# 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: Marsh





### **Example: Dune Restoration**



# **Example: Pocket Beach**



### FHWA's Eco-Logical Approach



### Research Gap: Nature-based Solutions and Integrated Approach







- Natural features
- Nature-based features
- Hybrid approaches

# **Program Overview**

U.S. Department of Transportation Federal Highway Administration

### 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

U.S. Rt 1B, New Hampshire. Credit: NH DOT



Participants at Alabama Peer Exchange. Credit: FHWA

FHWA Nature-based Resilience for Coastal Highways Website:

https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing\_a

nd\_current\_research/green\_infrastructure/

# **Implementation Guide**





- Implement nature-based solutions to enhance the resilience of coastal highways
- Overview
  - Technical factsheets
  - Benefits and typical costs
  - Implementation considerations

https://www.fhwa.dot.gov/environment/sustainability/resilienc e/ongoing\_and\_current\_research/green\_infrastructure/imple mentation\_guide/

### **Technical Fact Sheets**

#### **Overview of Technique**

- **Materials**
- Habitat Components
- Durability and Maintenance
- Design Life
- Ecological Services



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#### Implementation Notes

- Benefits
- Challenges
- Initial Cost
- O&M Cost **Benefits**

#### **Regional Factors**

### **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.





# Planning



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: <u>National</u> <u>Coastal Resilience</u> <u>Fund (NOAA & NFWF)</u> funds nature-based solutions to protect coastal communities



### **Site Assessment**

o × I Site Assessment Design Permitting Construction  $\mathbf{U}$ Monitoring

System Parameters	Hydrodynamic Parameters			
1. Shoreline Type	1. Wind Waves			
2. Infrastructure	2. Boat Wakes			
3. Erosion Rate	3. Currents			
4. Sea Level Rise	4. Ice			
5. Tide Range	5. Storm Surge			
<b>Terrestrial Parameters</b>	Ecological Parameters			
1. Upland Slope	1. Water Quality			
2. Shoreline Slope	2. Soil Type			
3. Width	3. Sunlight			
4. Nearshore Slope	4. Salinity			
5. Water Depth				
6. Soil Strength				
Additional Parameters				
1. Permits	4. Species			
2. End Effects	5. Debris			
3. Constructability	6. Monitoring			

# Design



- 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.

# **Design: Mobile Bay, AL**





An existing concrete seawall serves as bank stabilization for the Mobile Bay causeway.

### Design: Mobile Bay, AL

Conceptual planform diagram of a constructed marsh and breakwater system for Mobile Bay, AL.



<pre> • × Planning &amp; • ×↓ Funding </pre>	Permit Type:	Nationwide Permit	General Permit	Individual Permit
Site Assessment	Project Complexity	Low to moderate	Moderate	Moderate to high
Design	Permit Requirements	Strictly defined	Generally defined	Undefined
Permitting	Benefits	Short review period	Moderate review period	Few design constraints
Construction	Challenges	Many design constraints	Some design constraints	Long review period

### Construction



• Recommend the use of performance-based contracts



Planning & Funding Site Assessment Design Permitting Construction Monitoring

• Measure and assess project performance and impacts

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- Maintain to continue to provide expected benefits
- Implement adaptive management practices



### Work with Nature

