Nature-Based Solutions for Coastal Highway Resilience: An Implementation Guide

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Use of natural materials and processes as alternatives to, or ecological enhancements of, traditional shoreline stabilization and infrastructure protection techniques.
Example: Dune Restoration

Credit: Peter Slovinsky
Credit: Bret Webb

Planted, Salt-Tolerant, Native Vegetation
Added Sediment for Dune Restoration
Existing Dune Topography
Mean High Water

NOT TO SCALE
Example: Pocket Beach

Credit: Scott Douglass

Credit: Virginia Institute of Marine Science

Pocket Beach
Headland Structures

Pocket Beach
Headland Structure

Beach Sand Fill

NOT TO SCALE
FHWA’s Eco-Logical Approach

Eco-Logical Framework

Implementing Eco-Logical

Overview
STEP 1 Collaboration
STEP 2 Eco Status
STEP 3 Develop REF
STEP 4 Assess REF
STEP 5 Prioritize
STEP 6 Crediting
STEP 7 Agreements
STEP 8 Implement
STEP 9 Update REF

Credit: FHWA
Research Gap: Nature-based Solutions and Integrated Approach

- Natural features
- Nature-based features
- Hybrid approaches
Program Overview

Nature-Based Solutions for Coastal Highway Resilience

- 5 pilot projects
  - OR DOT
  - ME & NH DOTs jointly
  - MS DOT
  - DE DOT
  - US Army Corps of Engineers in NJ

- White paper
- Regional peer exchanges
- Implementation Guide

FHWA Nature-based Resilience for Coastal Highways Website:
• Implement nature-based solutions to enhance the resilience of coastal highways

• Overview
  – Technical factsheets
  – Benefits and typical costs
  – Implementation considerations

Overview of Technique

• Materials
• Habitat Components
• Durability and Maintenance
• Design Life
• Ecological Services

Case Study
Benefits

✓ Reduction in coastal flooding, wave heights, and erosion
✓ Ecological, water quality, habitat benefits
✓ Reasonable costs
✓ Naturally adapt to sea level rise
✓ Tourism and recreation benefits

Coastal habitats can reduce wave heights by 35-70% and are often less expensive than armoring.
Incorporating into transportation planning can help:

- Address both resilience and environmental objectives
- Allows systematic consideration
- Mobilize larger projects
- Take advantage of analyses by partners
**Funding**

- Funding opportunities:
  - Transportation
  - Coastal restoration
  - Hazard mitigation

- Example: [National Coastal Resilience Fund](#) (NOAA & NFWF) funds nature-based solutions to protect coastal communities
### System Parameters
1. Shoreline Type
2. Infrastructure
3. Erosion Rate
4. Sea Level Rise
5. Tide Range

### Hydrodynamic Parameters
1. Wind Waves
2. Boat Wakes
3. Currents
4. Ice
5. Storm Surge

### Terrestrial Parameters
1. Upland Slope
2. Shoreline Slope
3. Width
4. Nearshore Slope
5. Water Depth
6. Soil Strength

### Ecological Parameters
1. Water Quality
2. Soil Type
3. Sunlight
4. Salinity

### Additional Parameters
1. Permits
2. End Effects
3. Constructability
4. Species
5. Debris
6. Monitoring
• Illustrative lessons learned:
  – Loose substrate (e.g., oyster shell), coir fiber logs, and woody debris have not performed well when exposed to wave action.
  – Protection structures should primarily address the most common water level and wave conditions, in addition to considering infrequent but extreme events.
  – One common mistake is placing structures at sites where they may exacerbate shoreline erosion.
An existing concrete seawall serves as bank stabilization for the Mobile Bay causeway.
Conceptual planform diagram of a constructed marsh and breakwater system for Mobile Bay, AL.
## Permitting

<table>
<thead>
<tr>
<th>Permit Type:</th>
<th>Nationwide Permit</th>
<th>General Permit</th>
<th>Individual Permit</th>
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<tbody>
<tr>
<td>Project Complexity</td>
<td>Low to moderate</td>
<td>Moderate</td>
<td>Moderate to high</td>
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<td>Permit Requirements</td>
<td>Strictly defined</td>
<td>Generally defined</td>
<td>Undefined</td>
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<tr>
<td>Benefits</td>
<td>Short review period</td>
<td>Moderate review period</td>
<td>Few design constraints</td>
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<tr>
<td>Challenges</td>
<td>Many design constraints</td>
<td>Some design constraints</td>
<td>Long review period</td>
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</table>
• Recommend the use of performance-based contracts
• Measure and assess project performance and impacts
• Maintain to continue to provide expected benefits
• Implement adaptive management practices