Clifftop: Habitat Enhancement

A designated area vegetated with native plant species and designed to increase and enhance habitat for wildlife

PURPOSE

Plant root systems can bind together and with substrates to strengthen cliff while adding native diversity

ADVANTAGES

- Strengthens the cliff to reduce stormwater erosion
- Can improve the diversity in shoreline habitats
- Maintains the natural aesthetic of the cliff

DISADVANTAGES

- Provides limited cliff protection because the root strength, especially of grasses, does provide some benefit.
- Might need irrigation after initial construction to help vegetation set in

STRUCTURAL INTEGRITY
Low

CONSTRUCTION COST
Low

ADAPTABILITY
High

HAZARD REDUCTION
Moderate

ECOLOGICAL ENHANCEMENT
High

REGULATORY FEASIBILITY
High

Clifftop: Setback

An area along the edge of the cliff within which all or certain types of new development are prohibited

PURPOSE

Setbacks provide a buffer between potentially hazardous bluff failures and the developed area

ADVANTAGES

- Allows for natural erosion of the cliff edge
- Incorporates a measure of protection against slide activity
- Setback may be designated for habitat enhancement

DISADVANTAGES

- Much of the clifftop development is already close to the edge of the cliff
- A need to retrofit or remove vulnerable development may arise

STRUCTURAL INTEGRITY
N/A

CONSTRUCTION COST
› Low

ADAPTABILITY
››› High

HAZARD REDUCTION
››› High

ECOLOGICAL ENHANCEMENT
››› High

REGULATORY FEASIBILITY
››› High

Cliff Wall: Erosion Control Planting

Plantings on cliff wall selected for their ability to hold soil in place

PURPOSE

Use native plants to hold soil and rock in place

ADVANTAGES

- Creates wildlife habitat
- Improves aesthetic quality of cliff

DISADVANTAGES

- Difficult access to cliff face
- Needs temporary soil stabilization

STRUCTURAL INTEGRITY
›

CONSTRUCTION COST
›

ADAPTABILITY
›› Moderate

HAZARD REDUCTION
›

ECOLOGICAL ENHANCEMENT
››› High

REGULATORY FEASIBILITY
››› High

Cliff Wall: Cliff Stabilization

A sculpted concrete facing anchored to the cliff face and bedrock

PURPOSE

Protect the cliff against erosion

ADVANTAGES

- Reduces cliff erosion from wave action
- Mimics the natural aesthetic of the cliff wall
- Reduces hazards from rock falls

DISADVANTAGES

- Construction could potentially weaken cliff wall, as it relies on anchors drilled into the cliff face
- Removes sediment source from coastal processes
- The increased strength allows the cliff to act as a seawall and may therefore promote scouring

STRUCTURAL INTEGRITY
High

CONSTRUCTION COST
High

ADAPTABILITY

HAZARD REDUCTION
High

ECOLOGICAL ENHANCEMENT

REGULATORY FEASIBILITY

Back Beach: Seawall

A concrete structure built along a portion of the coast, between the ocean and assets to be protected

PURPOSE

Reduce the risk of coastal flooding and erosion

ADVANTAGES

- Prevents shoreline and cliff erosion by wave action
- Provide protection of upland assets from wave action
- Has narrow footprint along shore

DISADVANTAGES

- Removes sediment source from coastal processes
- Scouring at the base of the wall can take place and eventually erode the remaining beach
- Alters patterns of sand movement along t he shore
- Disrupts the natural ecosystem of the shoreline
- Fixes the shoreline location, eliminating natural variation over time

STRUCTURAL INTEGRITY

High

CONSTRUCTION COST

High

ADAPTABILITY

HAZARD REDUCTION

High

ECOLOGICAL ENHANCEMENT

REGULATORY FEASIBILITY

Back Beach: Vegetated Dune

An area with mounds of loose sand planted with dune vegetation

PURPOSE

Incorporate a sand reserve and reduce coastal flood hazards

ADVANTAGES

- Provides a measure of flood protection, based on the size of the dunes
- Can improve a diversity of shoreline habitats

DISADVANTAGES

- Sand from dunes can be blown into public areas, creating a maintenance issue
- Needs maintenance and revitalization after storm events
- Requires a wide beach

STRUCTURAL INTEGRITY
›

CONSTRUCTION COST
›› Moderate

ADAPTABILITY
››› High

HAZARD REDUCTION
›› Moderate

ECOLOGICAL ENHANCEMENT
››› High

REGULATORY FEASIBILITY
››› High

Back Beach: Raised Assets

Elevation of infrastructure and assets above projected flood levels

PURPOSE

Elevate infrastructure and assets above the level of wave action and wave runup

ADVANTAGES

- Reduces impacts of wave runup and coastal flooding on infrastructure and assets
- Does not increase footprint of existing infrastructure and assets
- Facilitates public access

DISADVANTAGES

- Complex design and construction effort required to avoid impact to utilities
- Needs planned, phased construction to implement in relation to daily traffic

STRUCTURAL INTEGRITY
High

CONSTRUCTION COST
High

ADAPTABILITY

HAZARD REDUCTION
High

ECOLOGICAL ENHANCEMENT

REGULATORY FEASIBILITY
Moderate

Back Beach: Shore Platform Enhancement

Enhancement of the bedrock with outcrops, mounds, or gradually rising features of cemented native material

PURPOSE

Improve wave attenuation over the shore platform

ADVANTAGES

- Strengthens the shore against erosion
- Consists of cemented native material and therefore retains the same color and material composition
- The features are erodible, with native material released back to the environment over time

DISADVANTAGES

- Construction could harm sand-burrowing species

STRUCTURAL INTEGRITY
Moderate

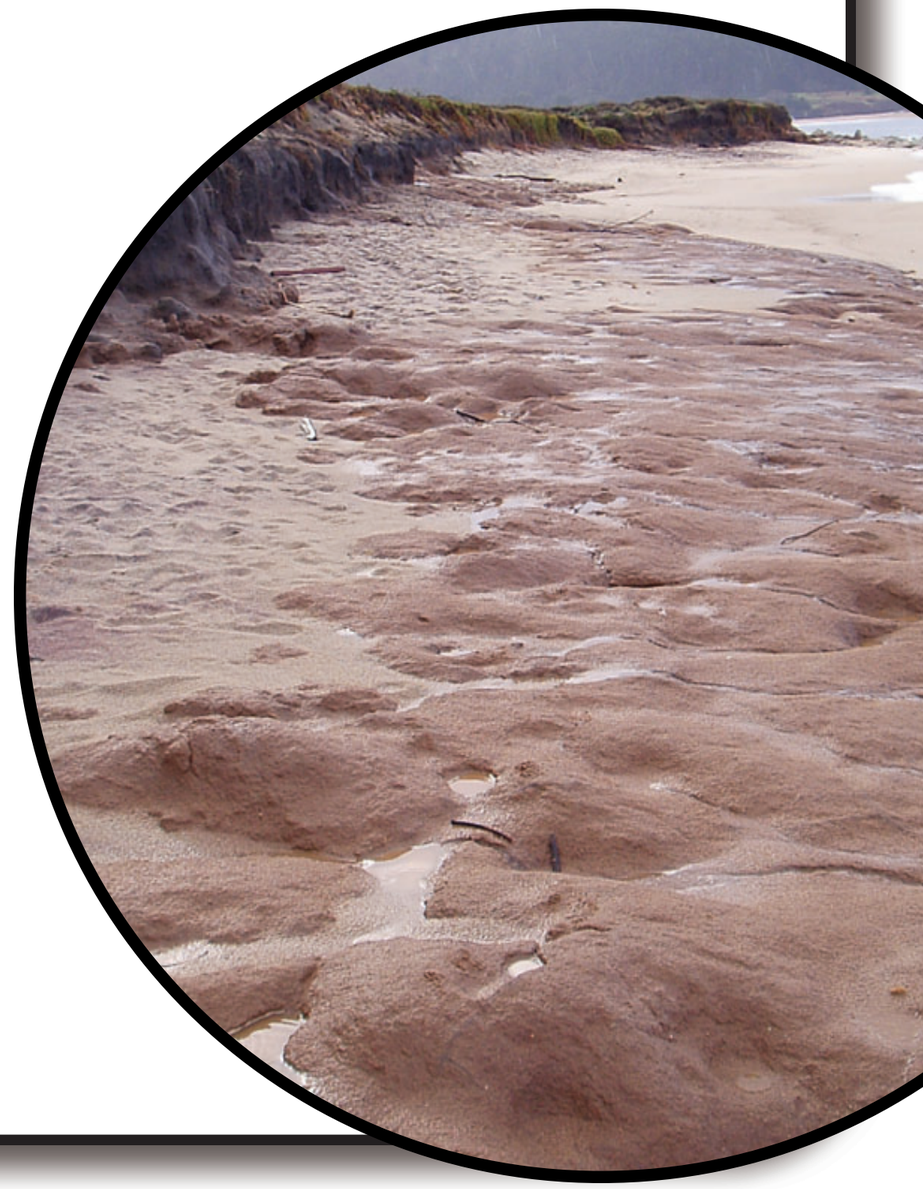
CONSTRUCTION COST
Moderate

ADAPTABILITY
Moderate

HAZARD REDUCTION
Moderate

ECOLOGICAL ENHANCEMENT
Moderate

REGULATORY FEASIBILITY
Moderate



Back Beach: Rock Revetment

A layer of large stone boulders (riprap) placed over an embankment to protect against erosion by wave action and currents

PURPOSE

Protect infrastructure from erosion and damage

ADVANTAGES

- Retains protective quality even as rocks shift and settle over time

DISADVANTAGES

- Occupies a significant footprint of what could otherwise be accessible beach space
- Fixes the shoreline location, eliminating natural variation over time
- Removes sediment source from coastal processes
- Disrupts natural systems

STRUCTURAL INTEGRITY
High

CONSTRUCTION COST
High

ADAPTABILITY
Moderate

HAZARD REDUCTION
Moderate

ECOLOGICAL ENHANCEMENT

REGULATORY FEASIBILITY
Moderate

Front Beach: Cobble Enhancement

A blanket, mound or berm of rounded stone (cobble) placed on the beach

PURPOSE

Mitigate coastal erosion hazards

ADVANTAGES

- Reduces or slows coastal erosion
- Dynamic feature that can be reshaped by wave action to protect the upland shoreline
- Maintains the shoreline's natural aesthetic

DISADVANTAGES

- May need addition of more cobble over time
- Vegetation has a hard time establishing in this environment

STRUCTURAL INTEGRITY
› Low

CONSTRUCTION COST
›› Moderate

ADAPTABILITY
››› High

HAZARD REDUCTION
›› Moderate

ECOLOGICAL ENHANCEMENT
›

REGULATORY FEASIBILITY
›› Moderate

Front Beach: Beach Nourishment

Imported sand placed on a beach, usually pumped via dredge or delivered by truck

PURPOSE

Widen beach and mitigate erosion

ADVANTAGES

- Replenishes eroding shoreline
- Provides a larger beach width for recreation and shoreline longevity
- Can provide habitat for marine mammals and shorebirds

DISADVANTAGES

- Large volume of sand needed
- Unpredictable longevity
- Can be disruptive to wildlife at the dredge and placement site

STRUCTURAL INTEGRITY
›

CONSTRUCTION COST
››› High

ADAPTABILITY
››› High

HAZARD REDUCTION
›› Moderate

ECOLOGICAL ENHANCEMENT
›

REGULATORY FEASIBILITY
›› Moderate

Offshore: Rocky Reef Habitat

A underwater mound of stones that creates habitat for marine plants and animals

PURPOSE

Create refuge for fish and invertebrates

ADVANTAGES

- Can support a diversity of marine wildlife
- Stabilizes sediment and reduces wave energy

DISADVANTAGES

- Can increase scouring at the base of the reef
- Research on the effectiveness of reducing wave energy is inconclusive

STRUCTURAL INTEGRITY
›

CONSTRUCTION COST
›› Moderate

ADAPTABILITY
›› Moderate

HAZARD REDUCTION
›› Moderate

ECOLOGICAL ENHANCEMENT
›› Moderate

REGULATORY FEASIBILITY
›

Offshore: Kelp Forest

A forest-like underwater habitat capable of supporting a diversity of marine species

PURPOSE

Create refuge for marine wildlife

ADVANTAGES

- Reduce wave energy before it hits the shoreline
- Would not negatively impact user experience

DISADVANTAGES

- May contribute to buildup of wrackline debris/organics
- Research on the effectiveness of kelp forests to reduce wave energy is limited

STRUCTURAL INTEGRITY
Moderate

CONSTRUCTION COST
Moderate

ADAPTABILITY

HAZARD REDUCTION
Moderate

ECOLOGICAL ENHANCEMENT
High

REGULATORY FEASIBILITY

Offshore: Groins

A linear structure of large boulders built perpendicular to the shoreline

PURPOSE

Stabilize a beach against erosion associated with longshore sand transport

ADVANTAGES

- Helps retain sand on the shoreline by reducing longshore sand transport
- The addition of sand helps widen the beach and protect upland assets

DISADVANTAGES

- Disrupts natural sand transport processes.
- Can increase erosion
- Can disrupt the user experience on the beach
- The disruption of sand transport processes can negatively impact wildlife

STRUCTURAL INTEGRITY
High

CONSTRUCTION COST
High

ADAPTABILITY

HAZARD REDUCTION

ECOLOGICAL ENHANCEMENT

REGULATORY FEASIBILITY
Moderate