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VIRGINIA INSTITUTE OF MARINE SCIENCE
1940-2015 75 YEARS

A Novel Remedial Approach for Contaminated Sediment: A Living Shoreline Pilot Project

AECOM

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Introduction

From 1926 to 1986, the former Lordship Gun Club, located on Long Island Sound in Stratford, Connecticut, was operated as a trap and skeet shooting facility, which resulted in the discharge of lead shot into surrounding waters and sediments. Between 1987 and 2000, studies were conducted to inform remedial decision-making; remediation occurred in several phases from 2000 to 2011. Remedial action involved excavation of shot-containing sediments and associated vegetation from the intertidal zone, lead shot extraction from excavated sediments, and replacement of sediments to their native locations. Subsequent monitoring has revealed that this action destabilized intertidal sediments and led to substantial erosion of the shoreline and dunes, which has limited efforts to reestablish native wetland vegetation. Erosion of sediment from the intertidal zone has also resulted in the concentration of residual lead shot on the sediment surface, which poses a potential exposure hazard to migratory waterfowl. To address these issues, a living shoreline pilot project, which includes an artificial reef and a smooth cordgrass (*Spartina alterniflora*) marsh, was constructed in May 2014. The purpose of the pilot project is to evaluate living shorelines for their potential to: (1) decrease shoreline and dune erosion at the site; (2) further reduce potential ecological exposure to residual lead shot; and, (3) restore wildlife habitat within the adjacent Housatonic River Estuary and Long Island Sound. Results are being evaluated in the context of a Before-After-Control-Impact (BACI) statistical framework. The design and preliminary data are shared.

Design Approach

Objectives

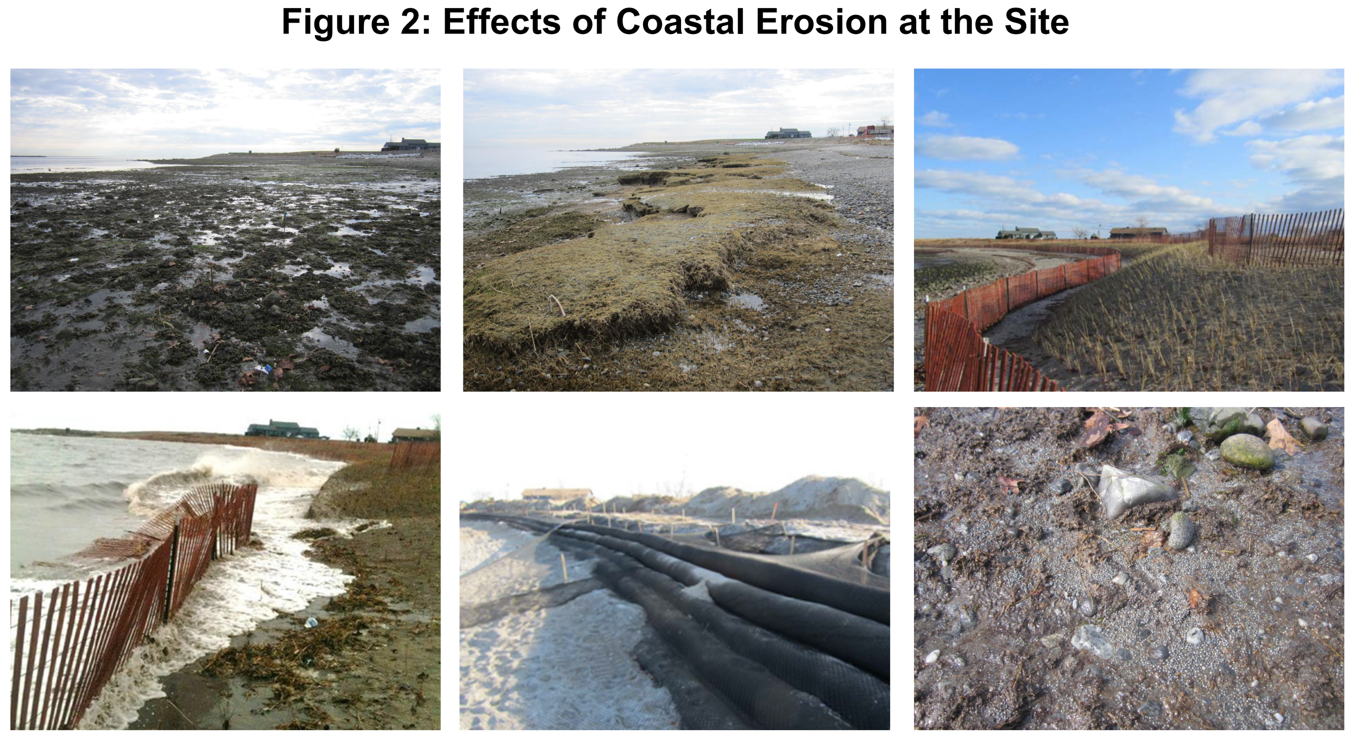
- Decrease erosion in the intertidal zone
- Reduce potential ecological exposure to residual lead shot
  - Disrupt longshore sediment transport
  - Accrete sediment to create a "clean cover" over exposed shot

Site Challenges

- Complex hydrodynamic setting (Figure 1)
  - Variable estuary discharge
  - Increasing prevalence / intensity of coastal storms
- Substantial erosion, shoreline migration over the past decade (Figure 2)
- Subsequent concentration of lead shot on the sediment surface (i.e., winnowing)

Figure 1: Site Location

Figure 2: Effects of Coastal Erosion at the Site



Design Criteria

- Mean High Water (MHW), Mean Low Water (MLW)
- Design storm events, storm surge, significant wave height, estuary discharge
- Wave transmission / attenuation
- Shear stress, sediment grain size, scour

Materials

- Multiple rows / sizes of concrete reef balls considered
  - Pallet ball: 4 ft. by 3 ft.
  - Ultra ball: 6 ft. by 4 ft.
- Special formulated concrete (freeze / thaw resistant)
- Fiberglass reinforced rebar (anchoring, if needed)

Construction

Final Design

- 2 rows of pallet balls (Figure 3)
- Attenuation for design storms
  - 2-year: 74%
  - 5-year: 41%
  - 10-year: 32%
  - 25-year: 25%
- Located ~ 75 ft. seaward of MLW (Figure 4)
- *Spartina alterniflora* planted landward of reef

Figure 3: Living Shoreline Design

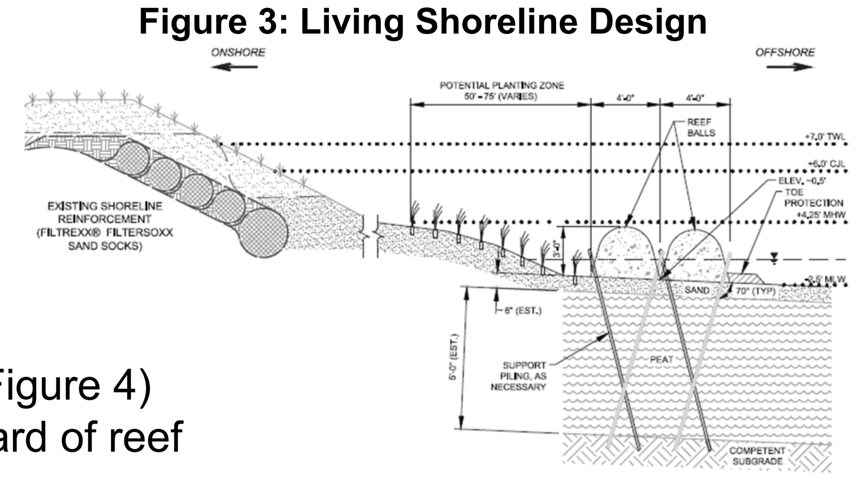


Figure 4: Construction Sequence

Monitoring

Approach

- Build on historical site investigations to document change over time (Figure 5)
- Use an adaptive management framework to inform future actions

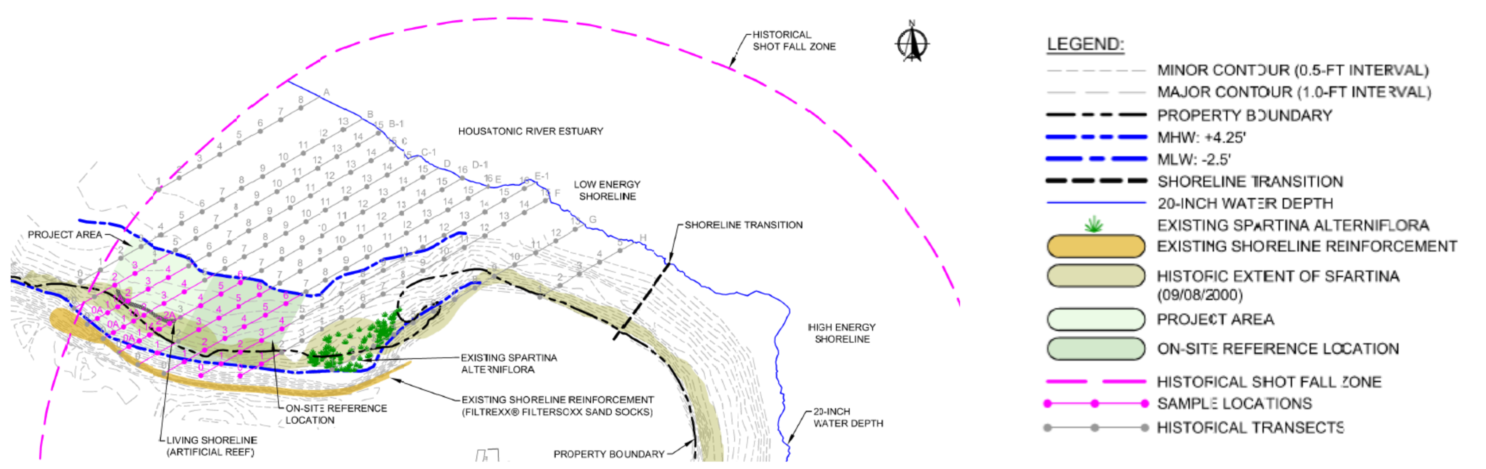
Abiotic

- Erosion (Figure 6)
- Lead shot density (Figure 7)
- Non-shot particulate lead concentrations in sediment
- Dissolved lead concentrations in interstitial pore water

Biotic

- Lead concentrations benthic tissue
- Lead concentrations in shellfish
- Dietary exposure to waterfowl (incidental ingestion of lead shot, sediment, etc.)

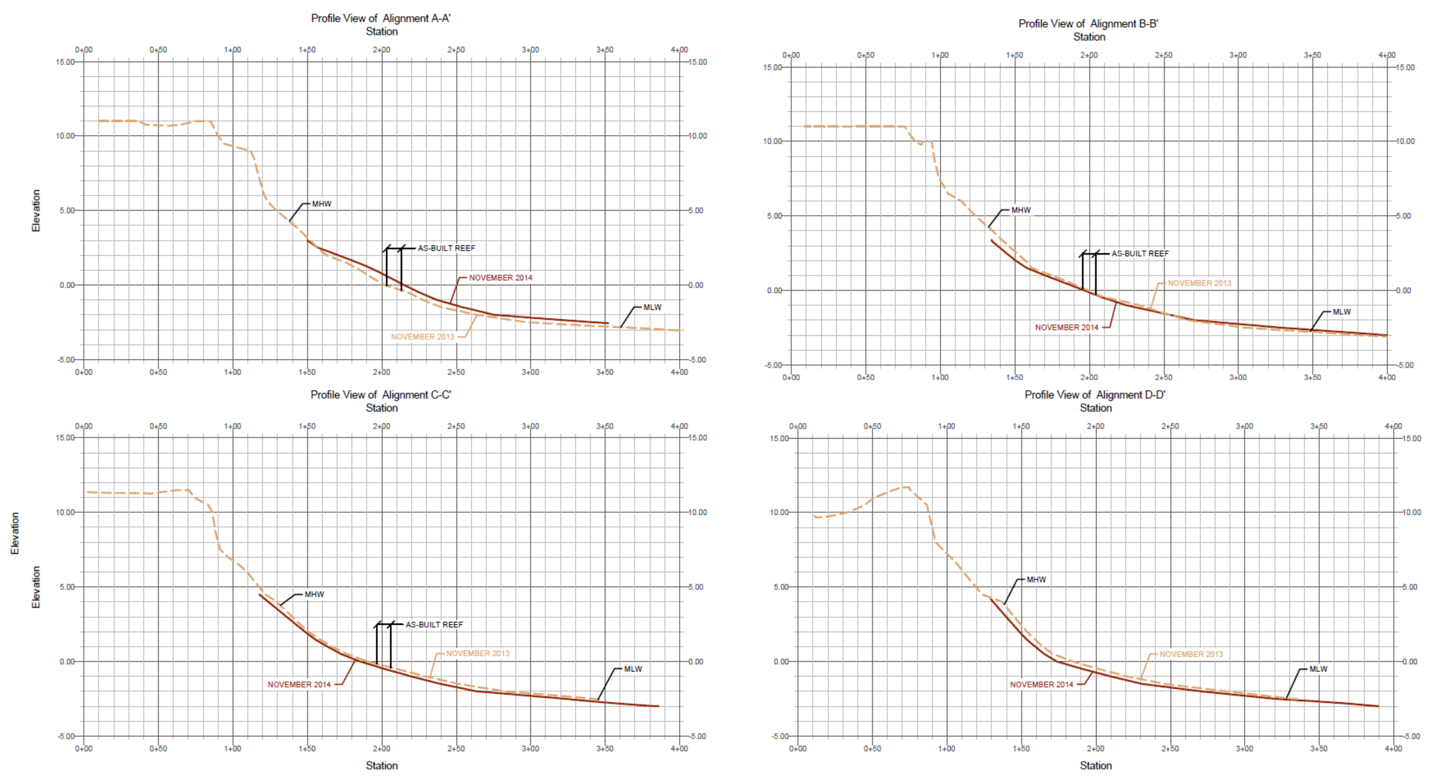
Figure 5: Monitoring Transects



Preliminary Results

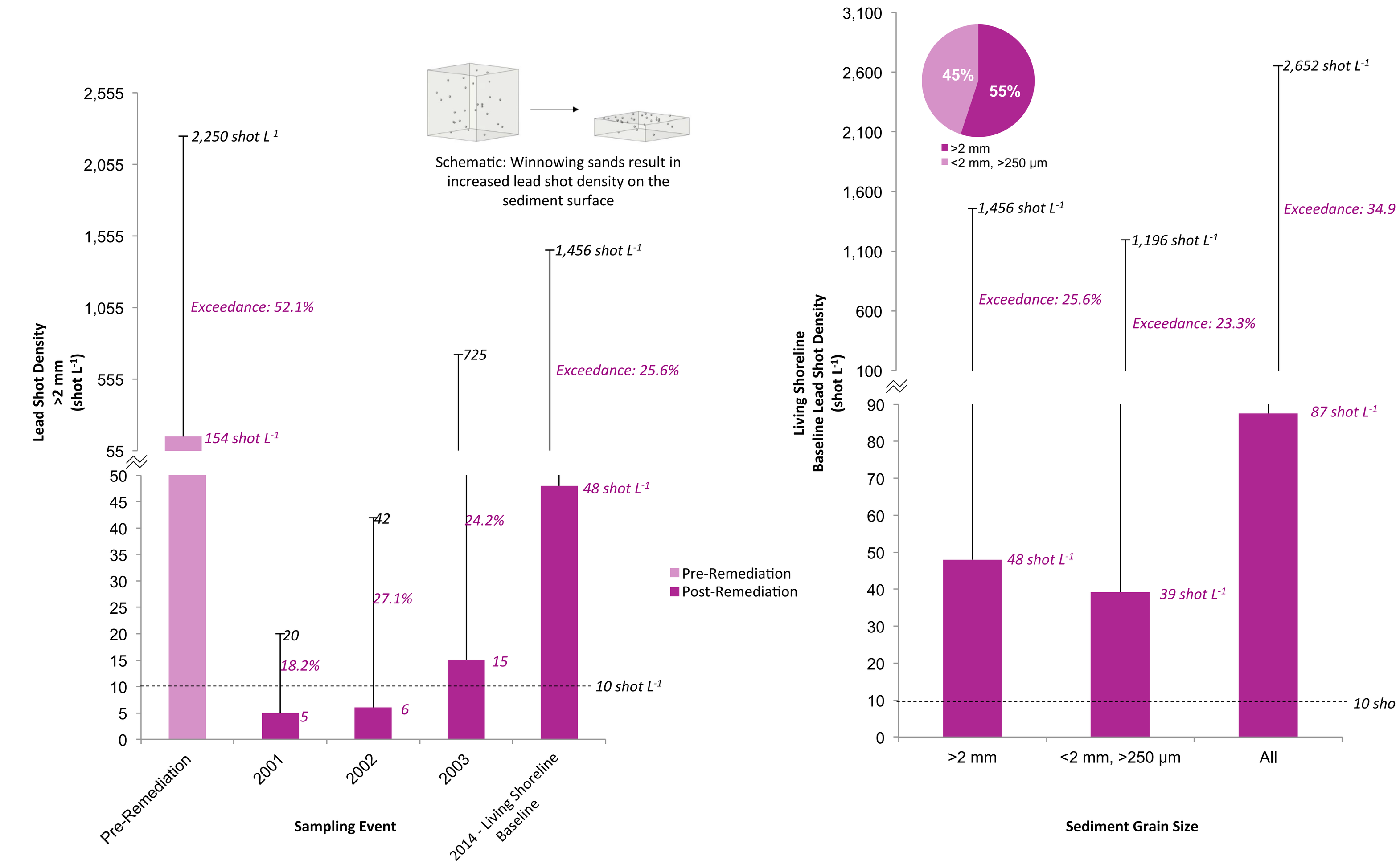
Erosion

Figure 6: Change in Elevation



Lead Shot Density

Figure 7: Baseline Lead Shot Density



Discussion

Figure 8: One Year Post-Construction

Erosion / Accretion

- No further erosion
- Accumulation of >6 in. fine grained sediment (Figure 8)

Potential Exposure

- Baseline characterization of lead in abiotic / biotic media, pending analysis of year-two data
- Historical loss of sediment increased lead shot density

Habitat

- Successful establishment of *Spartina* marsh

Path Forward

- Continued monitoring, presentation of year-two results
- Potential expansion beyond pilot footprint