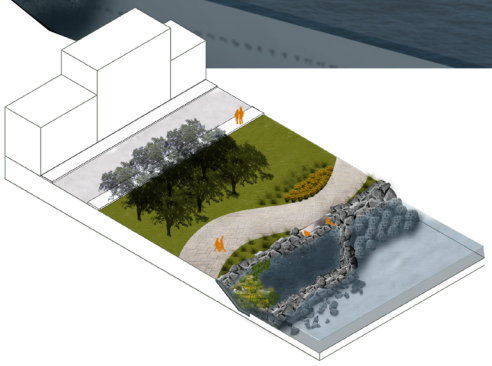
COASTAL EDITION

# NATURE-BASED SOLUTIONS FOR BIODIVERSITY



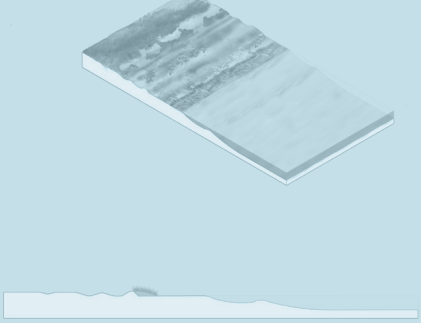
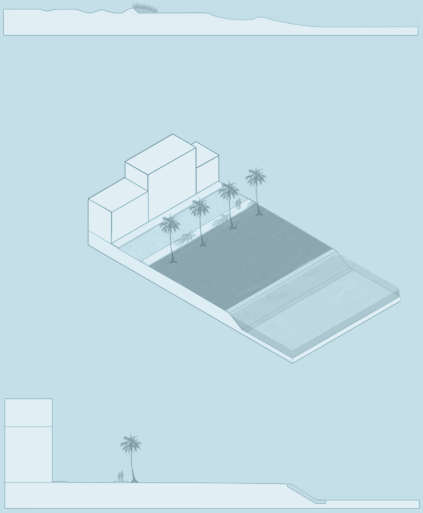
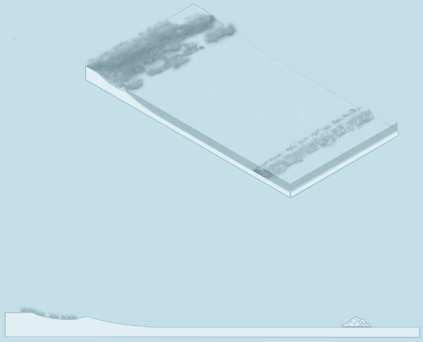
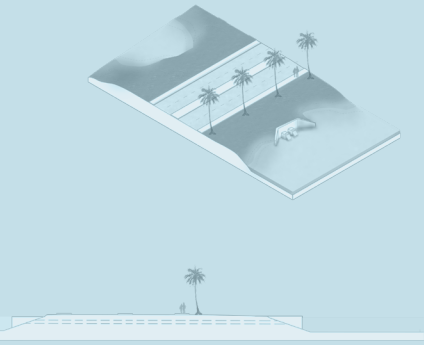
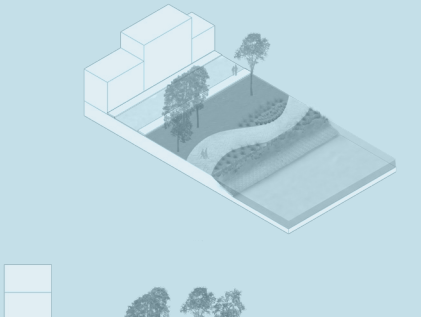
USACE: Burton Suedel, Amanda Tritinger, Kyle McKay
UGA: Jon Calabria, Matthew Bilskie, James Byers, Brock Woodson, Kelsey Broich, Emily Dolatowski, Eleanor Hair

US Army Corps of Engineers.

NETWORK FOR ENGINEERING WITH NATURE

UNIVERSITY OF GEORGIA

College of Engineering
Institute for Resilient Infrastructure Systems
College of Environment + Design
Carl Vinson Institute of Government

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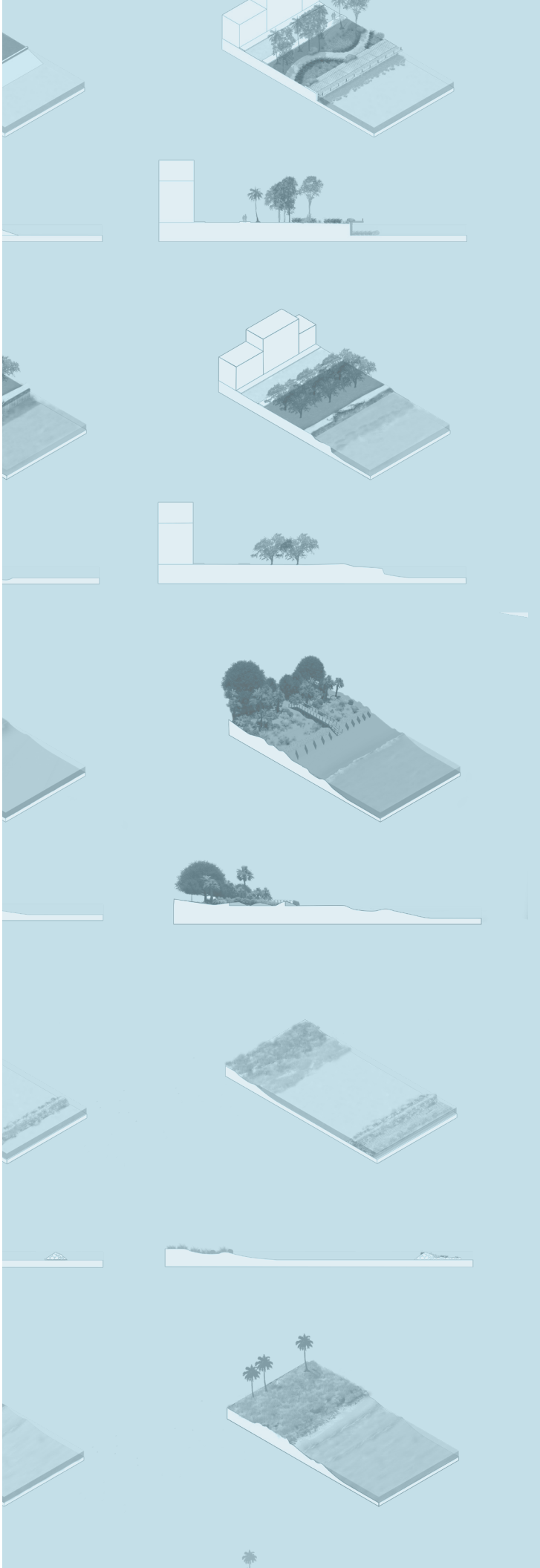
# Overview

As shorelines change and infrastructure ages, communities may be faced with how to strengthen their shoreline or protect against flooding. Using an example of a failing bulkhead that is slated for repair, landscape architecture can play a meaningful role in each step of the process for implementing nature-based infrastructure: scoping, decision-making, implementation, and operations.

When assembling a project team, nature-based infrastructure expertise should be identified and included to help define the nature and scope of the bulkhead repair. In planning, drawings and renderings of various bulkhead designs are developed by landscape architects and designers to help facilitate a transparent evaluation of the alternatives being considered, inform the analysis and identify the highest priority alternatives.

When communities are faced with decision-making, effective communication can be promoted by landscape architecture drawings and renderings. These graphics serve as communication tools to visualize the final alternative bulkhead design and its inherent benefits. These inherent benefits can be better understood after implementation. In the design of bulkhead alternatives, landscape architects and designers promote biodiversity while considering other project objectives such as local hydrodynamic conditions and recreational benefits. Design features that are convertible or modifiable based on lessons learned or in response to changing environmental conditions can also be communicated by landscape architecture graphics.

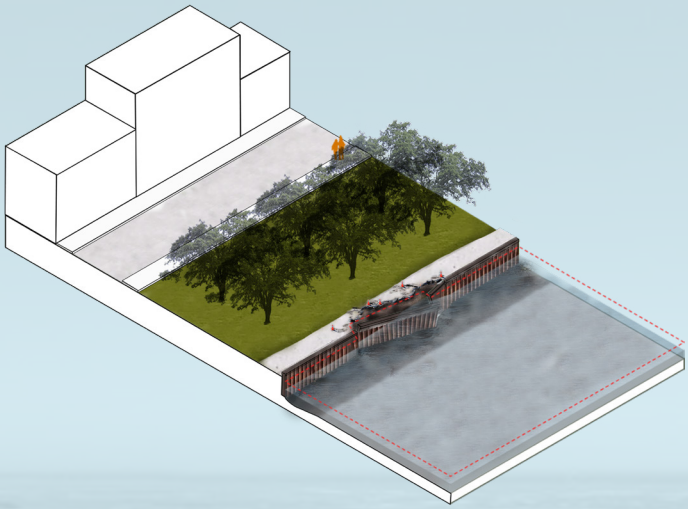
In addition to design, landscape architecture renderings can be used to create outreach material for the general public and design professionals, supporting education and training efforts as well as the development of technical reports. Especially in supporting education, training, and technical reports. Lessons learned from the design process and long-term maintenance of the alternative design can inform webinars or workshops and further the development of Engineering With Nature (EWN) practices. The following handout explores aspects of EWN and landscape architecture that promote biodiversity on coastal infrastructure. This series of graphics has been used in several deliverables: a journal article, a technical series and an ArcGIS storymap.



# Building Back Better

Communities and decision-makers are evaluating proper solutions for failing infrastructure. If a bulkhead fails, fixing a bulkhead may be costly and not adaptable to changes associated with sea level rise. If replaced with a nature-based solution, the shoreline can be more adaptable to change and provide a variety of ecosystem services such as health benefits, habitat, recreational activities and urban cooling.

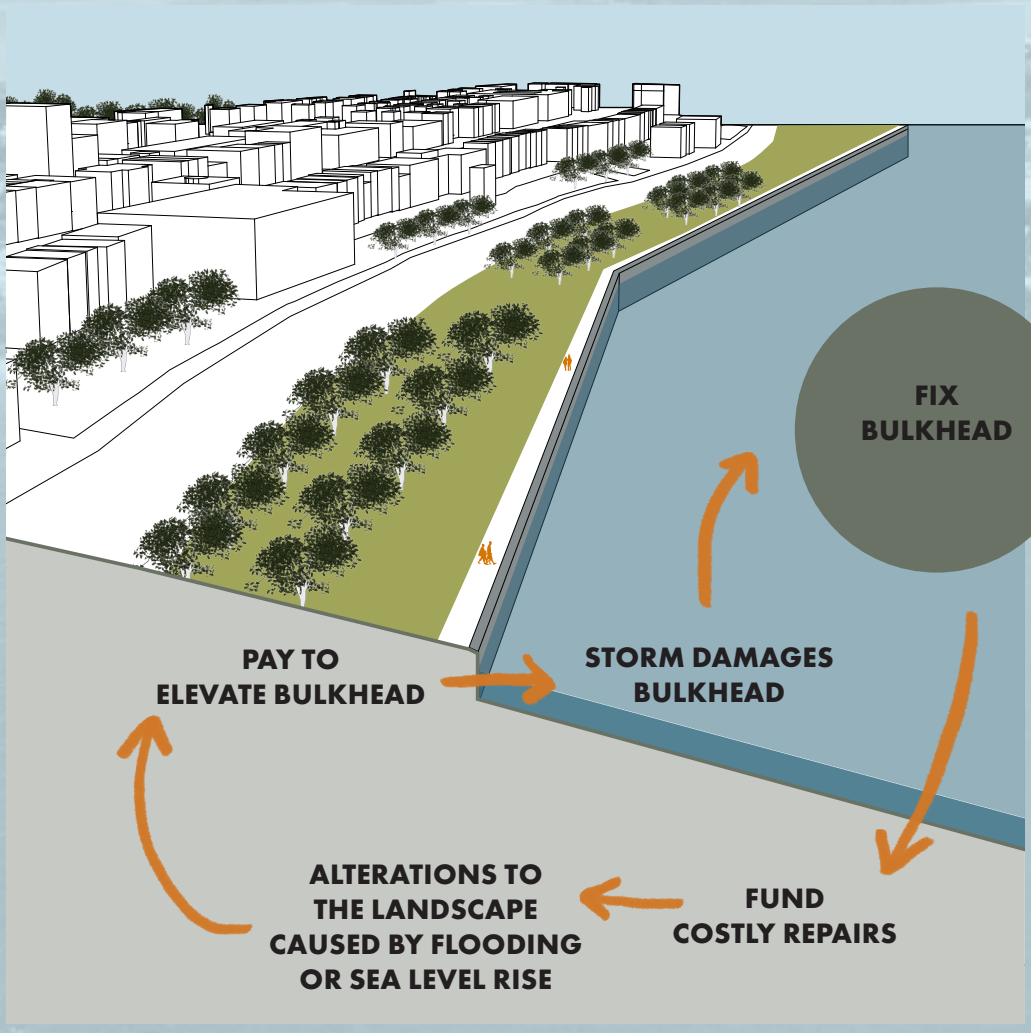
The conceptual framework below demonstrates two alternatives communities can pursue to address a failing bulkhead.



**FAILING BULKHEAD**

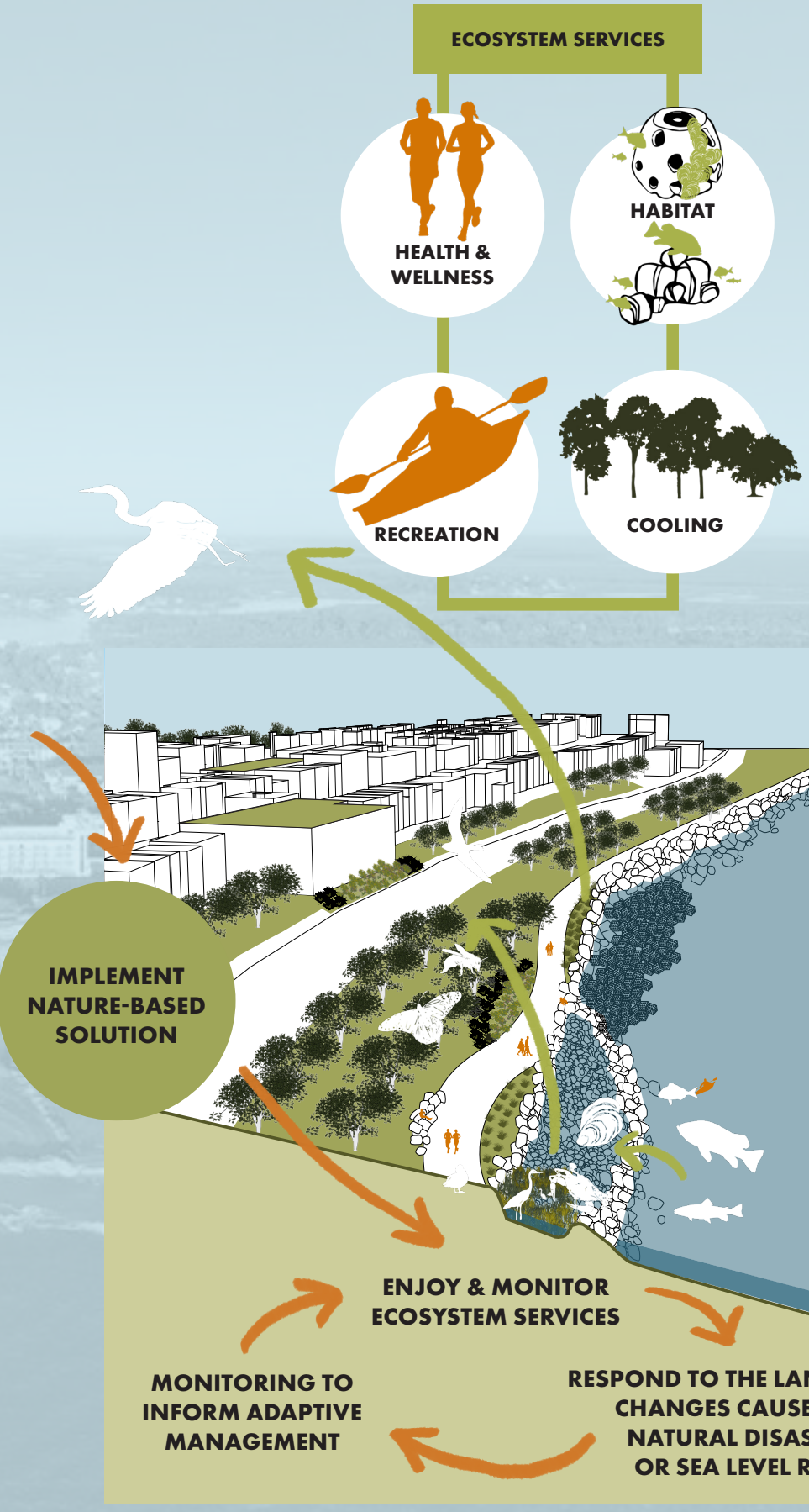
**EVALUATE SOLUTION**

**ENGAGE COMMUNITY**




**GRAY INFRASTRUCTURE**

Bulkheads, seawalls and revetments are all gray infrastructure examples. Many of these structures use concrete or riprap to resist flooding or erosion.

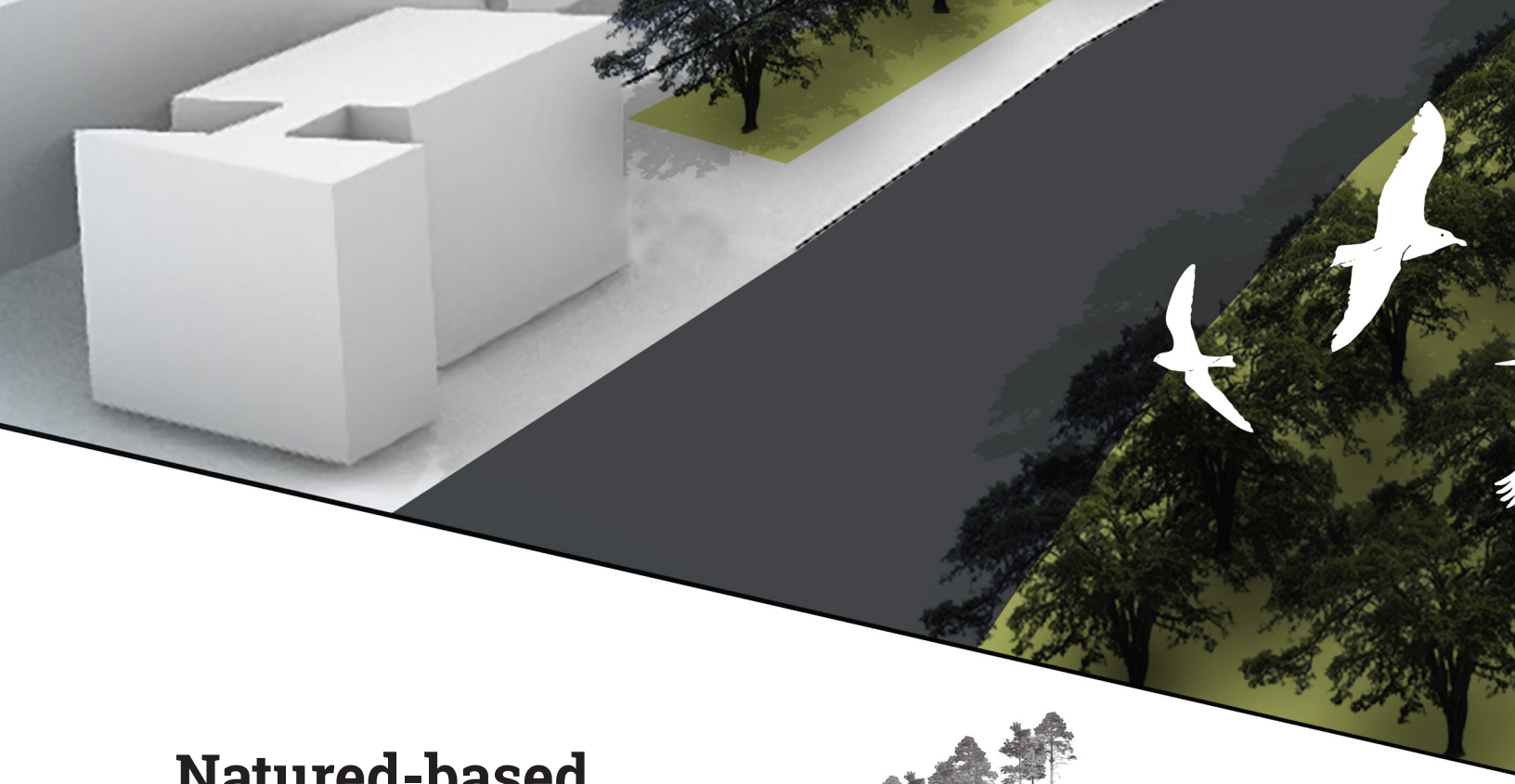



## HYBRID INFRASTRUCTURE

Hybrid infrastructure consists of conventional gray infrastructure modified or paired with green infrastructure practices such as native plantings or living shorelines.

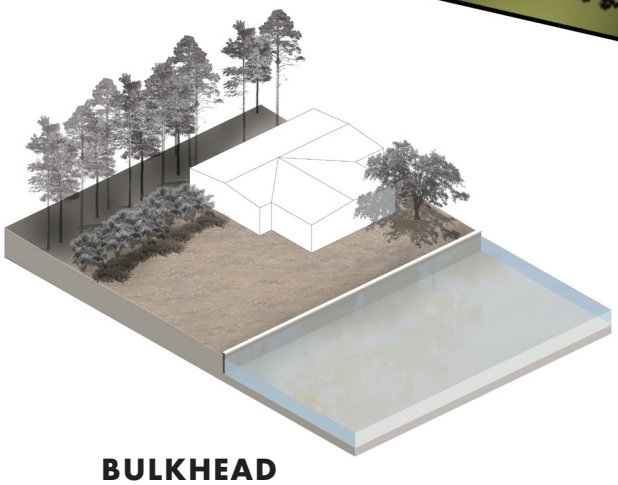
## GREEN INFRASTRUCTURE

Green infrastructure imitates nature to address flooding, stormwater management or erosion. One example of green infrastructure includes living shorelines designed to strengthen the shore by encouraging the growth of oyster reefs.



# Natured-based Infrastructure for Biodiversity

The graphics below demonstrate the basic concepts to enhance biodiversity for gray infrastructure. Planting native trees and vegetation, using a variety of rock sizes, and connecting people to the water can enhance coastal infrastructure. Designing for biodiversity provides many ecosystem services including improved water quality, habitat connectivity and urban cooling.



**BULKHEAD**

## Creating Biodiversity

Planting native trees supports habitat for native insects and food for birds

Native perennials and grasses provide habitat for birds, insects and food for pollinators

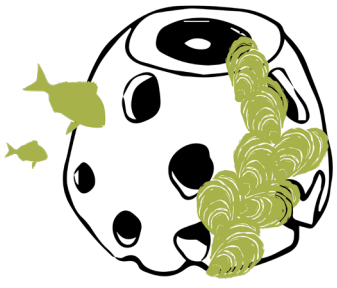
Varying rock sizes create interstitial space for small organisms and crustaceans

## Conventional Gray Infrastructure

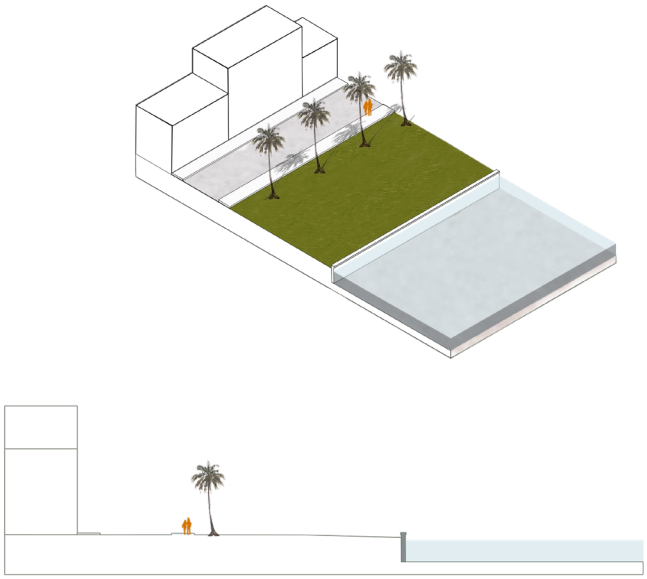
Conventional gray infrastructure like bulkheads limit access to water, disrupt natural habitat transgression and limit opportunities for habitat.

Large rocks provide protection for smaller fish to hide from predators

Large rocks create habitat for large and medium fish



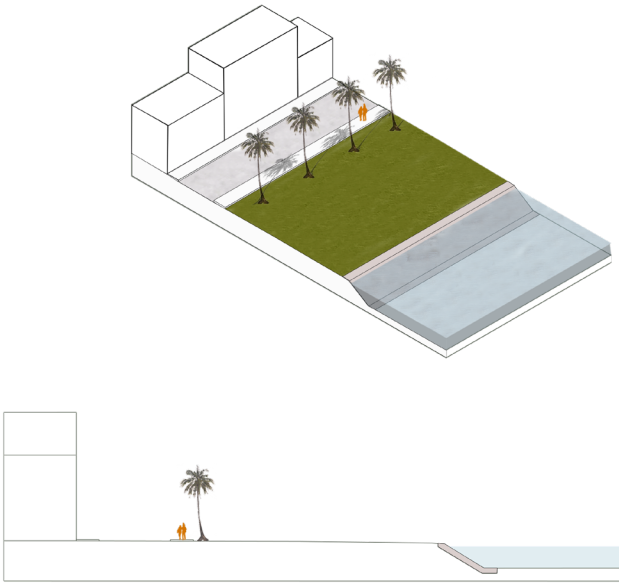
Nature-based reef structures encourage oyster reefs, coral reefs and habitat for small organisms



**BULKHEAD**

Bulkheads stabilize the shoreline, retain soil and provide protection against wave action.

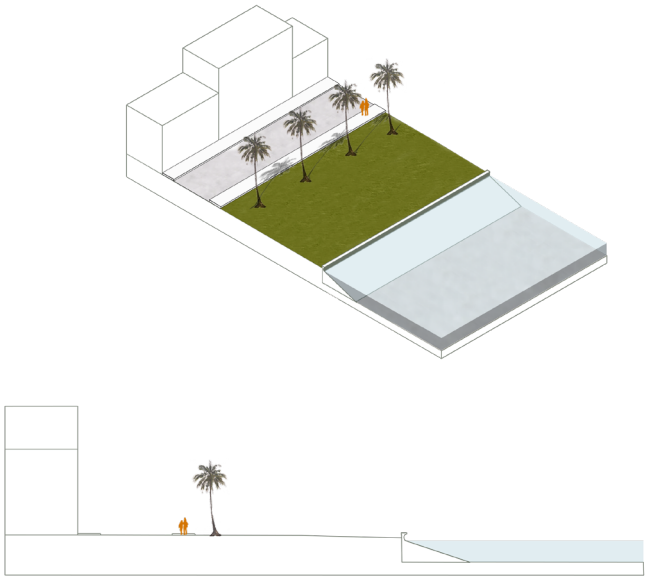
**GRAY INFRASTRUCTURE**



**REVETMENT**

Revetments provide protection against erosion caused by wave action.

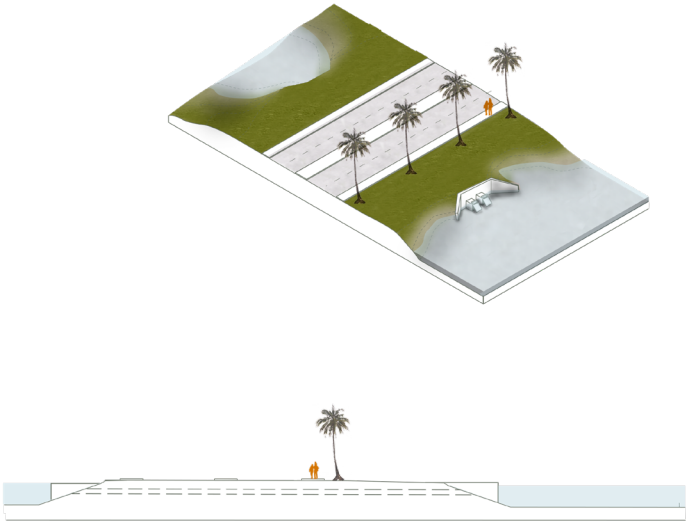
**GRAY INFRASTRUCTURE**



**SEAWALL**

Seawalls provide protection against erosion and flooding.

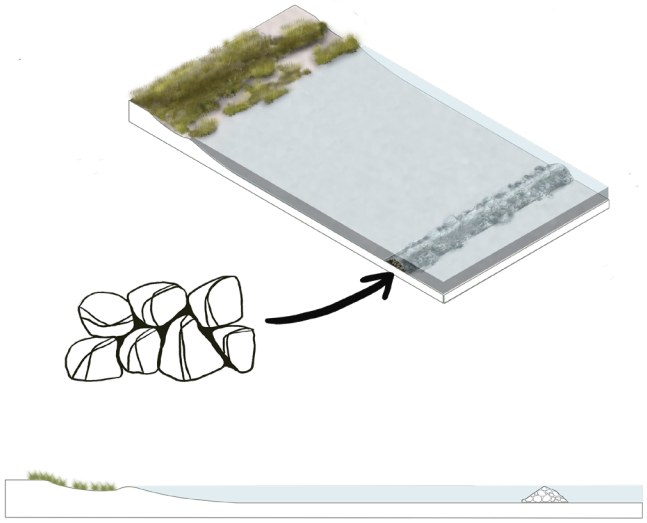
**GRAY INFRASTRUCTURE**



**TIDE GATE**

Tide gates regulate water level to reduce flooding and improve marsh habitat.

**GRAY INFRASTRUCTURE**



**BREAKWATER**

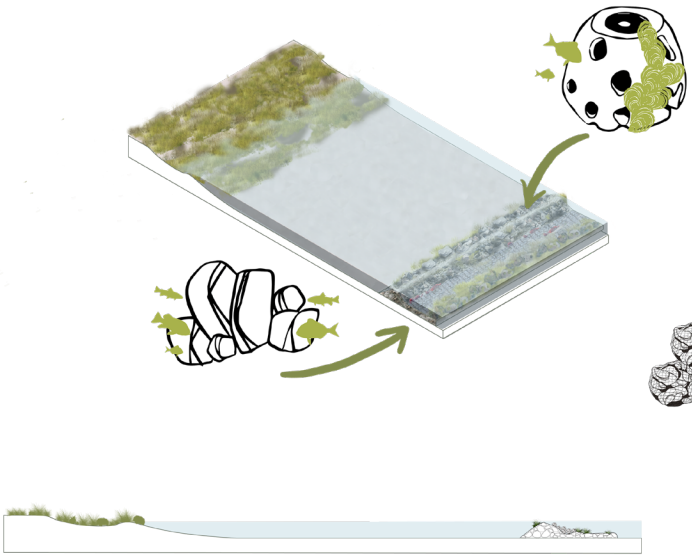
Breakwaters mitigate the force of waves on the shoreline by "breaking" the waves.

**GRAY INFRASTRUCTURE**


**ENHANCED TIDE GATE**

Enhanced tides gate use textured walls to create habitat. A variety of native plants are planted along the shore.

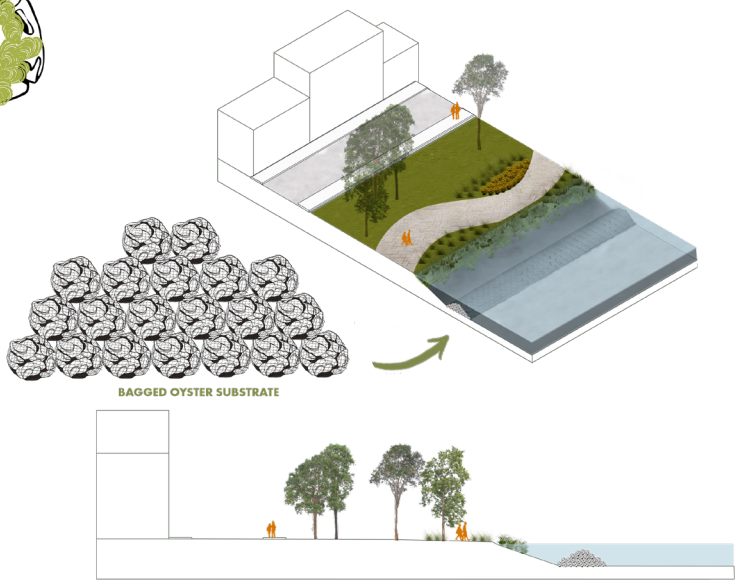
**HYBRID INFRASTRUCTURE**



**BREAKWATER REEF**

Breakwater reefs composed of varying rock sizes provide habitat and protection for smaller organisms.

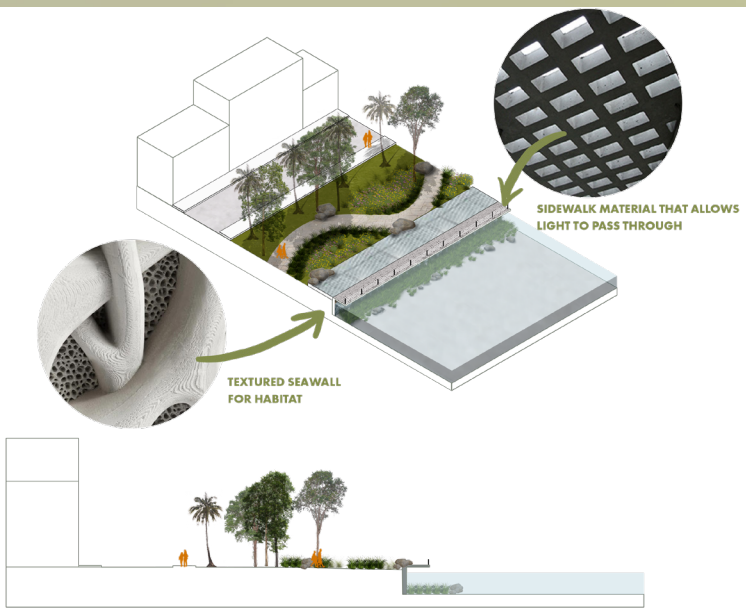
**HYBRID INFRASTRUCTURE**




**OYSTER SILL**

Loose or bagged oyster shell serves as substrate for new oysters that settle and grow, stabilizing the shoreline.

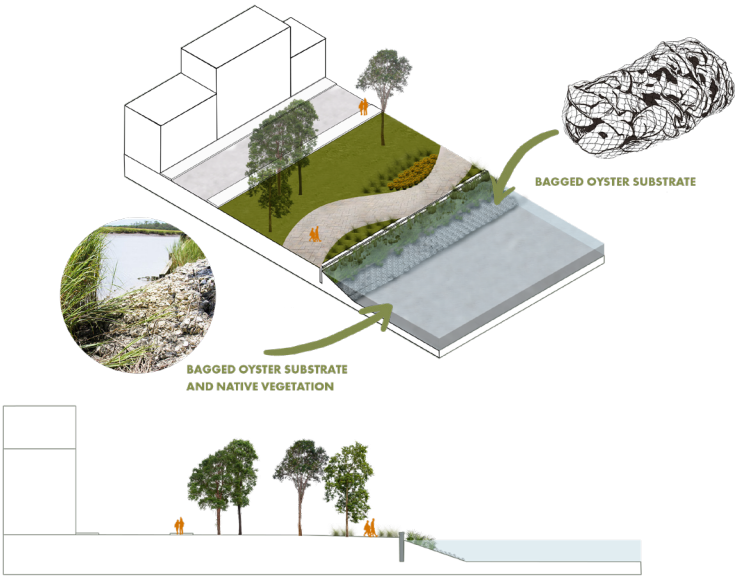
**HYBRID INFRASTRUCTURE**




### ENHANCED SEAWALL

Enhanced seawalls with overhang material that allows light to pass through encourages plant to growth and creates habitat.

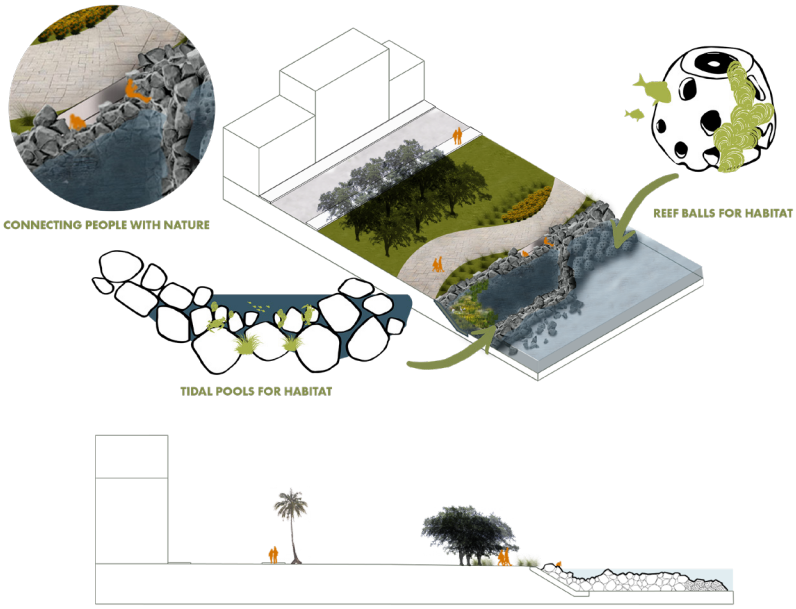
HYBRID INFRASTRUCTURE




### WALL WITH LIVING SHORELINE

Bagged oyster substrate encourages oyster growth along the shoreline. Native vegetation provides habitat along the shoreline.

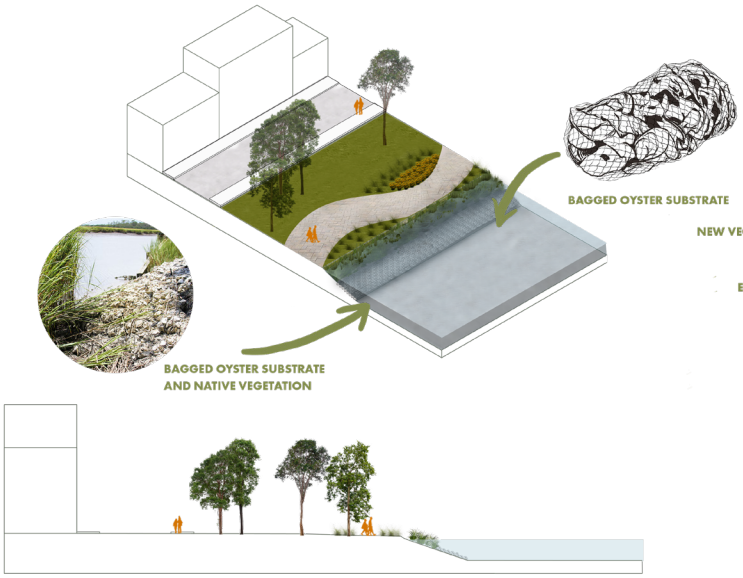
HYBRID INFRASTRUCTURE




### ENHANCED REVETMENT

Enhanced revetments use nature-based reef structures to provide habitat and protection against predators for smaller organisms. The tidal pools provide rocky intertidal habitat for organisms that adapt to the changing tides such as snails, crabs and mussels.

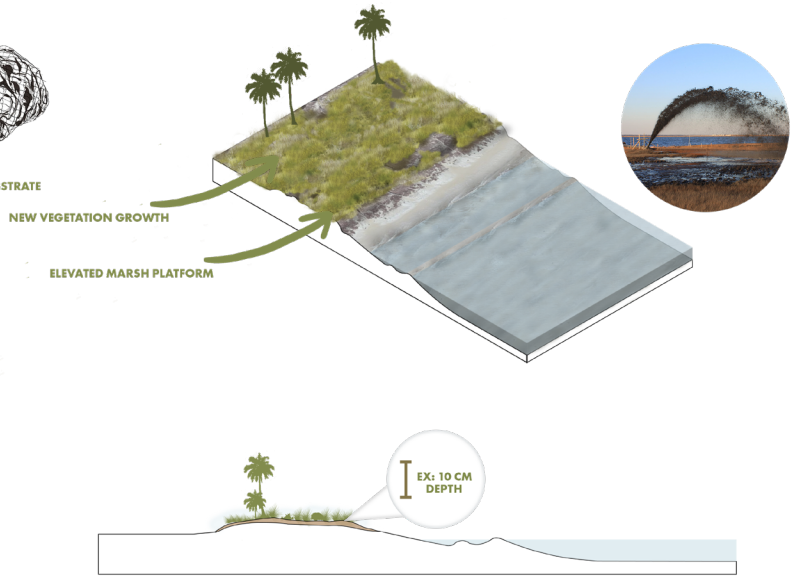
HYBRID INFRASTRUCTURE




## LIVING SHORELINE

Loose or bagged oyster shell serves as substrate for new oysters that settle and grow, stabilizing the shoreline. Native vegetation provides habitat and additional stabilization along the shoreline.

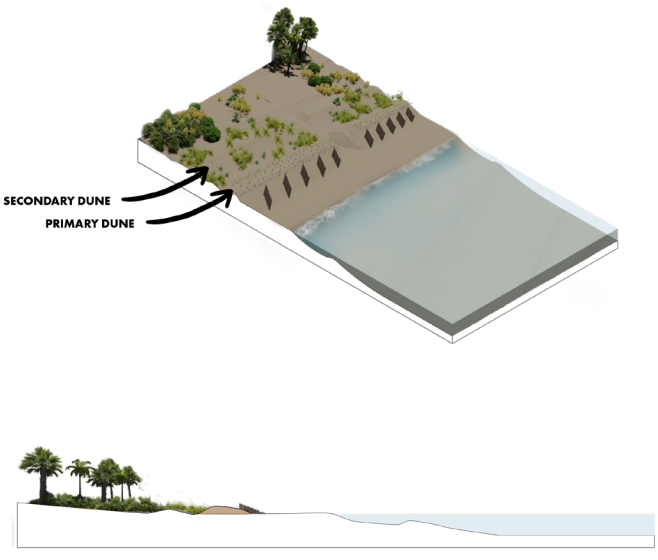
**GREEN INFRASTRUCTURE**




## THIN LAYER PLACEMENT

Thin layer placement spreads a thin layer of dredge material over a marsh to raise its elevation.

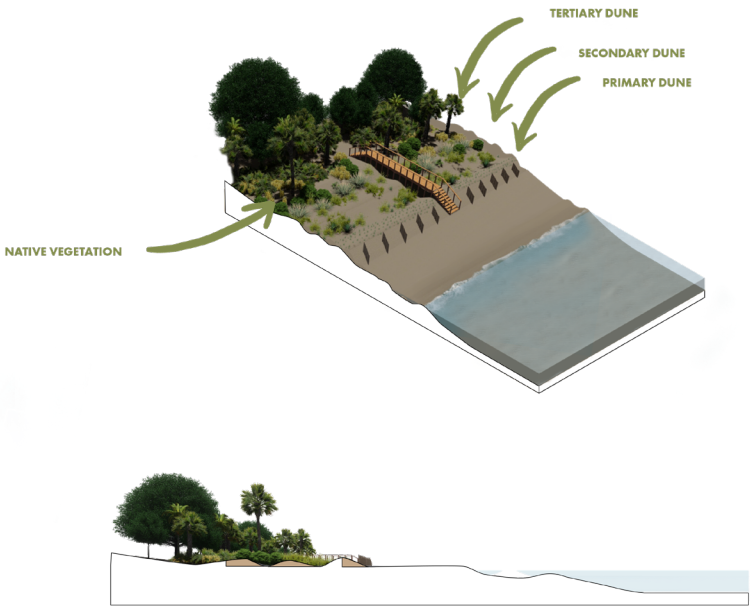
**GREEN INFRASTRUCTURE**




## DUNE RESTORATION

Intact dune systems provide protection to inland infrastructure.

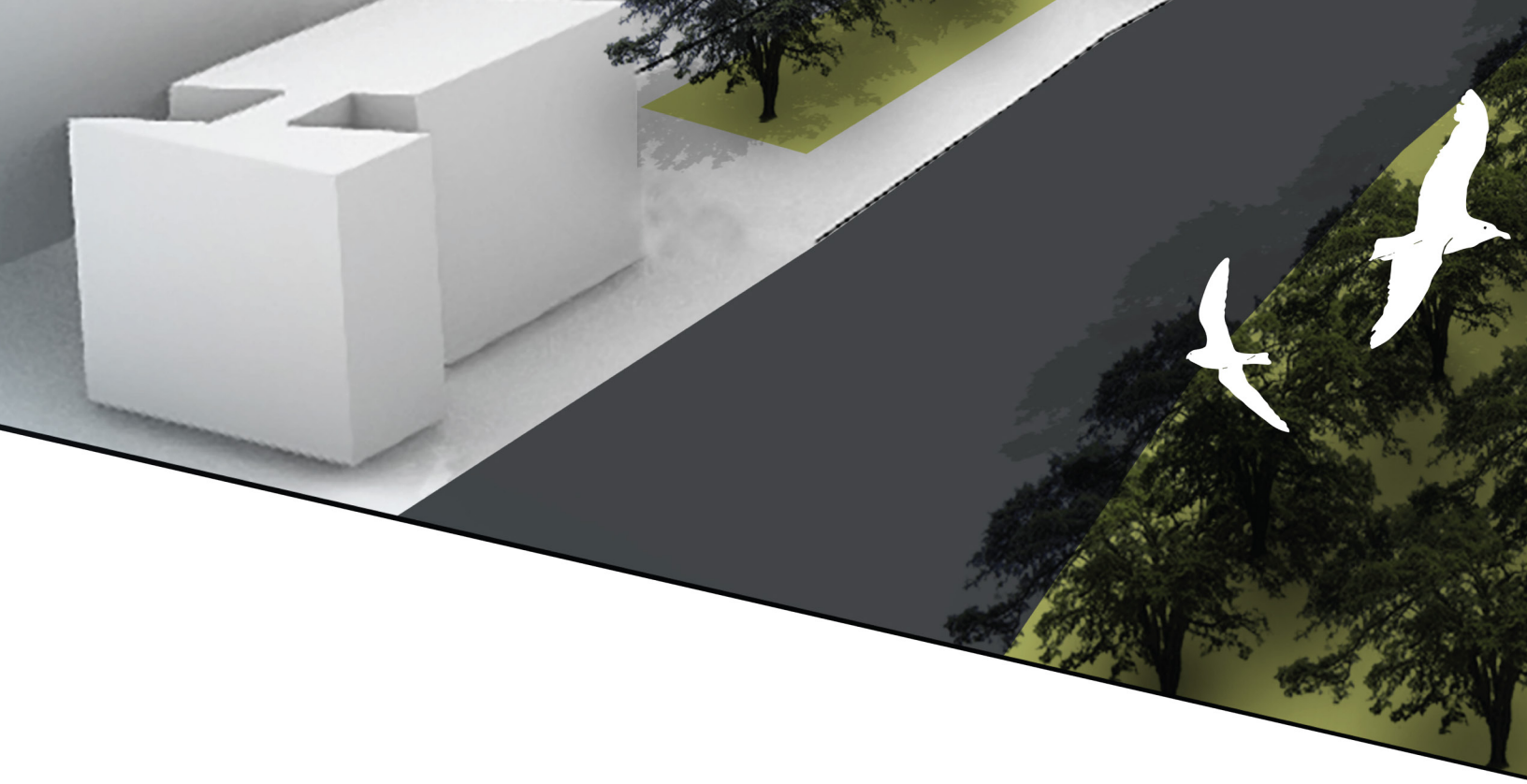
**GREEN INFRASTRUCTURE**




## ENHANCED DUNE RESTORATION

Enhanced dune restorations provide an extra layer of protection with a tertiary dune. Boardwalks provide beach access, while ensuring dune systems remain intact and protect inland infrastructure.

**GREEN INFRASTRUCTURE**



## Journal Article

Suedel BC, Calabria J, Bilskie MV, Byers JE, Broich K, McKay SK, Tritinger AS, Woodson CB, Dolatowski E. "Engineering coastal structures to centrally embrace biodiversity." Journal of Environmental Management 323:116138-116138

## Presentations

Broich, K., Calabria, J., Dolatowski, E. (2022). Council of Educators in Landscape Architecture (CELA) 2022. In CELA Annual Conference . Tamaya, NM.

Calabria, J., Dolatowski, E., Hair, E., and Broich, K. (2022). Restoring Americas Estuaries. In National strategy to restore Coastal Habitat: Restoring America's Estuaries. New Orleans, LA.

## Upcoming Publications

A technical series for Engineer Research and Development Center (ERDC)'s Knowledge Core, a collection of research publications and historical knowledge.

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