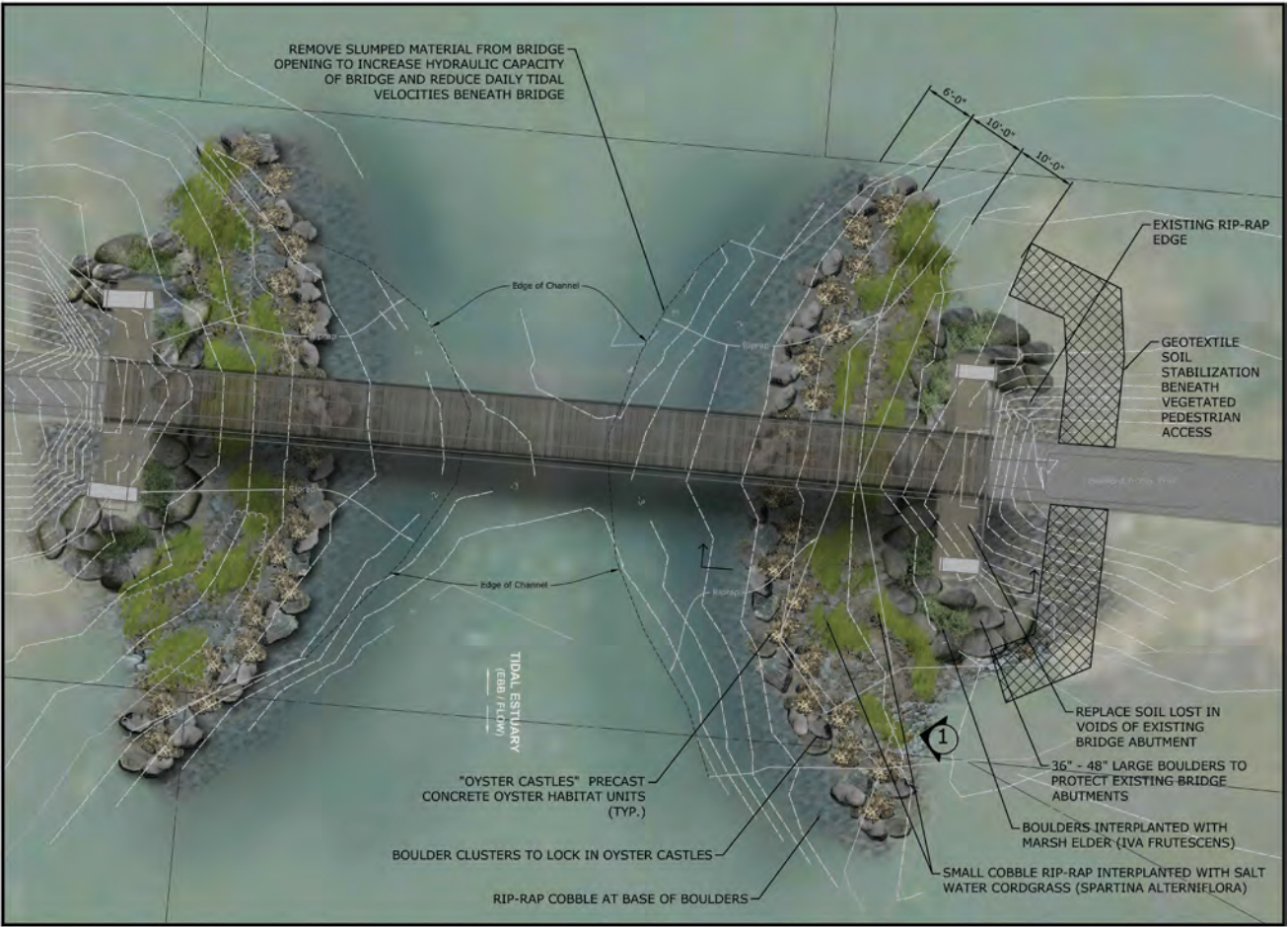
RESILIENT LIVING EDGE • [Natural - Hybrid]

Reconfigure and stabilize with natural and artificial materials interplanted with native plants and shrubs.



DESIGN ELEMENTS

- OLD TROLLEY LINE TURNED PEDESTRIAN BRIDGE AND IMPORTANT COMMUNITY ASSET
- SCOUR HAS EXPOSED THE BRIDGE ABUTMENTS
- PROTECTION OF THE BRIDGE MAY BE POSSIBLE USING LIVING EDGE TECHNIQUES COMBINED WITH HARD STRUCTURES
- THE DESIGN ENVISIONS A WIDENING OF THE CHANNEL COUPLED WITH THE USES OF OYSTER CASTLES, ROCKY MATERIAL, AND GRASSES IN THE INTERTIDAL ZONE TO STABILIZE THE BANKS
- BOULDERS WOULD BE PLACED AGAINST THE ABUTMENTS
- WITH SEA LEVEL RISE OF 1-2 FEET, THE ZONATION OF THE INTERTIDAL ZONE BENEATH THE BRIDGE MAY SHIFT UPLAND
- LINEAR, HIGH USE, PUBLIC TRAIL SPANNING CRITICAL ESTUARY AND TIDAL MARSH COMPLEX



MILONE & MACBROOM

GEI Consultants

BRANFORD, CONNECTICUT

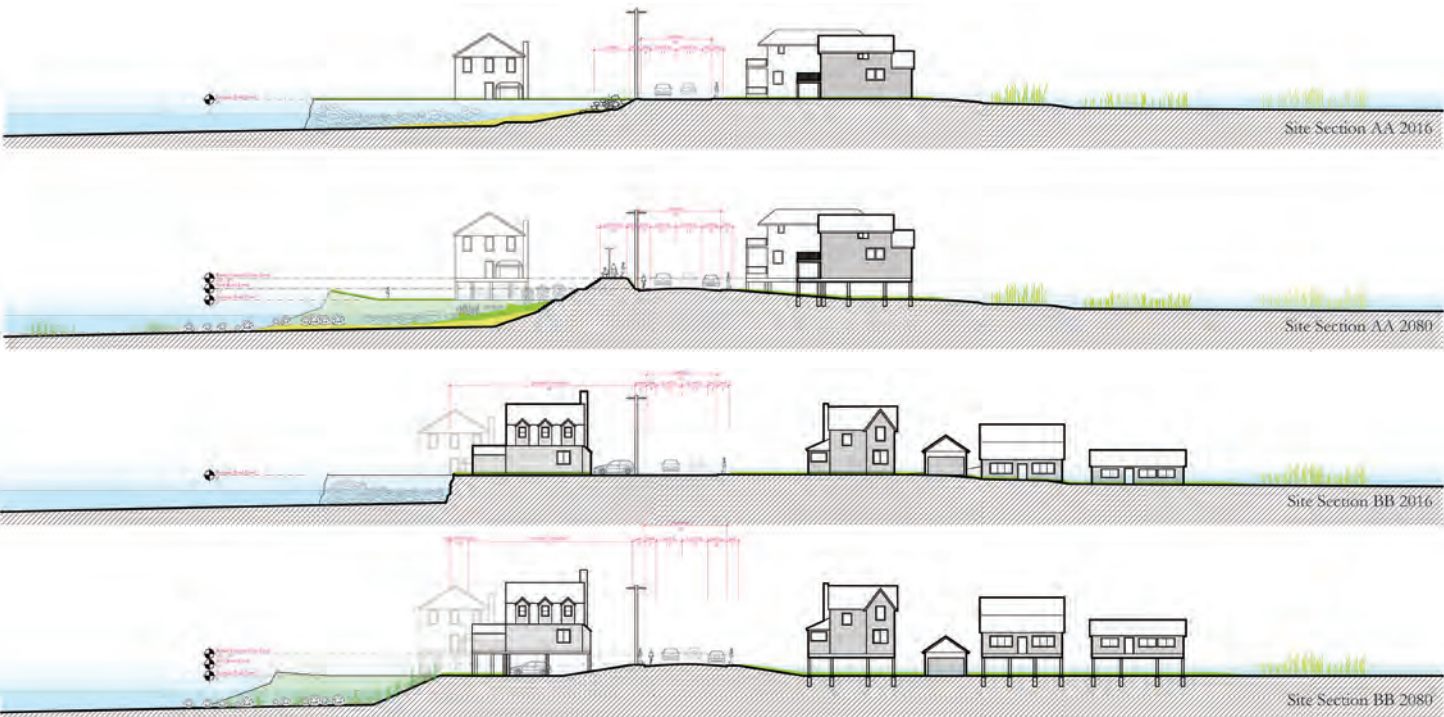
RESILIENT LIVING EDGE • [Suburban – Hybrid]

Installation of sill and vegetation with structures elevated to reduce erosion and protect built environment.



DESIGN ELEMENTS

- COMPLEX COMBINATION OF RESIDENTIAL, CRITICAL COASTAL ACCESS ROUTE, AND TIDAL CONNECTIONS TO UPSTREAM MARSH COMPLEX
- NATURAL COASTAL EDGE COMPROMISED OVER TIME DUE TO DEVELOPMENT, INCREASE WAVE ENERGY, AND SEA LEVEL RISE
- FOCUS ON ESTABLISHING STORM SURGE PROTECTION FOR RESIDENTIAL AND TRANSPORTATION ROUTE COUPLE WITH STABILIZED TIDAL CHANNEL UNDER ROAD
- INSTALLATION OF BREAKWATER/SILL AUGMENTED WITH TIDAL MARSH PLANTINGS
- STONE REVETMENT ADDED ALONG RAISED SECTION OF ROAD IN AREAS VULNERABLE TO SCOUR
- RAISING OF ROAD, PROTECTIVE WALL, AND RESIDENTIAL TO MINIMIZE IMPACT LONG TERM
- WATERSHED SCALE MANAGEMENT ZONES TO PROMOTE LAND USE PRACTICES FAVORABLE TO MARSH COMPLEX AND ESTUARY
- DESIGN PROVIDES RESILIENT ROADWAY CORRIDOR PROTOTYPE ALLOWING FOR PEDESTRIAN USE, HYDROLOGICAL CONNECTIVITY, AND ACCOMODATION OF FUTURE FLOODING



Yale

BRANFORD, CONNECTICUT

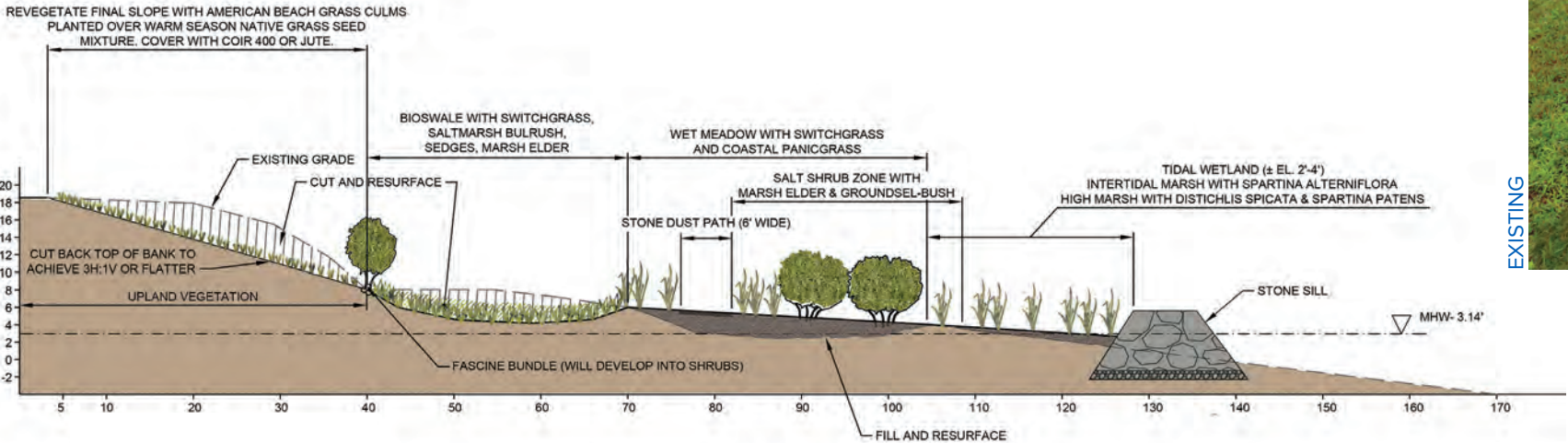
SLOPE ENHANCEMENT • [Natural]

Installation of sill, vegetation, and green infrastructure features to stabilize slope and protect adjoining resources.



DESIGN ELEMENTS

- PREDOMINANTLY NATURAL EMBANKMENT WITH ONGOING EROSION AND LIMITED ATTEMPTS TO STABILIZE
- LACK OF COASTAL NATIVE GRASSLAND OR SHRUB HABITAT – MANICURED LAWN CURRENTLY
- FOCUS ON REGRADING SLOPE, INSTALLATION OF BIOSWALES AT TOE, DEMARKATION OF PEDESTRIAN PATH WITH ACCESS STAIRS, AND TIDAL WETLAND CREATION BEHIND STONE SILL
- CUT, RESURFACE, AND VEGETATE SLOPE WITH BEACH GRASS PLANTED OVER WARM SEASON NATIVE GRASSES SECURED BY FASCINE BUNDLES AT SLOPE'S TOE
- INSTALL BIOSWALES FOR SURFACE RUNOFF FROM SLOPE WITH SALT TOLERANT HERBACEOUS
- PLANT SALT TOLERANT SHRUBS LANDWARD OF GAPS IN STONE SILL TO INCREASE WAVE ATTENUATION
- DESIGN PROVIDES INCREASED STABILITY AND DECREASED EROSION TO SLOPE THOUGH REGRADING, TOE ENHANCEMENT, SURFACE RUNOFF INFILTRATION, STORM SURGE ATTENUATION, AND DIRECTED PUBLIC ACCESS



EXISTING

PROPOSED



MILONE & MACBROOM

GEI Consultants

STRATFORD, CONNECTICUT

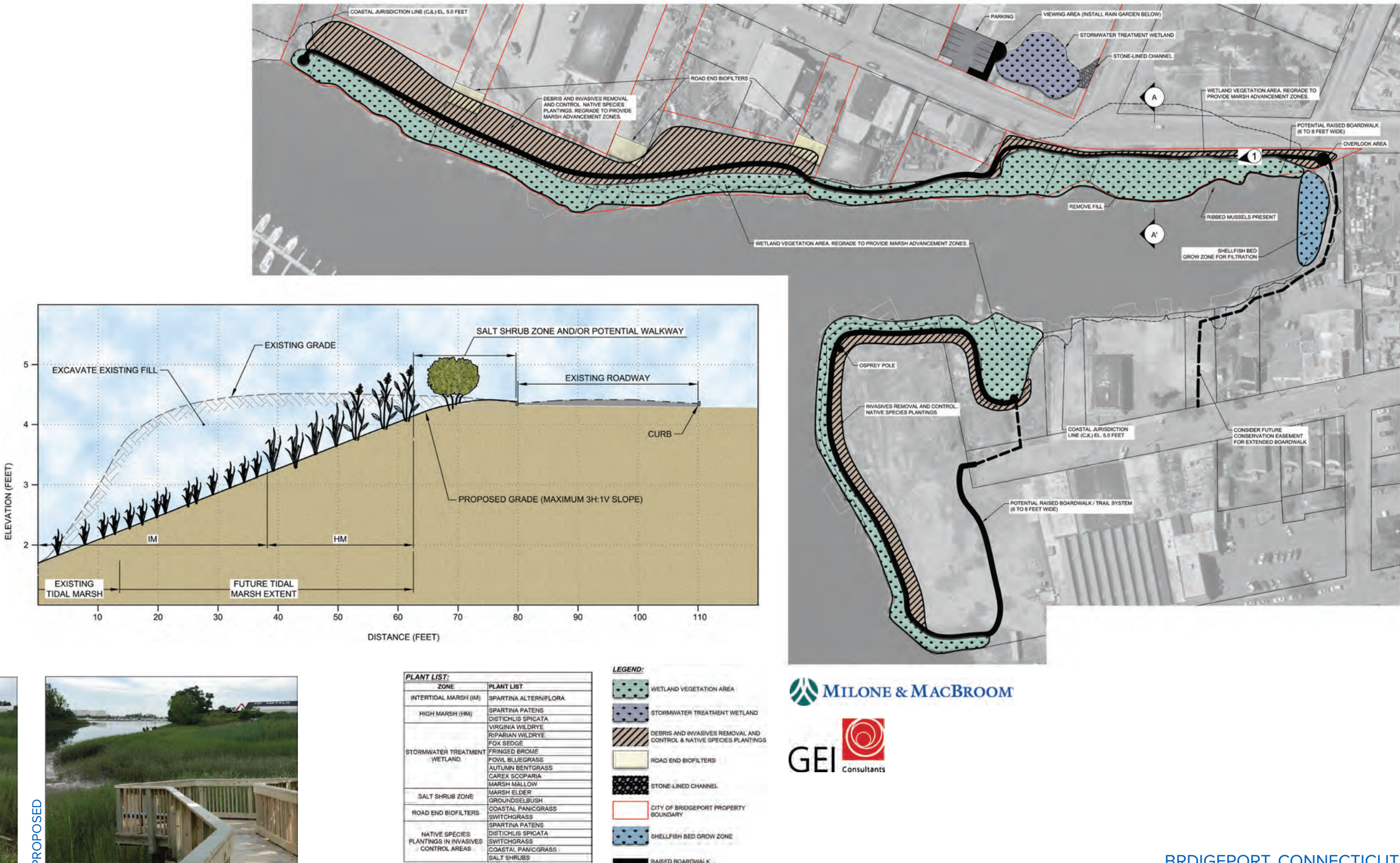
SLOPE ENHANCEMENT • [Urban - Fixed]

Fill removal, slope recontouring, and vegetation/green infrastructure installation to improve filtration, flood storage, and public access.



DESIGN ELEMENTS

- COMPLEX COMBINATION OF VULNERABLE ADJOINING USES INCLUDING CRITICAL MULTI-MODAL TRANSPORTATION HUB, POWER SUBSTATION, AND MUNICIPAL FACILITIES
- FOCUS ON CONSTRUCTING A FLOODABLE PUBLIC PARK WITH ELEVATED LANDFORMS ABUTTING FLOODWALL ALONG ELEVATED RAIL BRIDGE
- PROTECTION OF FRONT EDGE USING LIVING EDGE TECHNIQUES COMBINED WITH STONE REVETMENT IN VULNERABLE SECTIONS
- ESTABLISH AN URBAN MULTI-USE PATH WITH PARKING LOT TO CONNECT SERIES OF PUBLIC AREAS ALONG WATERFRONT
- TIE IN FLOOD STORAGE AND WAVE ATTENUATION FEATURES ONSITE WITH COMPREHENSIVE INSTALLATION OF BIOSWALES AND LOW RETAINING WALLS BACK INTO ADJOINING STREETSCAPES AS WELL AS ROAD ELEVATION AND REMOVABLE FLOODGATES AT UNDERPASS
- DESIGN PROVIDES RESILIENT, MULTI-PURPOSE SPACE AS FIRST LINE OF DEFENSE FOR CRITICAL FACILITIES TIED TO A COMPREHENSIVE AND STRATEGIC FLOOD ACCOMMODATION PLAN FOR THE ADJOINING URBAN LANDSCAPE



EXISTING



PROPOSED

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UNIMPROVED SPACE • [Urban – Flexible]

Multi-function revitalization as public amenity and flood protection for adjoining critical facilities.



EXISTING

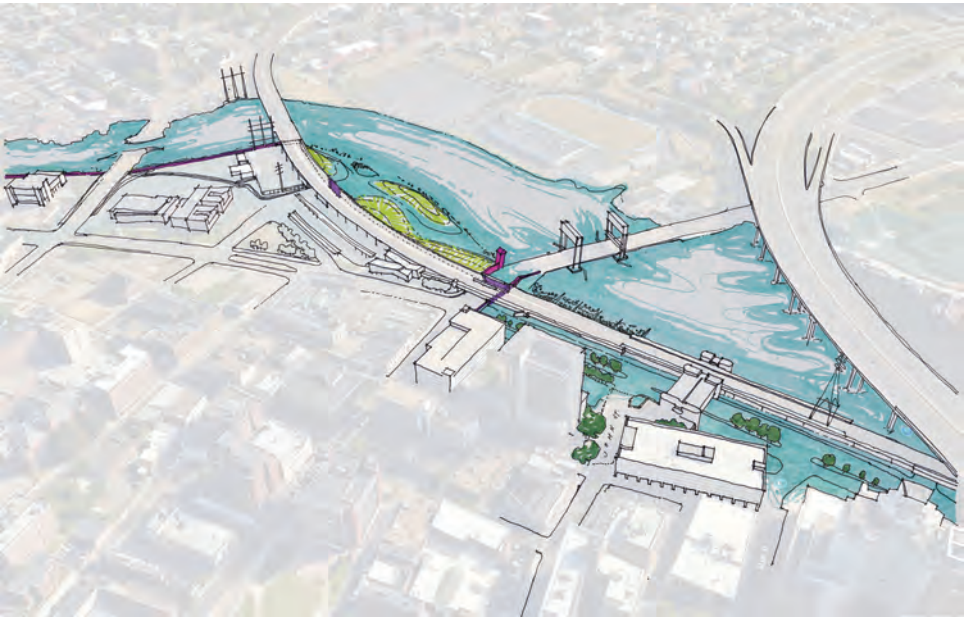


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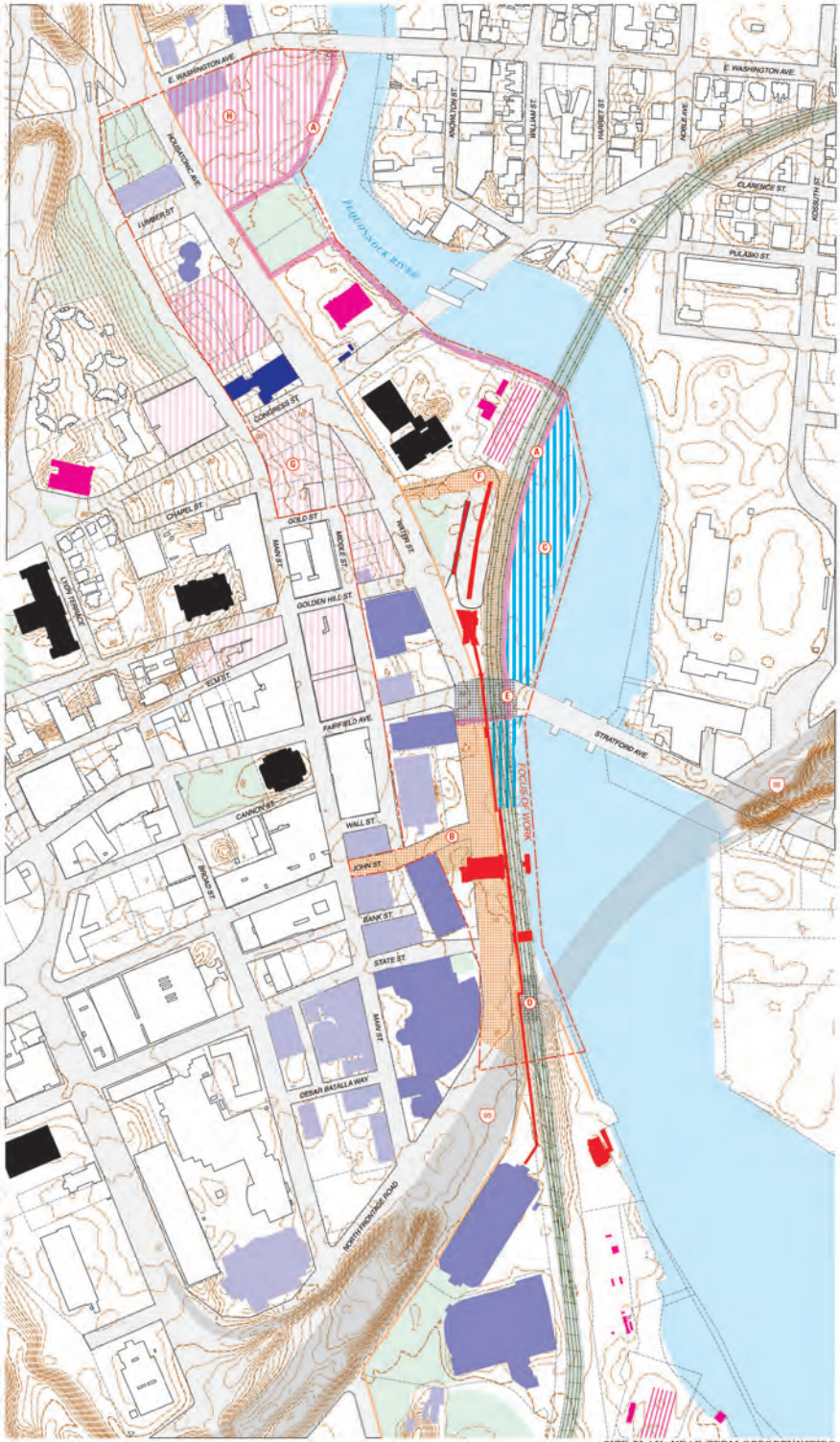
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NEAR TERM CONCEPTUAL DESIGN OPPORTUNITIES	
Existing Building in CAT 1 Surge Zone (subject to long-term SLR inundation)	Dark blue square
Existing Building in CAT 2 Surge Zone	Medium blue square
Existing Building in CAT 3 Surge Zone	Light blue square
Existing Building Outside of Surge or Focus	White square
Critical Facility	Pink square
Transportation-Related Structure	Red square
Government / Institutional	Black square
Development Parcel in 2011 North Downtown Village RFP	Light pink square
New Development Parcel	Dark pink square
Assessment area for future floodwall	Light pink square with horizontal lines
Assessment area for future flood gates	Dark pink square with horizontal lines
Assessment area for future public park and living shoreline protection	Blue square with vertical lines
Near-term streetscape and public realm improvement areas with storm protection	Orange square
Public sidewalk / multi-use path	Orange line

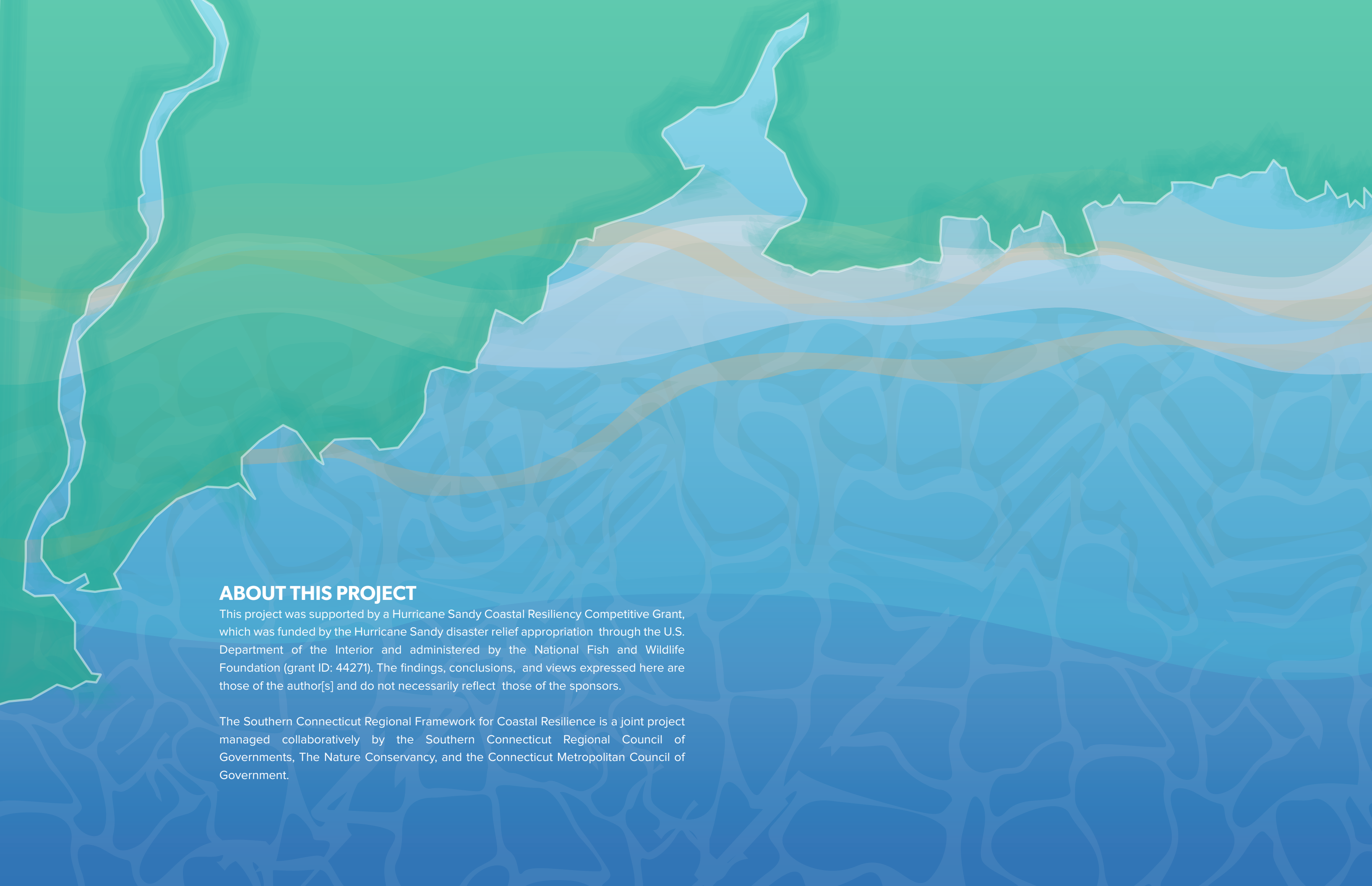


PROPOSED



Yale

BRIDGEPORT, CONNECTICUT



ABOUT THIS PROJECT

This project was supported by a Hurricane Sandy Coastal Resiliency Competitive Grant, which was funded by the Hurricane Sandy disaster relief appropriation through the U.S. Department of the Interior and administered by the National Fish and Wildlife Foundation (grant ID: 44271). The findings, conclusions, and views expressed here are those of the author[s] and do not necessarily reflect those of the sponsors.

The Southern Connecticut Regional Framework for Coastal Resilience is a joint project managed collaboratively by the Southern Connecticut Regional Council of Governments, The Nature Conservancy, and the Connecticut Metropolitan Council of Government.