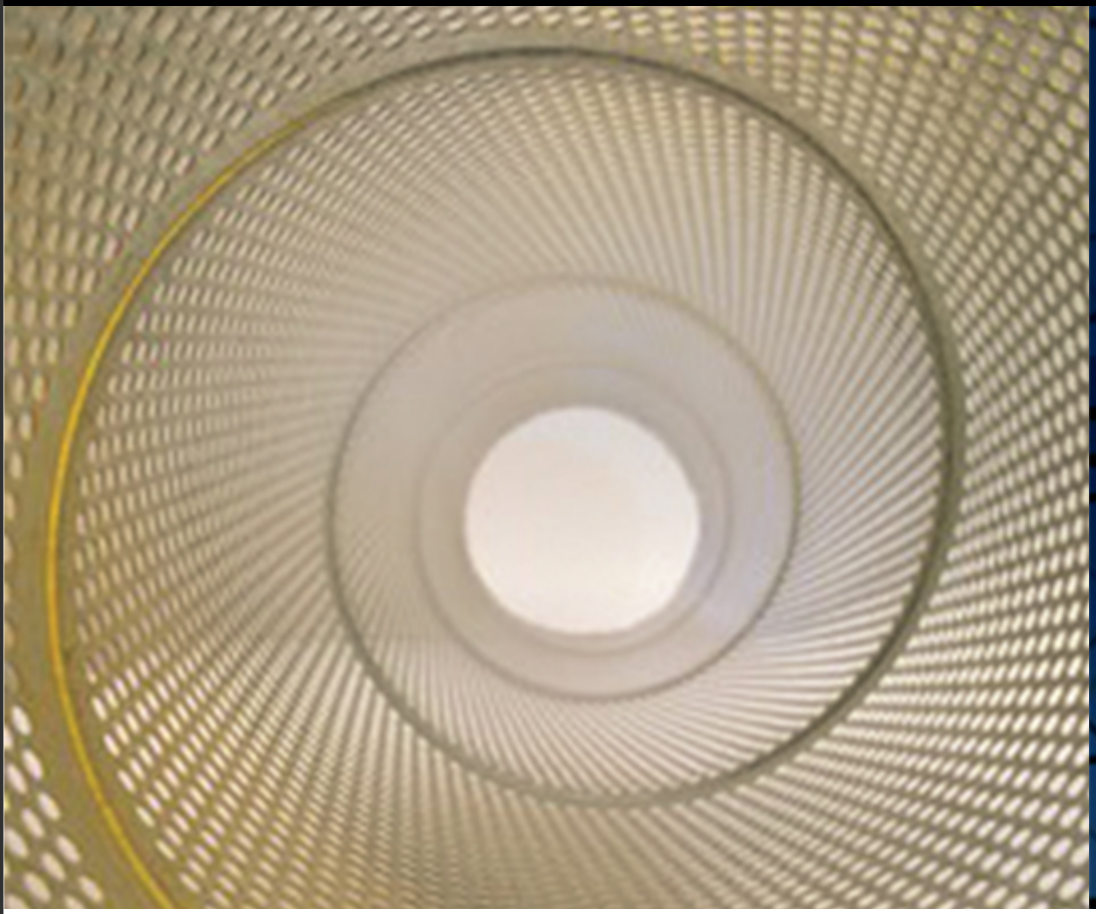
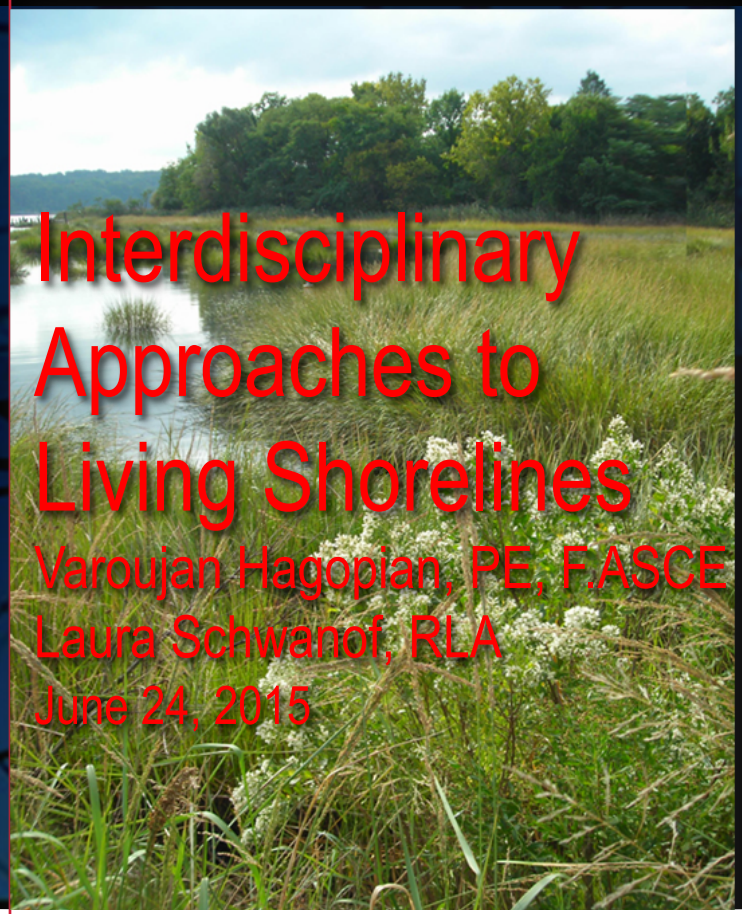
Consulting Engineers and Scientists





Interdisciplinary Approaches to Living Shorelines

Varoujan Hagopian, PE, F.ASCE
Laura Schwanof, RLA

June 24, 2015

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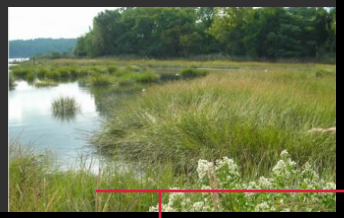
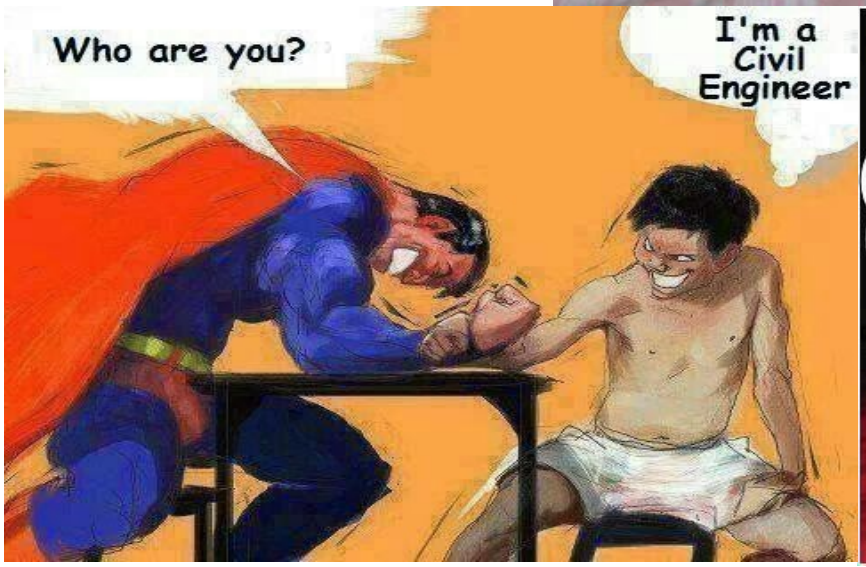


Lets Get Started…

Varoujan and

Laura welcome you…



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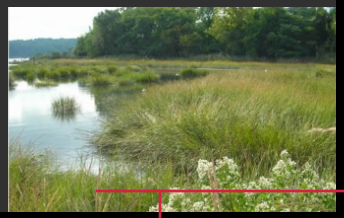

Interdisciplinary Approach to Living Shorelines

- Importance of Interdisciplinary Approaches
- Case Studies
  - Examples of Collaboration
  - Lessons Learned
  - Simple Rules & Takeaways
- Moving Forward: Tools & Strategies for Effective Design & Implementation

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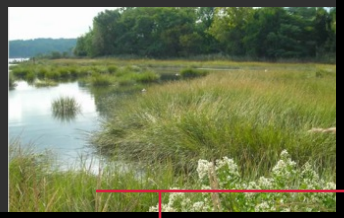

Living Shorelines IN Connecticut

CTDEEP Working Definition of Living Shorelines:

"Living shorelines: A shoreline erosion control management practice which also restores, enhances, maintains or creates natural coastal or riparian habitat, functions and processes. Coastal and riparian habitats include but are not limited to intertidal flats, tidal marsh, beach/dune systems, and bluffs. Living shorelines may include structural features that are combined with natural components to attenuate wave energy and currents".

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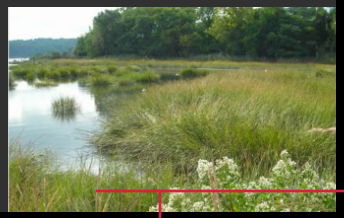

"Living Shorelines Protected, Restore & Enhance Natural Habitats & Coastal Procesesses…"

BEFORE:
Mid 1900's method of stabilizing shorelines using various forms of construction debris…

AFTER:
Replacing rubble with clean backfill, controlling toe erosion and restoring ecological function & value

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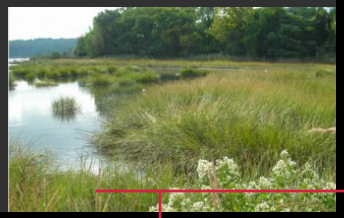


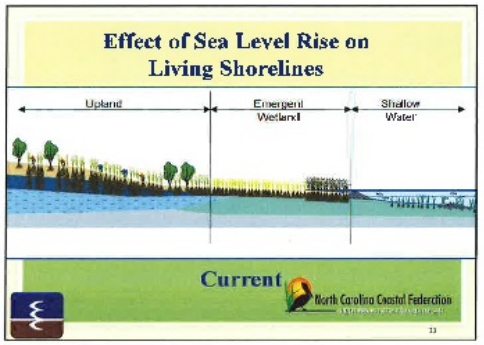
Why Build a Living Shoreline ?

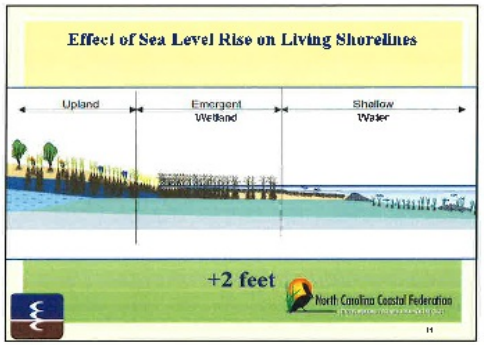
Living Shorelines are complex systems. Build them to enhance, protect and increase coastal resiliency…

- An integrated approach is the best possible way to optimize the outcome;
- Engineering, coupled with good science, understanding of coastal ecology and site design through an interdisciplinary approach and regulatory partnership.

Lets review some of the sea level rise effects:

1- Inundation & habitat impacts
2- Erosion
3- Salt Marsh loss and migration
4- Shoreline retreat
5- Upland Flooding
6- Ecological Change
7- Habitat tradeoff evaluation
8- Economic Impact





Source: Environmental Concern

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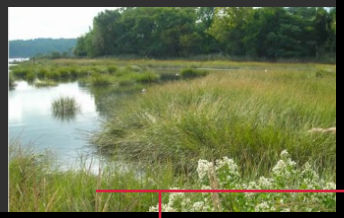
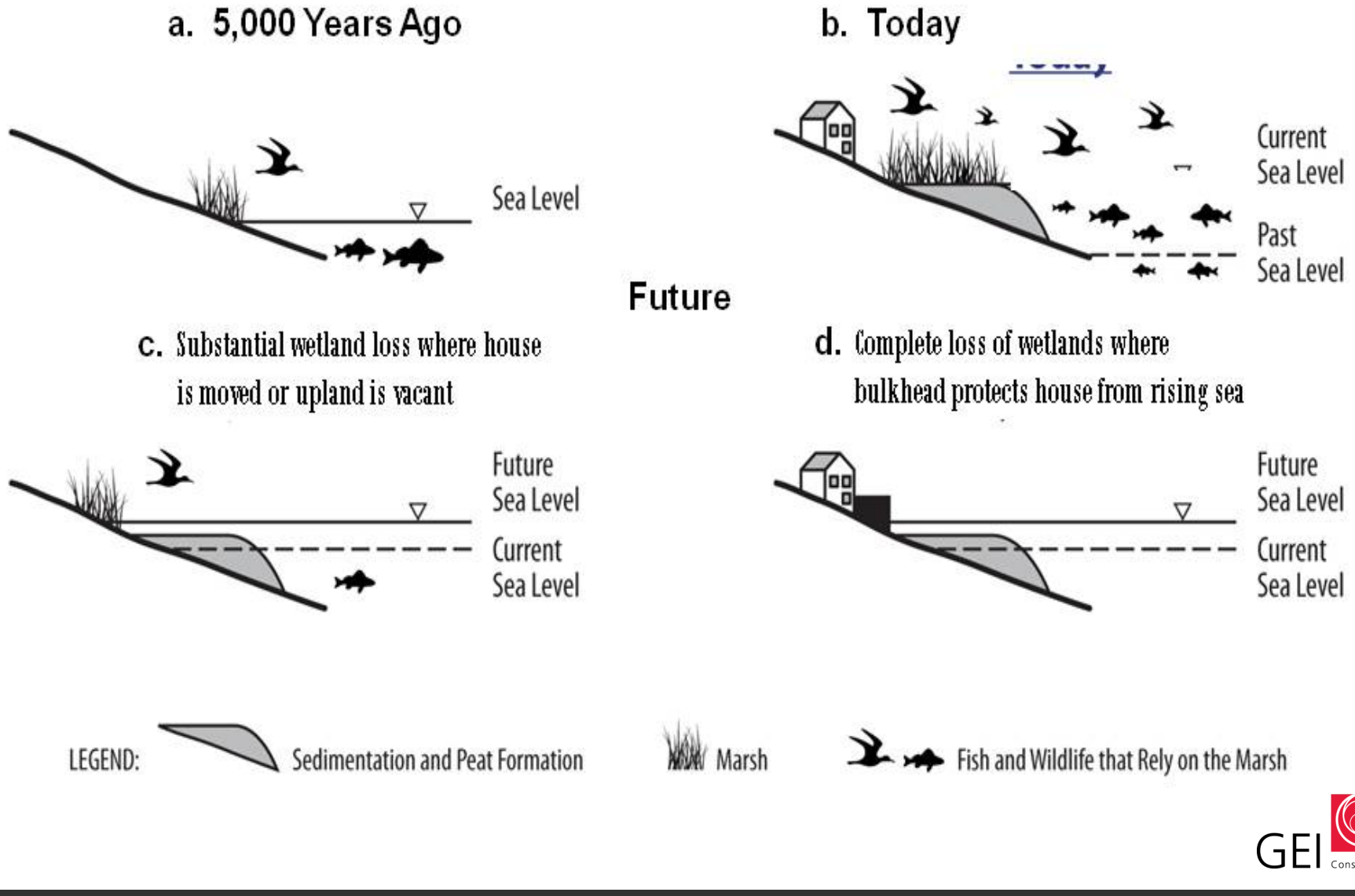


Observed Changes in The Coastal Environment



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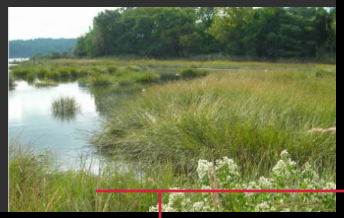

Direct Benefit of a Salt Marsh / Living Shoreline

A healthy salt marsh reduces up to 50% of the incoming wave energy within the first 15 to 20 feet of area and up to 95% over 150 to 200 feet

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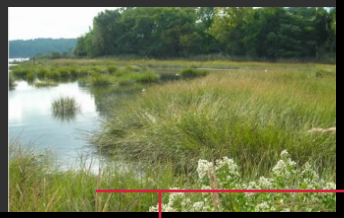

Benefits / Shortfall of Living Shorelines

Benefits:

- Maintains natural shoreline processes and sand migration
- Absorbs moderate storm surge and dynamic energy
- Provides habitat for marine organisms plus an adjacent upland buffer
- Protects shorelines from erosion
- Less costly to build compared to hard structures, sea walls, bulkheads, groins or rock revetments
- Absorbs and traps green house gasses
- Enhances the visual appeal of the shoreline
- Minimizes impacts on adjacent properties

Shortfall:

- Not as effective in high energy zones
- Requires annual inspections and periodic maintenance
- Technology and materials are still evolving
- Still many unproven options to consider and/or be wary of
- False sense of security (in moderate to high energy zones)
- The regulatory strategy is still evolving

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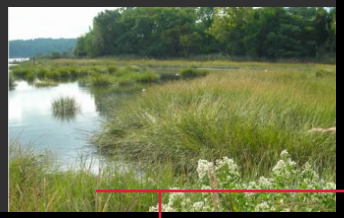

Site Specific Solutions for Living Shorelines

- Low Energy site = Living Shorelines are ideal solution

  Less than 2 feet of short waves, low current & low storm surge

- Medium Energy site = Consider A Hybrid system, hard sill and plants

  Two (2) to 5 foot waves, moderate currents/storm surge

- High energy site = Use Hard structures with biogenic design to promote habitat diversity

  Higher wave energy (greater than 5 feet), severe exposure, high storm surge, overtopping and erosion

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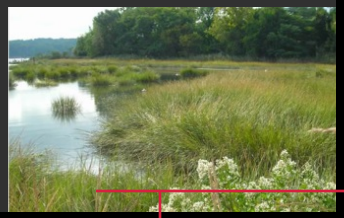
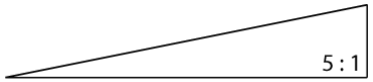


Many Choices for Treatments

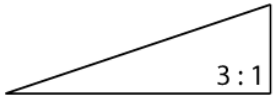
Plants as Primary Support (5:1 and flatter)

- Plugged or seeded
- Low energy environment
- No concentrated surface flows (sheet flow only)



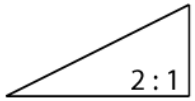
Plants with Erosion Control (5:1 to 3:1)

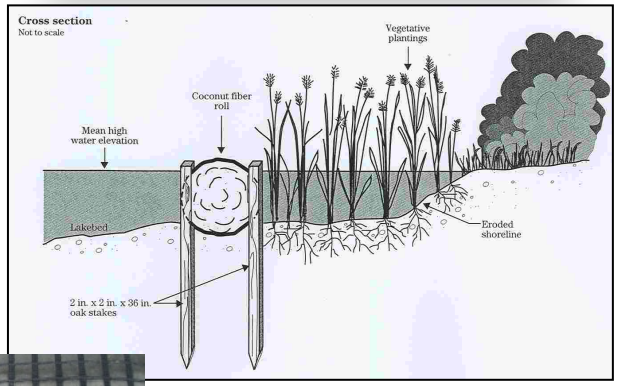
- Plugged or seeded
- Low energy environment
- Sheet flow only



Plants as Structural Support (3:1 to 2:1)

- Brushmattress, Fascines, Live stakes, etc.
- Low to moderate energy environment
- Seeding may be included





Additional Structural Support Needed (>2:1 slope)

- Hybrid practices, sills, crib walls, etc.
- Moderate energy environment

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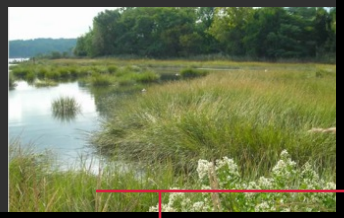

Interdisciplinary Coordination is Essential

- Living Shorelines/Hybrid Design must balance the dynamic forces, control erosion and build resilience through restoration, enhancement of natural processes of coastal and riparian habitat, and evaluate tradeoffs.

- Design complexities require a variety of expertise:
  - Planners
  - Engineers
  - Landscape Architects
  - Coastal Ecologists & Scientists
  - Regulatory community
  - Public education

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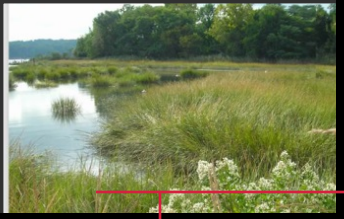

Some Relevant Project Examples

- Charleston, South Carolina
- Shaffer Paper (Industrial site), South Boston, MA
- Coastal Bank Stabilization, Nantucket, MA
- Clippership Wharf, Boston Harbor, MA
- Aunt Amy's Creek, Stony Brook Harbor, NY
- Binder Bluff Stabilization, Lloyd Harbor, NY

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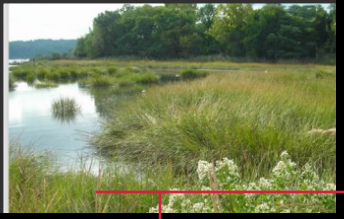

Charleston, SC – Functions & Values

Salt Marshes are diverse ecosystems that function as spawning beds for a large variety of marine life, and improve water quality through:

- uptake of nutrients, filtration, denitrification and sediment retention; and
- provide habitat enhancement for 80% of breeding bird population.

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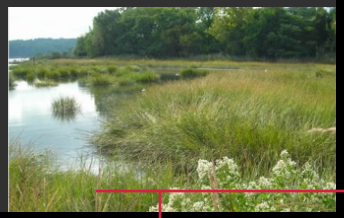
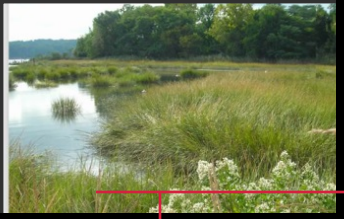


Shaffer Paper Project, So. Boston, MA

Converting an existing Broken Granite wall into a Living Shoreline

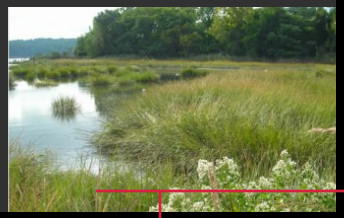
GEI Consultants



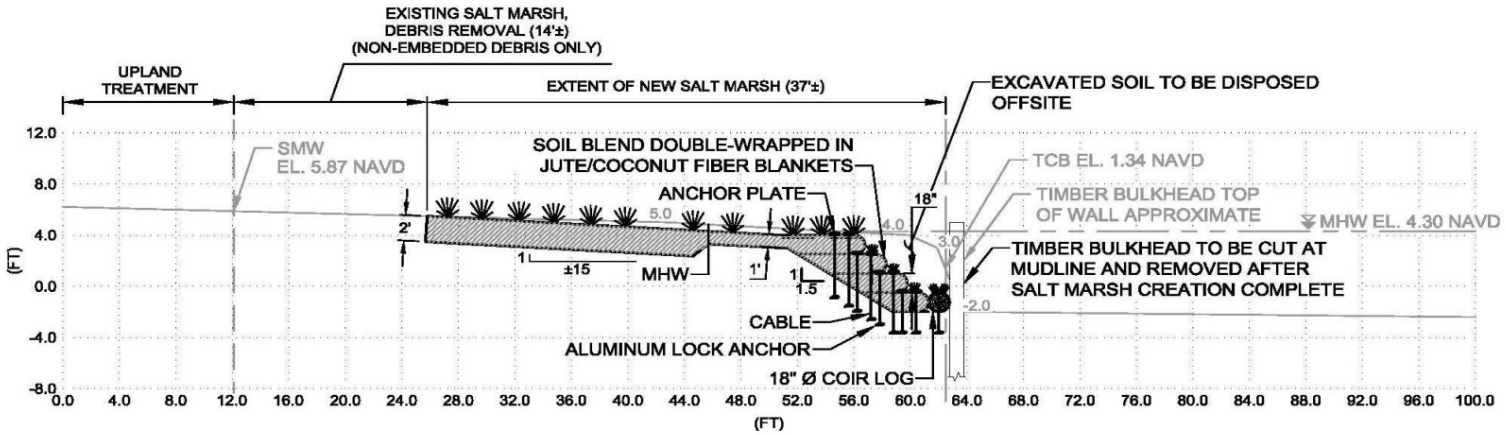
Shaffer Paper Project, So. Boston, MA

Dilapidated Timber Bulkhead to be changed to a Living Shoreline

GEI Consultants

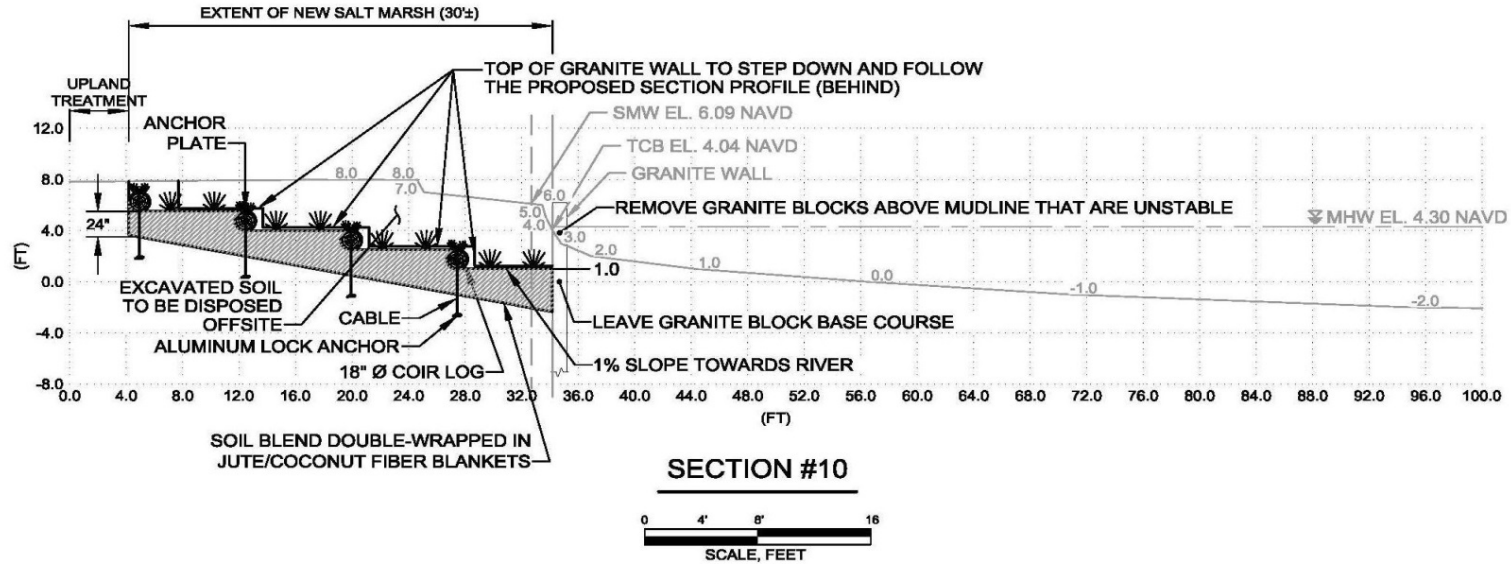


Shaffer Paper, Proposed Living Shoreline Sections



SECTION #5

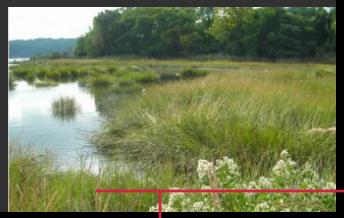
SCALE, FEET



SECTION #10

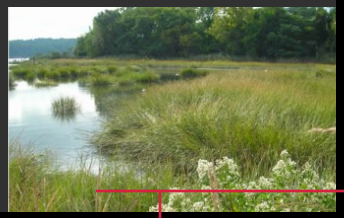
SCALE, FEET

GEI Consultants



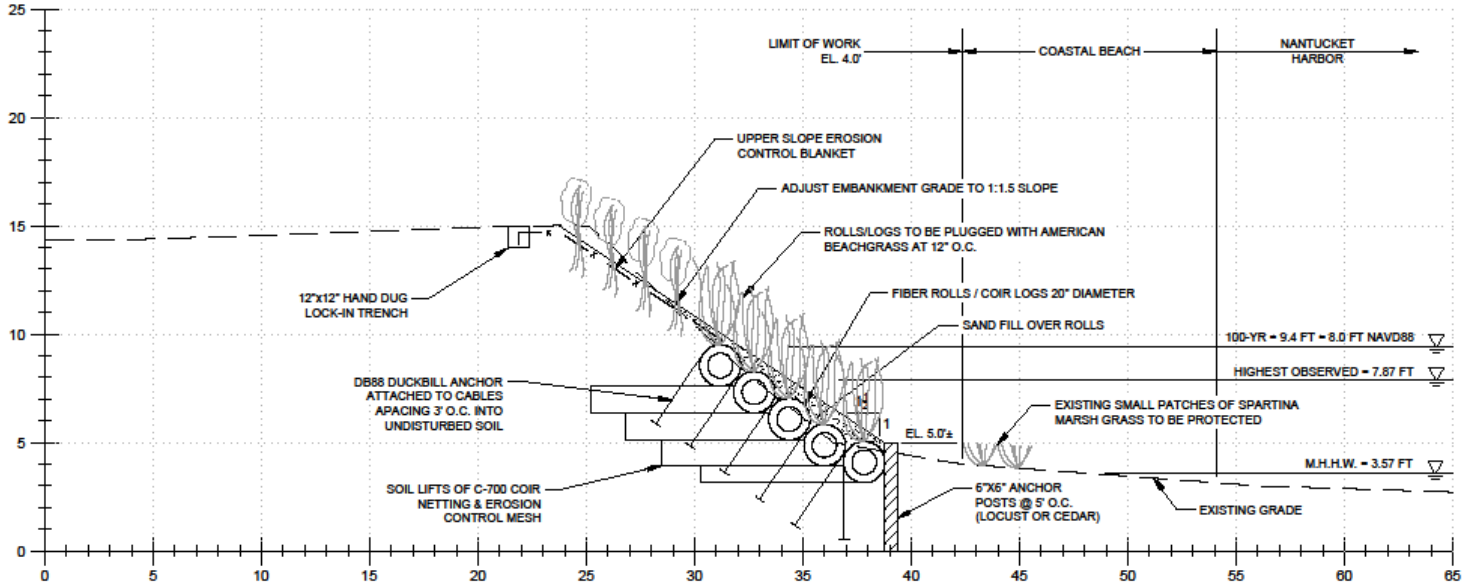
Coastal Bank Stabilization, Nantucket MA

GEI Consultants



Nantucket MA, Proposed Restoration

Section B



DRAFT

PLANTING:

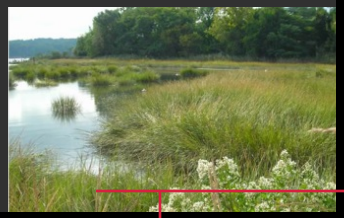
1. UPPER SLOPE TO BE PLANTED WITH SWITCHGRASS AND ATLANTIC COASTAL PANIC GRASS AT 12" O.C.
2. FIBER ROLLS TO BE PLUGGED WITH AMERICAN BEACHGRASS AT 12" O.C.

0 5' 10'

SCALE: 1" = 5'

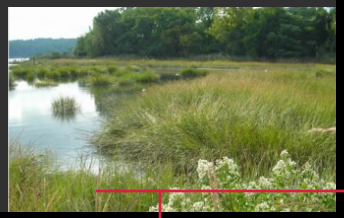
Slope Stability 4 Middle Valley Road Nantucket, Massachusetts		GEI Consultants	SECTION B
Private Owner		Project 141524-0	February 2015 Fig. 4

\\bos1v-fs02\PROJECTS\DATA\2014\1415240 4 Middle Valley Rd Nantucket\Drawings\Slope Cut Sections.dwg - 2/16/2015



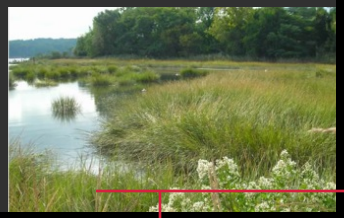
Alternative Stabilization, Nantucket MA

GEI Consultants

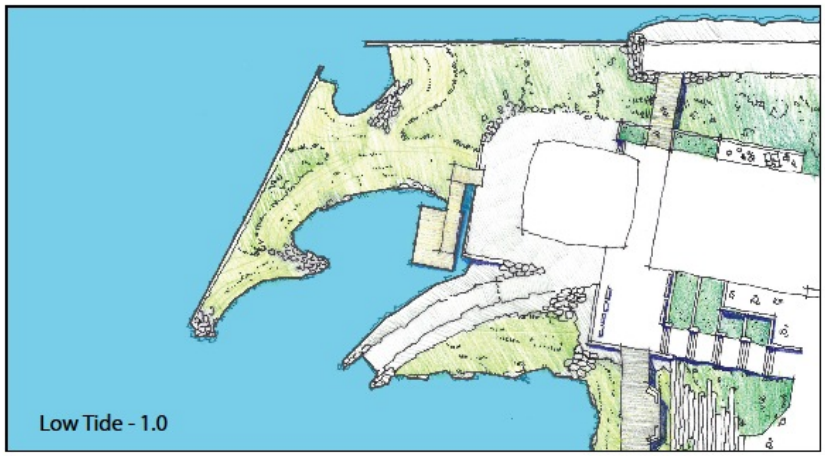


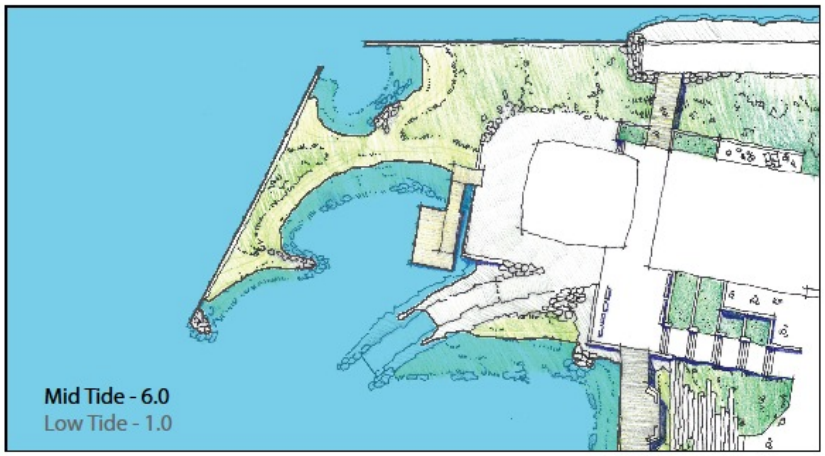
Alternative Stabilization, Nantucket MA

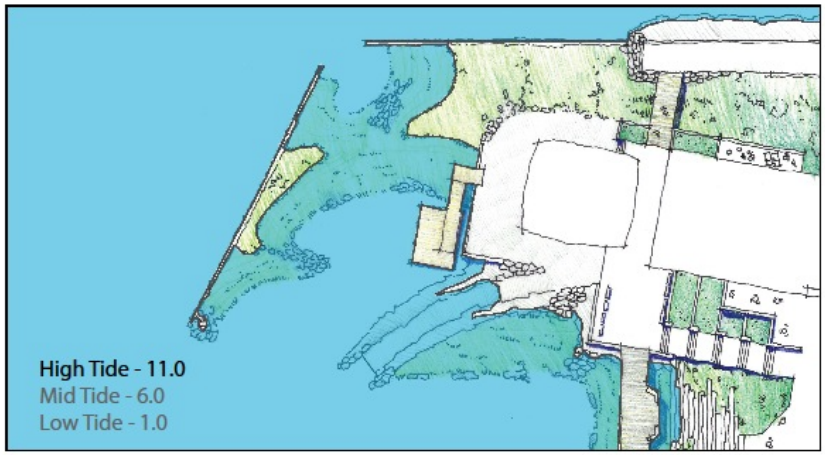
GEI Consultants

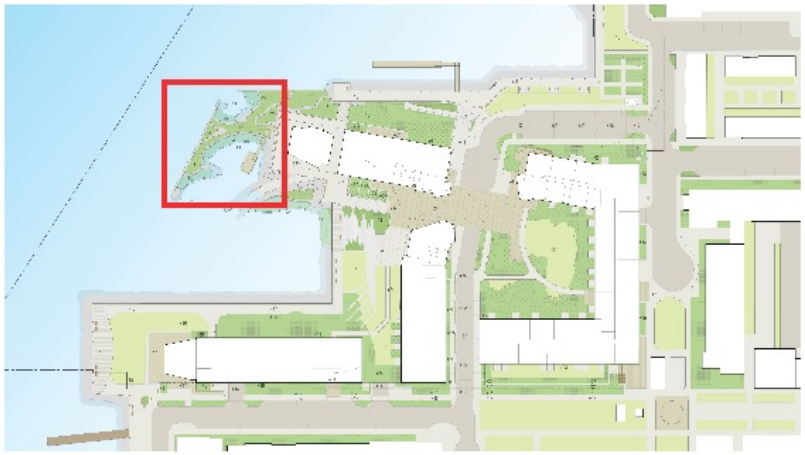


Clippership Wharf, Boston Harbor, MA
New Development by Lend Lease









Clippership Wharf

Tidal Exposure

April 28, 2015

HALVORSON DESIGN PARTNERSHIP
LANDSCAPE ARCHITECTURE

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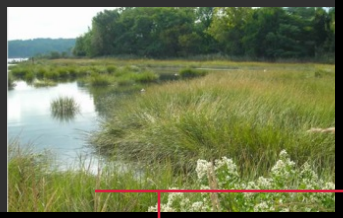
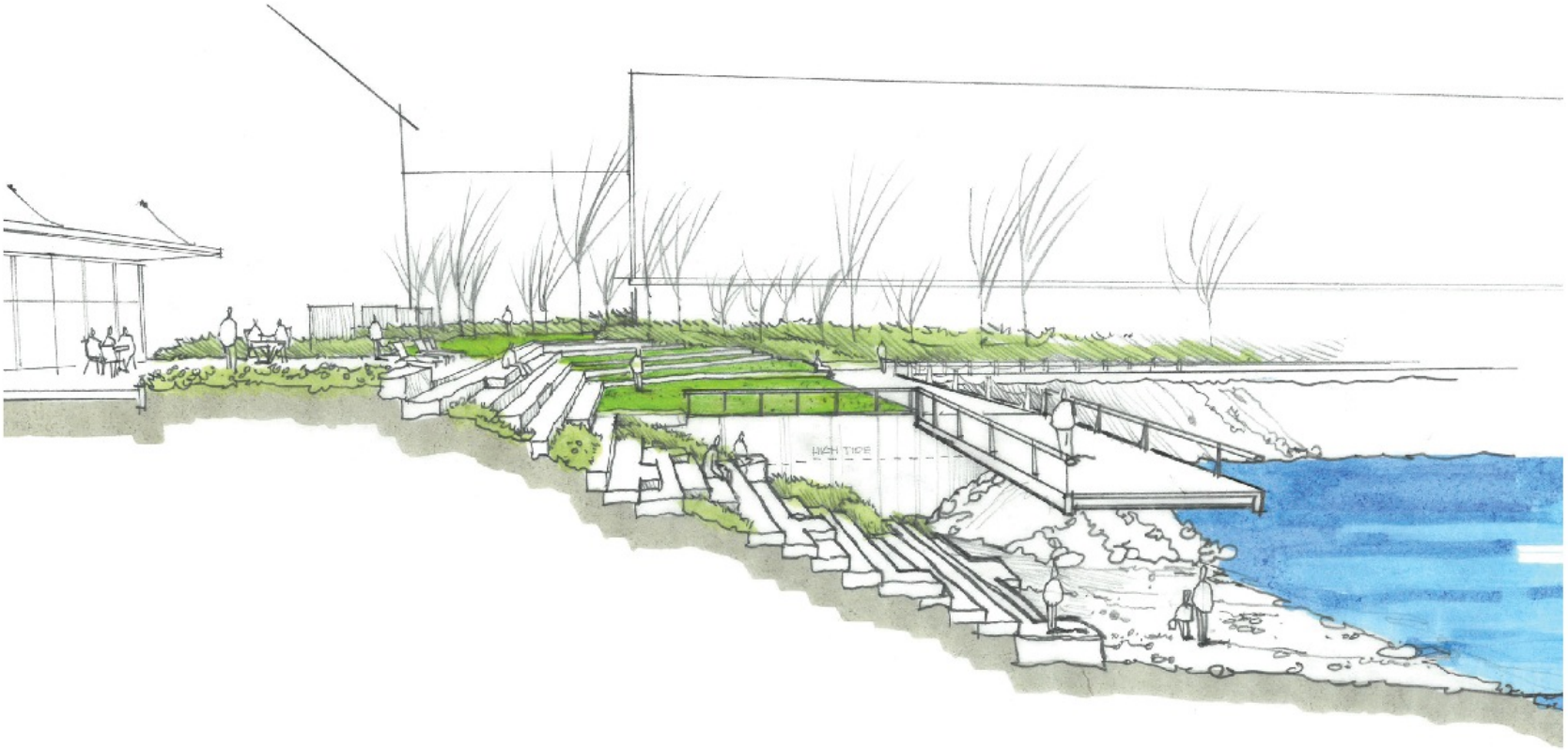


Clippership Wharf, Boston Harbor, MA
Hybrid Living Shoreline



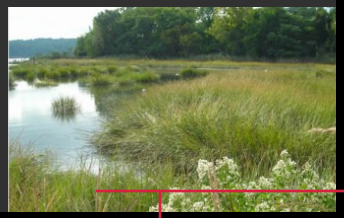
Clippership Wharf

Stone Terracing to Rocky Beach - Conceptual Cross Section

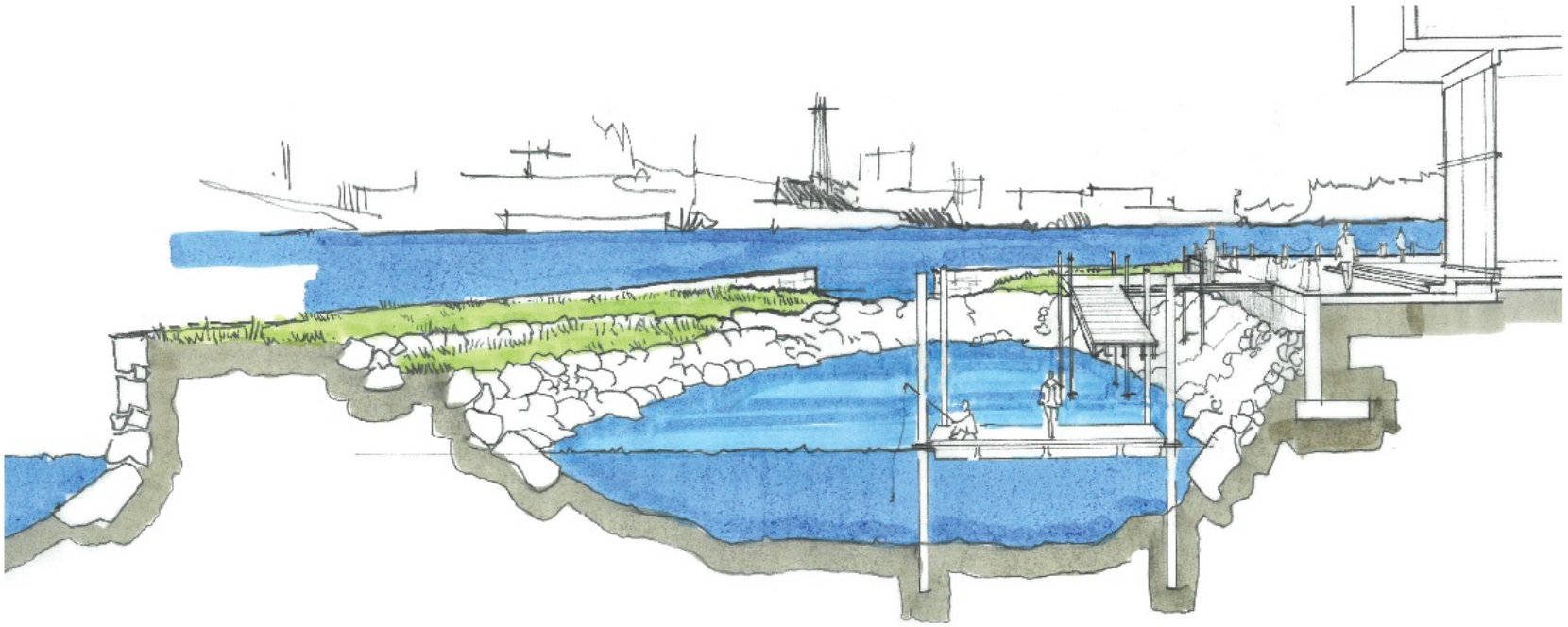
April 28, 2015

HALVORSON DESIGN PARTNERSHIP
LANDSCAPE ARCHITECTURE

GEI Consultants



Clippership Wharf, Boston Harbor, MA
Hybrid Living Shoreline



Living Shoreline Section

Clippership Wharf

Precedent Images

April 28, 2015

HALVORSON DESIGN PARTNERSHIP
LANDSCAPE ARCHITECTURE

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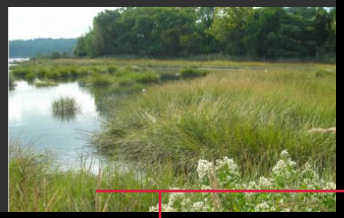
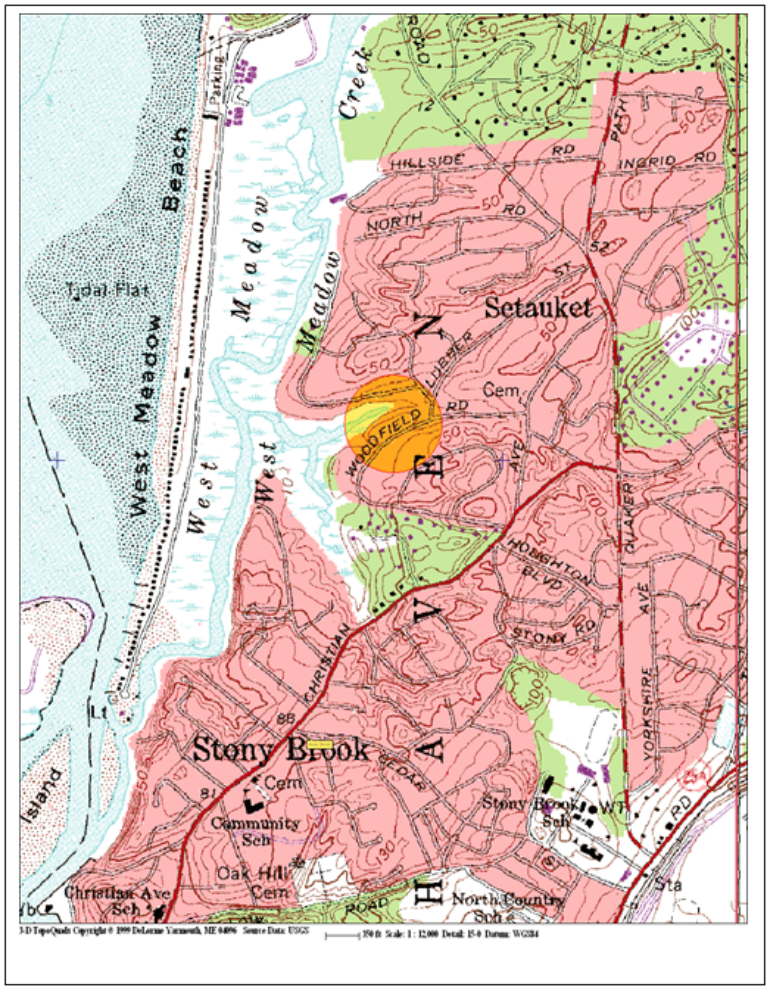
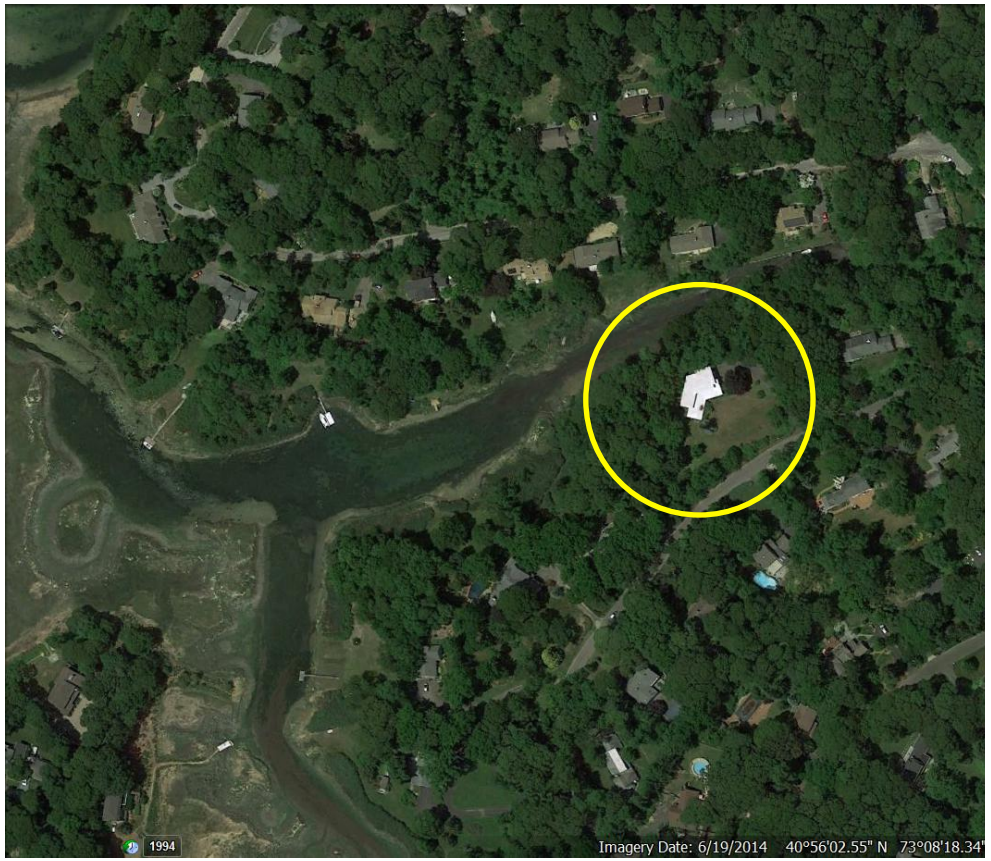


Aunt Amy's Creek, Stony Brook, NY



Project location



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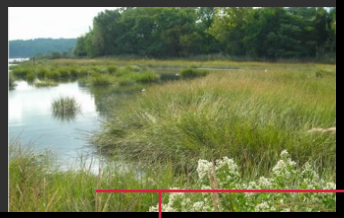

Aunt Amy's Creek, Stony Brook, NY

2007 - Initial Eroded Condition
Undercut bank varied 2-1/2' to 4'

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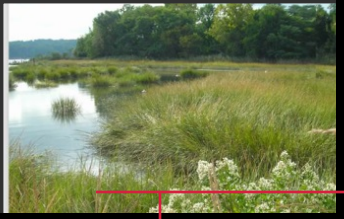
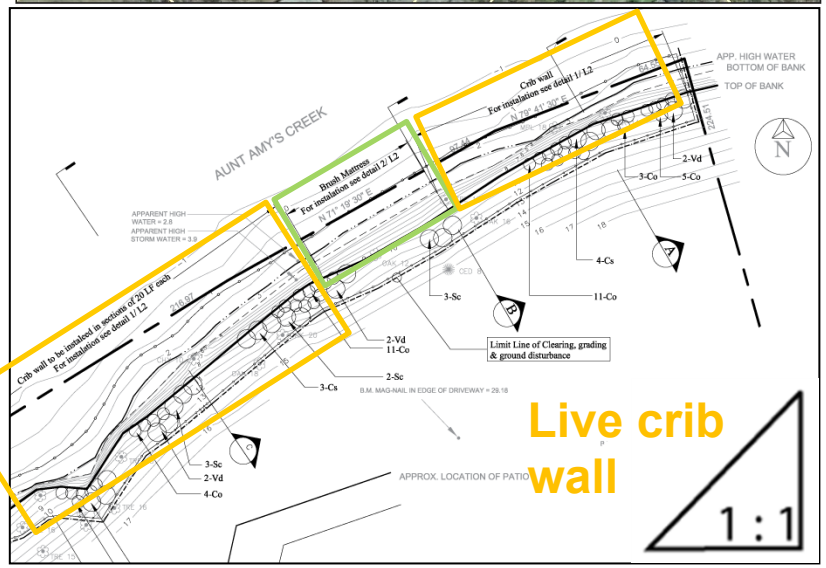


Aunt Amy's Creek, Stony Brook, NY



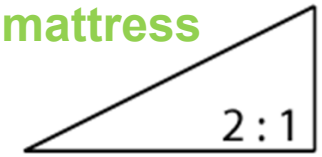
PLANNING TIMELINE:

- May 2007 – Initial site reconnaissance;
- July 2007 – Site topographic survey;
- November 2007 – Plans completed; USACE, State & local permit applications submitted;

  .....16 months later.....
- March 2009 - Permits approved;

  .....then.....

Brushmattress



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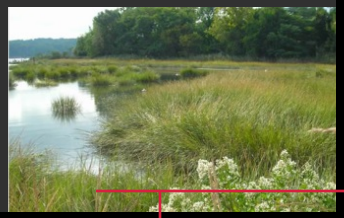
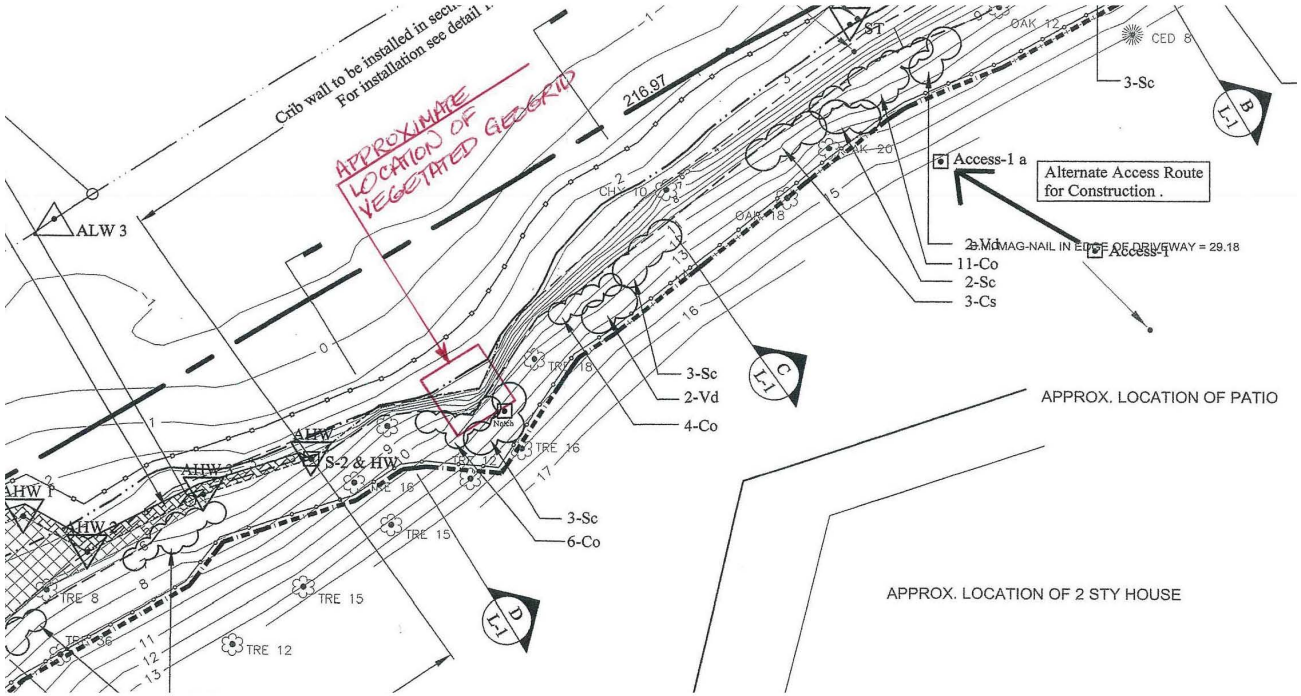


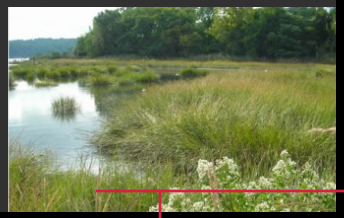
Aunt Amy's Creek, Stony Brook, NY

PLANNING TIMELINE:

- April 2009 – Permit modification (Due to extended agency review period, the undercut banks widened to 4-5 feet requiring additional engineering…)



GEI Consultants



Aunt Amy's Creek, Stony Brook, NY

CONSTRUCTION PHASE

Site work commenced May 2009

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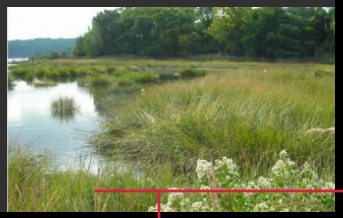

Aunt Amy's Creek, Stony Brook, NY

CONSTRUCTION PHASE

Crib wall transitioning to brushmattress

Stone base to weep springs
& geogrid tie backs

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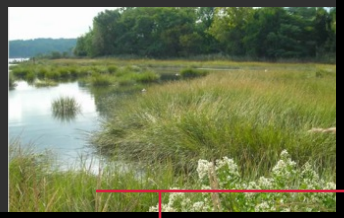

Aunt Amy's Creek, Stony Brook, NY

CONSTRUCTION PHASE

Live stakes/whips

Live crib wall

Brushmattress

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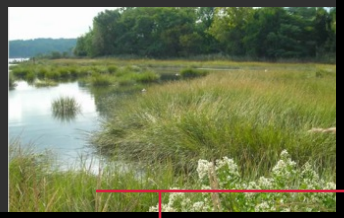
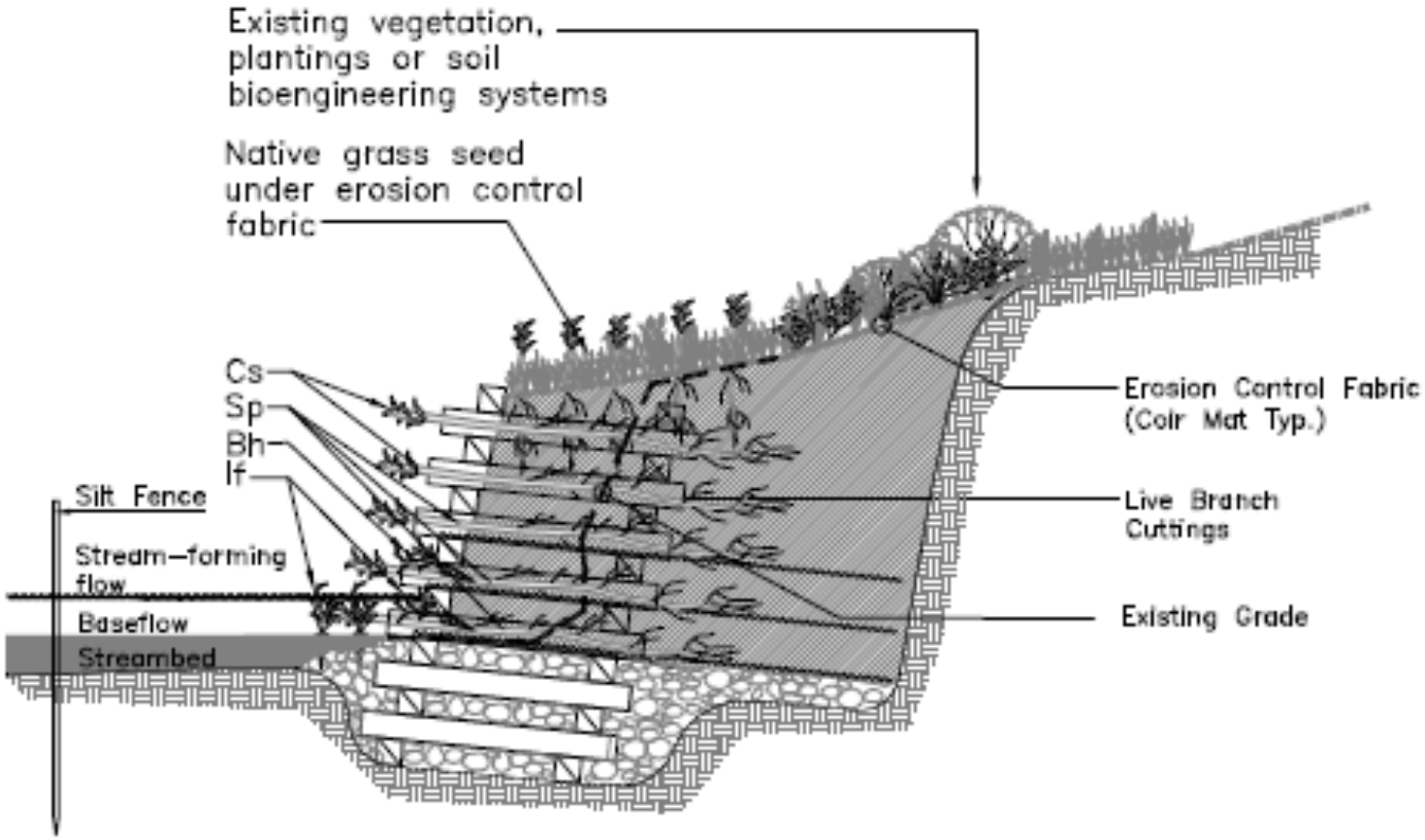


Aunt Amy's Creek, Stony Brook, NY



AS BUILT LIVE CRIBWALL PLANTING DETAIL

Section View Scale: 1/4"=1'-0"

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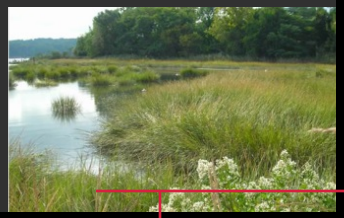

Aunt Amy's Creek, Stony Brook, NY

MONITORING PHASE - Brushmattress

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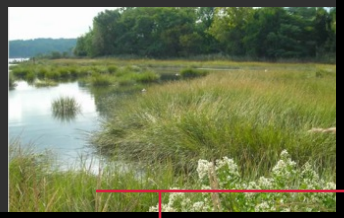

Aunt Amy's Creek, Stony Brook, NY

MONITORING PHASE – Live Crib Wall

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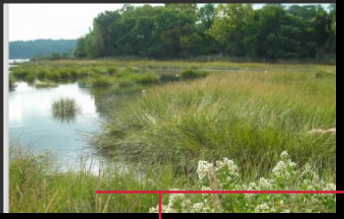

Binder Bluff, Lloyd Harbor, NY

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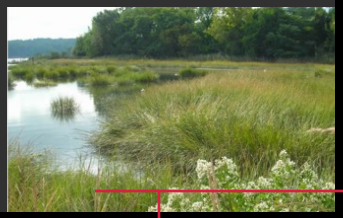
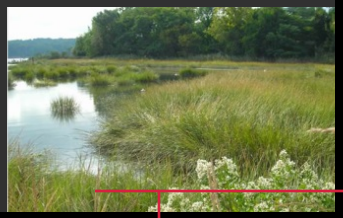


Binder Bluff, Lloyd Harbor, NY

GEI Consultants



Binder Bluff, Lloyd Harbor, NY

Initial Pre-Sandy Condition

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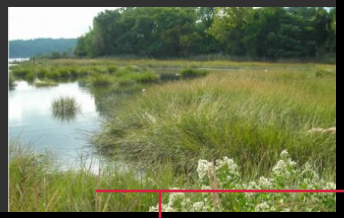
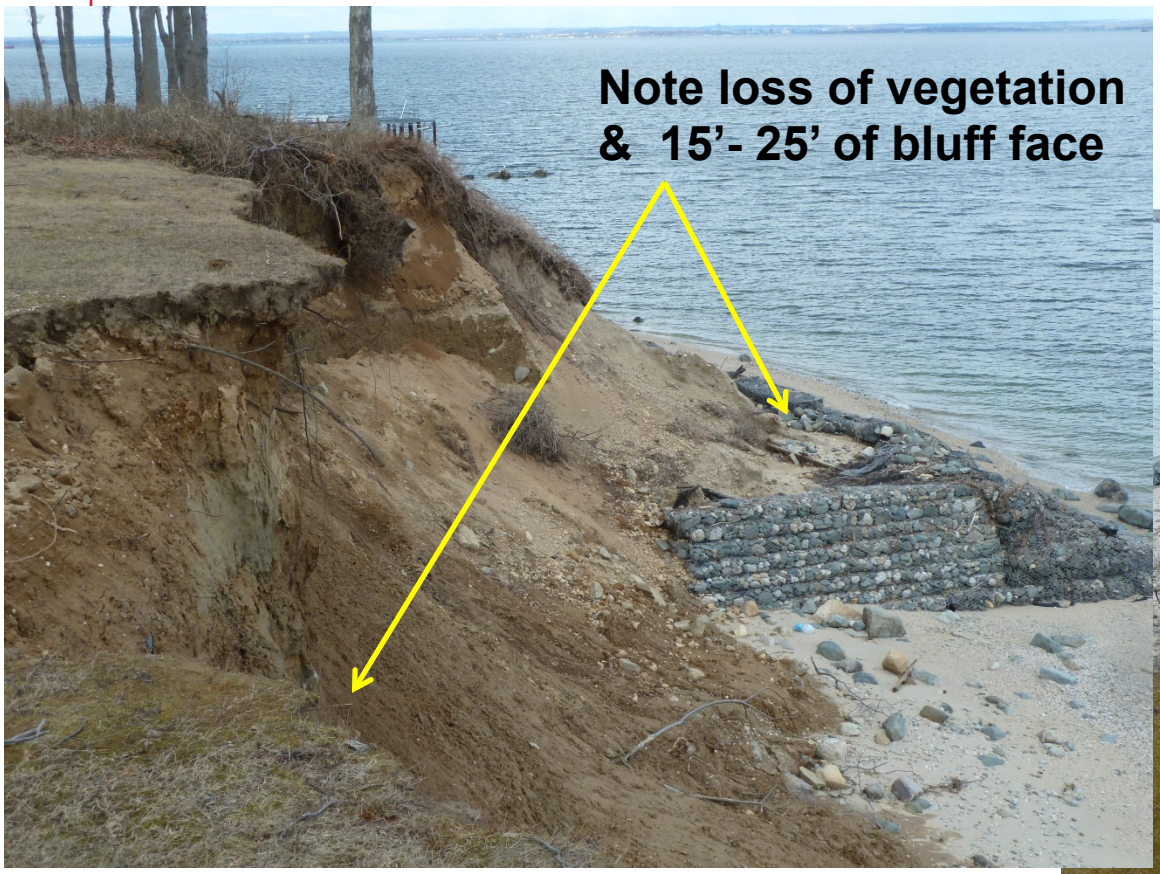


Binder Bluff, Lloyd Harbor, NY



Post - Sandy Condition

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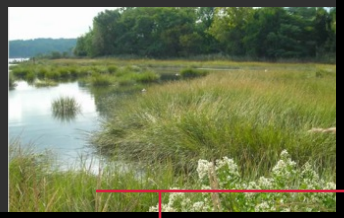

Binder Bluff, Lloyd Harbor, NY

Overtopping & failure of adjacent gabion wall

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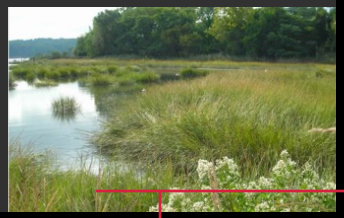
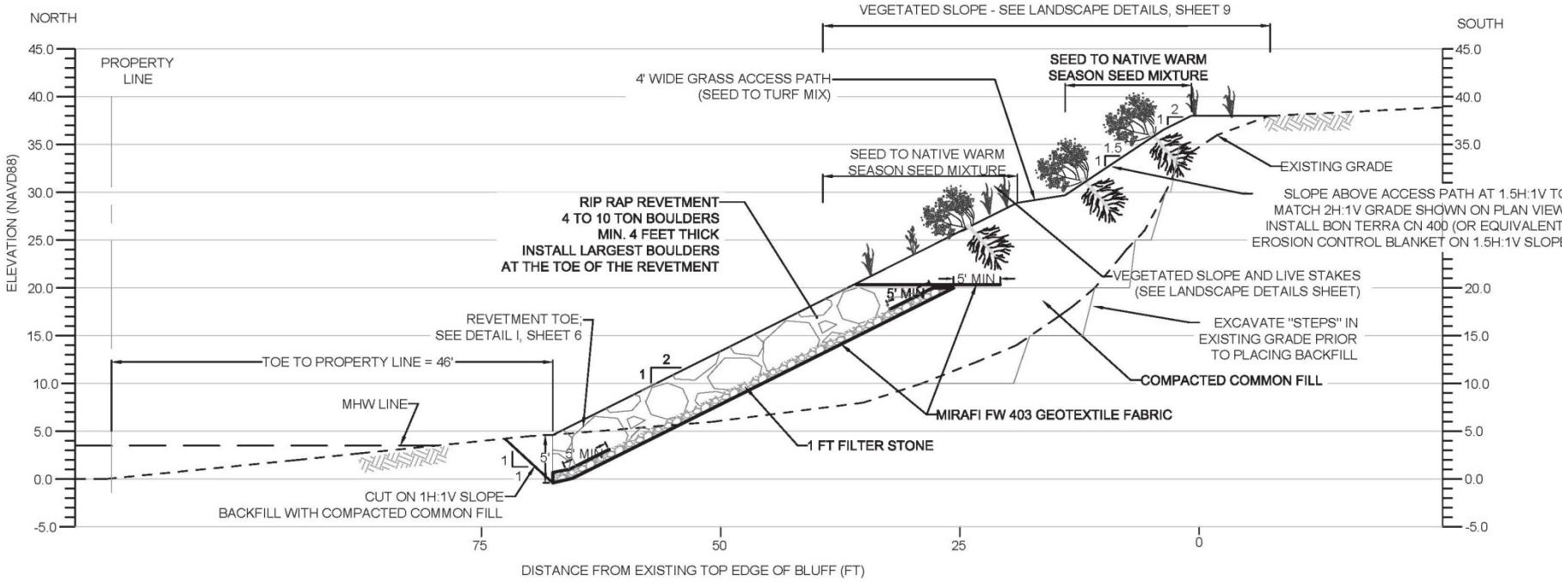


Binder Bluff, Lloyd Harbor, NY



SLOPE CROSS SECTION 2/4

SCALE: 1"=10'

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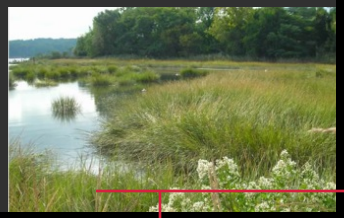

Key Design Considerations

1. Calculate the length of “Effective Fetch” or open water distance to determine the level of exposure to guide the design;
2. Control overland drainage & hydraulic pressure;
3. Conduct slope stability analysis & sediment gradation test;
4. Protect the base and the toe from undermining;
5. Protect the flanks;
6. Prevent overtopping;
7. Create a diverse habitat;
8. Encourage biogenic processes;
9. Account for sea level rise;
10. 3 Years minimum monitoring & maintenance program

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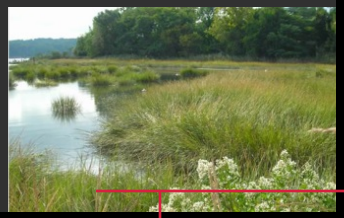

Conclusions / Steps Forward

1. Understanding the Working Definition of Living Shorelines
2. Benefits of Living Shorelines
3. Site Characterization - Low, Medium & High Energy Shorelines
4. Appropriate Treatment Selection
5. Importance of Interdisciplinary Approach
6. Living Shorelines Applications – Case Studies & Lessons Learned
7. Work With Your Regulators
8. Key Design Considerations

QUESTIONS??

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