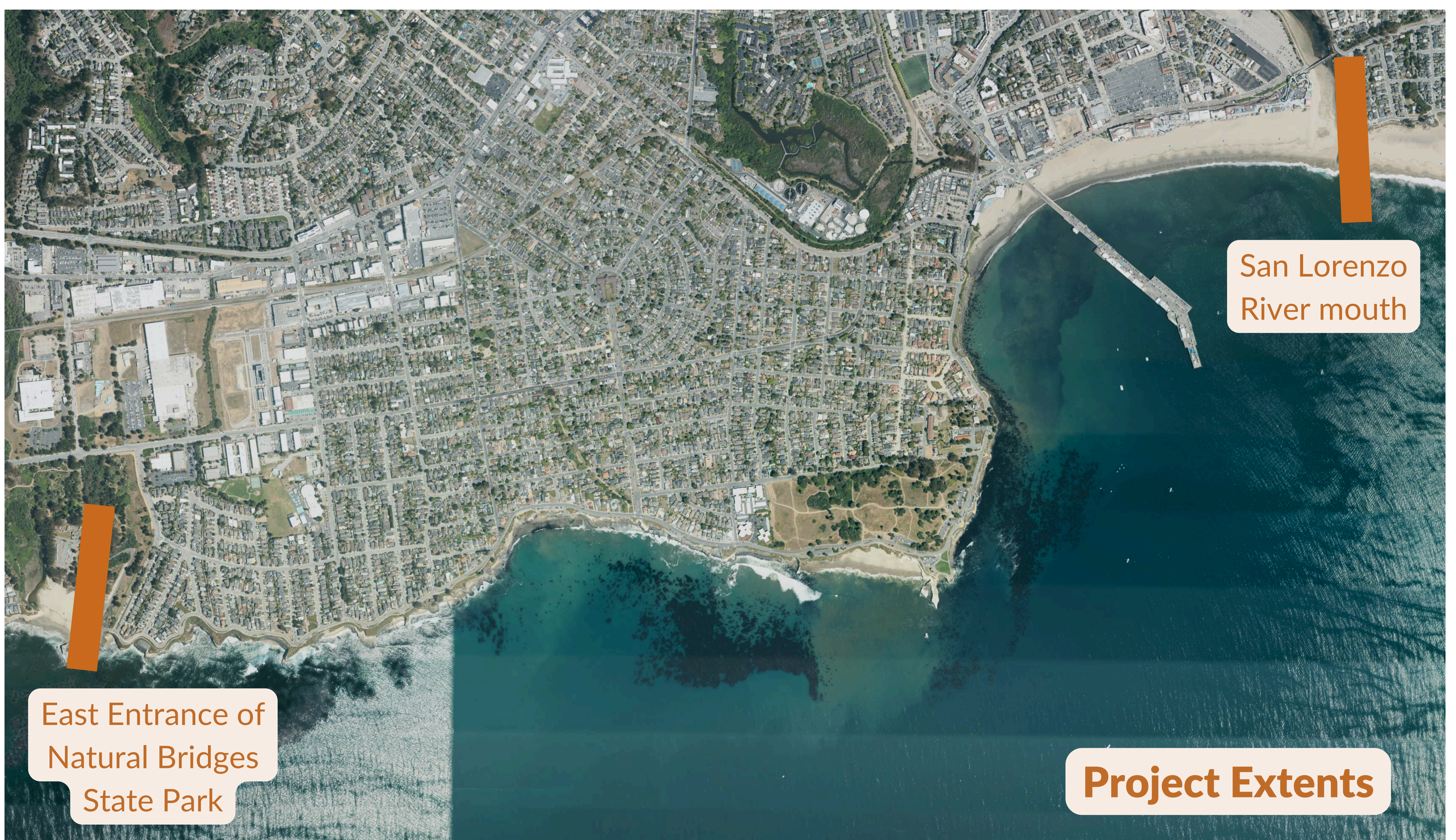


# LIVING SHORELINES, NATURE-BASED SOLUTIONS, SAND MANAGEMENT FEASIBILITY STUDY

## WHAT IS OUR PROJECT?

We conducted a feasibility study of nature-based solutions and sand management along the coastline from the east entrance of Natural Bridges State Park to the San Lorenzo River mouth. Nature-based solutions limit shoreline erosion and flooding or overtopping from high coastal water levels, and aim to preserve and enhance natural habitats. This study built on prior work, identifying feasible nature-based solutions at various locations and offering recommendations for near and longer-term implementation. For the near-term recommendations, the project team evaluated and developed conceptual designs for three sites and brought one to 30% design. This project included community engagement with focus groups, public events and a forthcoming new virtual reality experience.



## WHAT WERE THE GOALS?

PROTECT FROM  
COASTAL HAZARDS

IMPROVE HABITAT

MAINTAIN COASTAL  
ACCESS

LEVERAGE LOCAL  
AND TRIBAL  
KNOWLEDGE

MAINTAIN  
RECREATION

CONSIDER PUBLIC  
SAFETY

CONSIDER  
ADAPTABILITY



# FUTURE VULNERABILITY WITH SEA LEVEL RISE



The vulnerability of each coastal segment is relative to other coastal segments and this map illustrates the combined vulnerability for flooding and erosion. In the case of blufftop locations, wave overtopping is considered flooding for the purpose of the analysis.

## Key Findings:

1. The segment from Woodrow Avenue to Columbia Street is highly vulnerable to wave overtopping and erosion.
2. Lighthouse Point and Its Beach are highly vulnerable to erosion.
3. Mitchell's Cove and Cowell/Main Beach are highly vulnerable to wave overtopping and flooding respectively.



# WHAT ARE POSSIBLE NATURE-BASED SOLUTIONS?

## NATIVE PLANT RESTORATION



### BENEFITS

- Limits erosion
- Improves habitat diversity
- Recruits sediment for dunes

### FEASIBILITY

- Low cost
- Requires maintenance
- Vulnerable to strong storms

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## VEGETATED SAND DUNES



### BENEFITS

- Limits erosion by absorbing wave energy
- Limits wave runup compared to walls and armor
- Co-exists with beach
- Increases habitat diversity

### FEASIBILITY

- Needs wide, existing beach
- Needs ongoing maintenance

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## COBBLE BERMS



### BENEFITS

- Limits erosion by absorbing wave energy
- Less wave runup compared to walls and rock armor
- Can coexist with beach
- Potential increase in habitat diversity

### FEASIBILITY

- Minimum space requirements
- Less stable than rock armor

---

## STORMWATER MANAGEMENT



### BENEFITS

- Addresses rising groundwater
- Limits potential flooding from stormwater
- Limits bluff erosion

### FEASIBILITY

- Relatively low cost (depends on extent of change)
- Low maintenance



# WHAT ARE POSSIBLE NATURE-BASED SOLUTIONS?

## LIVING BREAKWATERS/ARTIFICIAL REEFS



### BENEFITS

- Limits erosion by ‘tripping’ waves offshore
- Can coexist with beach
- Potential increase in habitat diversity

### FEASIBILITY

- High cost
- Difficult to construct
- May impact kelp beds
- Uncertain permitting pathway

## SAND MANAGEMENT



### BENEFITS

- Can be paired with other solutions
- Maintains recreation and access
- Limits erosion during some events

### FEASIBILITY

- Moderate cost
- Nearby examples for permitting
- Sand alone cannot defend against all events
- Requires maintenance/replenishment

## SAND RETENTION WITH HEADLANDS



### BENEFITS

- Potential to retain more sand
- Wider beaches can reduce wave erosion
- Headlands could be designed to improve habitat diversity

### FEASIBILITY

- High cost
- Uncertain permitting pathway
- May impact subtidal habitats
- Sand will still erode in winter

## GREEN-GREY APPROACHES



We considered approaches that improve habitat along stretches of the coast that are currently armored with riprap or seawalls. These approaches contain a wide umbrella of designs (e.g. concrete tide pool units).

### What about kelp?

Our healthy kelp beds off the coast can help protect the shoreline from small, wind-driven waves. They cannot protect against large storm events with powerful waves. The location of these kelp beds impact the feasibility of certain nature-based solutions.





# WEST CLIFF SHORELINE CONTEXT

## Current

Coastal Storms

Seasonal and  
Pocket Beaches

Headlands and  
Rocky Habitats

Healthy Kelp  
Forests



- Coastal storms cause waves to overtop the shoreline and erode vulnerable areas.
- Beaches experience both tidal and seasonal variability.
- Sand availability is also seasonally impacted.
- Kelp reduces energy of smaller wind-driven waves only.

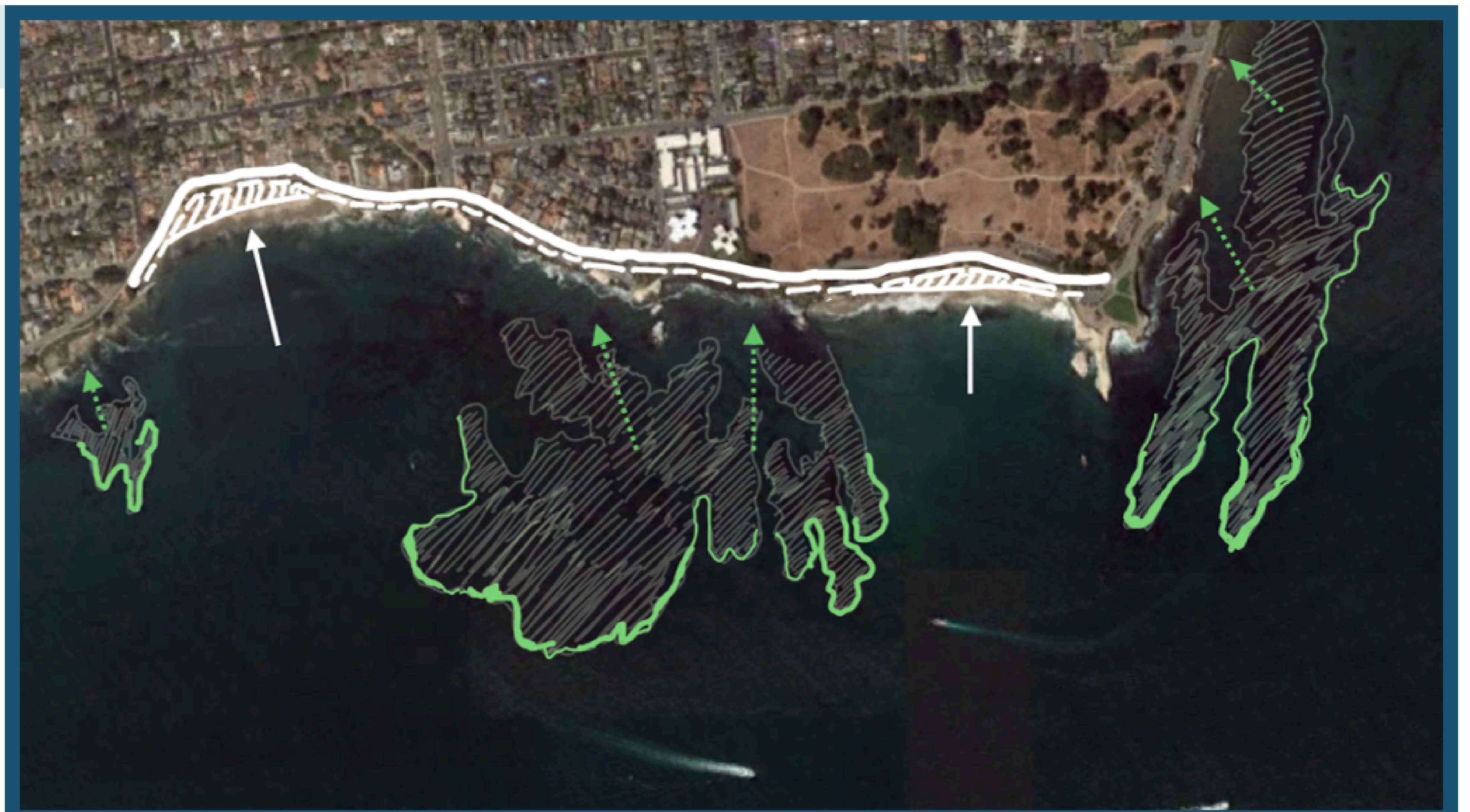
## Future

Increasing Sea  
Level

Increasing  
Coastal Storms

Beach Loss and  
Cliff Erosion

Offshore Habitat  
Migration



With climate change:

- Flooding and wave overtopping could worsen.
- Headlands and rocky habitats could likely erode.
- Beaches would narrow and disappear.
- Offshore habitats like kelp forests could move to shallower depths towards shore.



# FEEDBACK ON SITE 1 MAIN BEACH

Please add a sticky note for each question regarding the vegetated dune design for the east side of Main Beach. Add a star next to any comments you agree with.

WHAT DO YOU LIKE?

WHAT ARE YOUR CONCERNS?



# FEEDBACK ON SITES 2 AND 3

## WEST CLIFF DRIVE

Please add a sticky note for each question regarding the recommendations and future considerations for Sites 2 (west end of Its Beach) and 3 (Mitchell’s Cove). Add a star next to any comments you agree with.

### WHAT DO YOU LIKE?

Site 2 (Its Beach)

Site 3 (Mitchell’s Cove)

### WHAT ARE YOUR CONCERNS?

Site 2 (Its Beach)

Site 3 (Mitchell’s Cove)



# WHAT SHOULD BE MONITORED DURING THESE PROJECTS?

Please add a star or add a sticky note with your own option to the “Other” box.

EROSION

NATIVE PLANT  
ESTABLISHMENT

BIRD HABITAT

SUCCESS OF DUNE  
MATERIAL TYPE

BEACH WIDTH

IMPACT ON  
RECREATIONAL USES

OTHER?



# NEXT STEPS

## THIS PROJECT

- Project will end in July 2025, providing recommendations for the study area and including a 30% design for a vegetated dune on Main Beach.
- A final report will be available on the City website.
- A new virtual reality experience will be released in July.
- Potentially a high level feasibility analysis will be added for an artificial reef by the Santa Cruz Wharf.

## UPCOMING COASTAL MANAGEMENT WORK

- Engaging with the California Artificial Reef Program Plan, a combined effort by the Department of Fish and Wildlife, Ocean Protection Council, and SeaGrant.
- Forthcoming City Projects
  - 3 medium-term Shoreline Adaptation Management Plans focused on 20-year time horizon, implementation projects and funding for 3 areas: Seabright/East Cliff, Cowell/Main Beach, and West Cliff.
  - Lighthouse Point Hazard Analysis and Adaptation Solution Evaluation (timing to be determined).

## Stay up to date with coastal management planning!

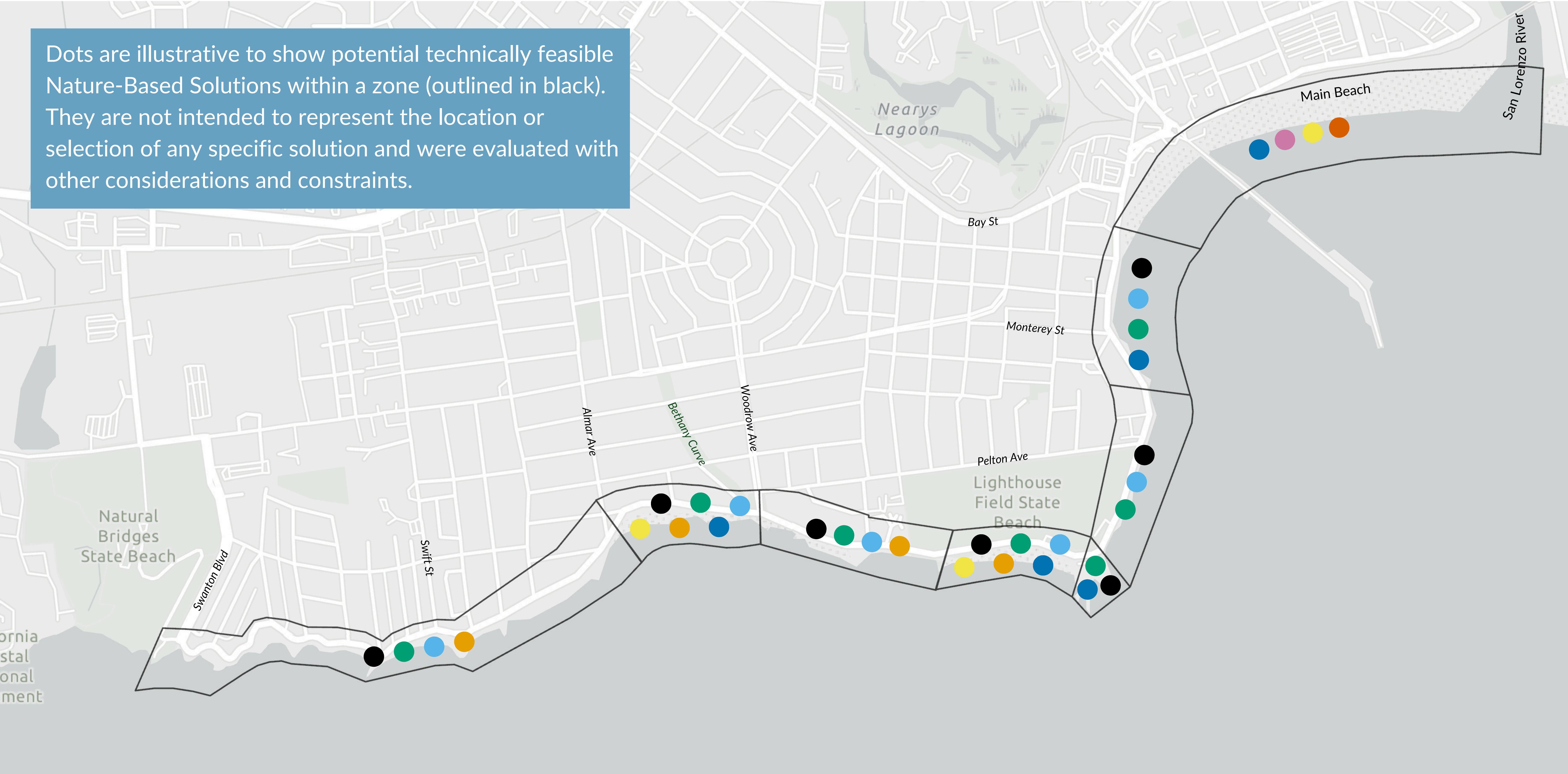
Updates are provided in the City Manager's weekly newsletter. Sign up to receive these updates using the QR code.





# FEASIBLE NATURE-BASED SOLUTIONS

Dots are illustrative to show potential technically feasible Nature-Based Solutions within a zone (outlined in black). They are not intended to represent the location or selection of any specific solution and were evaluated with other considerations and constraints.



Green-Gray Approaches



Native Plant Restoration



Stormwater Management



Living Breakwaters/  
Artificial Reefs



Cobble Berms



Sand Management



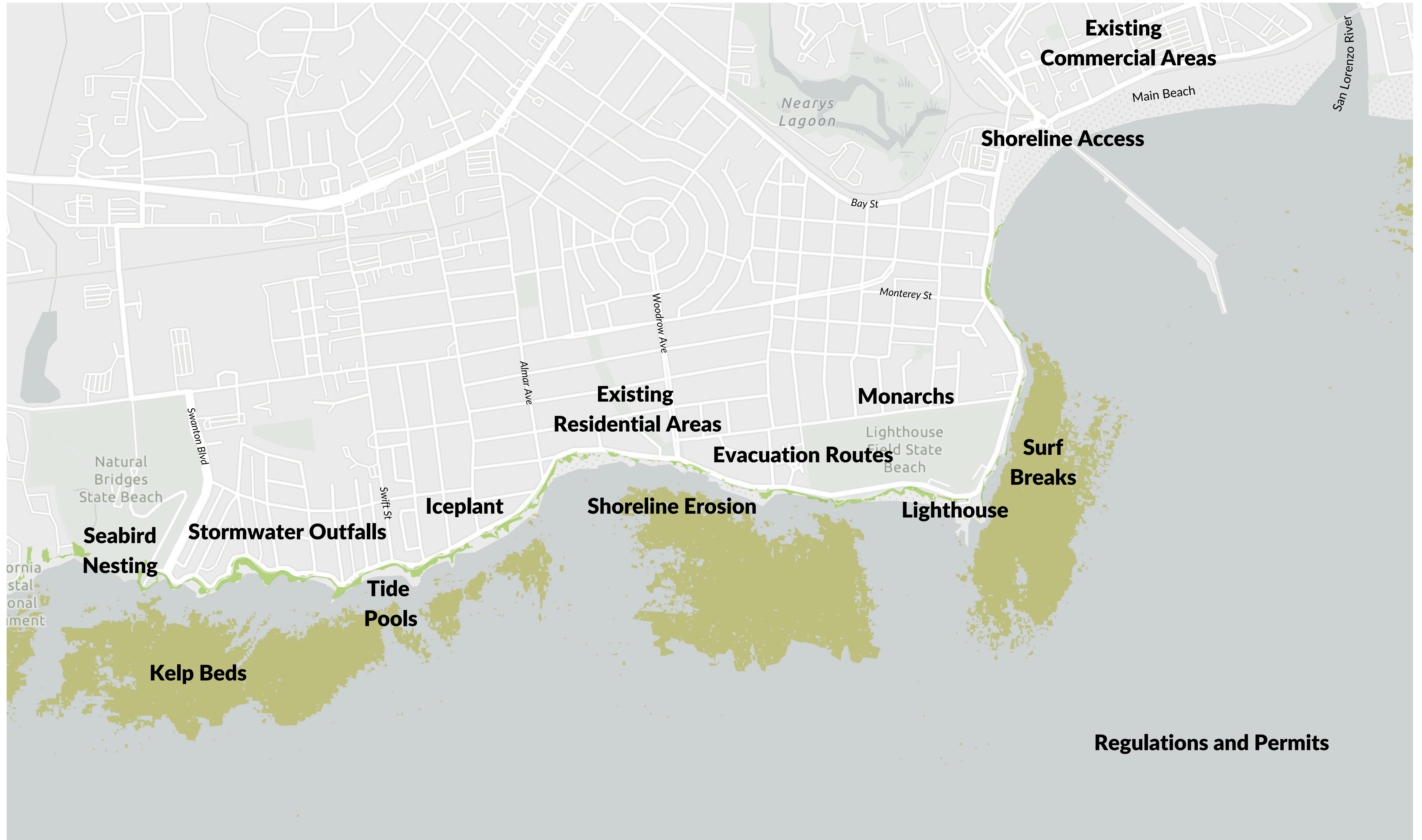
Sand Retention  
with Headland



Vegetated Sand Dunes



# CONSTRAINTS AND CONSIDERATIONS





# WHY USE A VEGETATED DUNE?

## Coastal Hazard Protection Benefits

- Preserves beach width and buffers coast from storms.

Without a dune, 3 feet of sea level rise could cause **100 feet of beach loss**. A 5 foot high dune is estimated to **preserve 10–20 feet of beach** with 3 feet of sea level rise.

## Community Benefits

- Provides public access and recreation.
- Connects people to dune habitat and creates educational opportunities.

## Ecological Benefits

- Restores habitat and increases connectivity for common native species. Some examples are shown to the right.

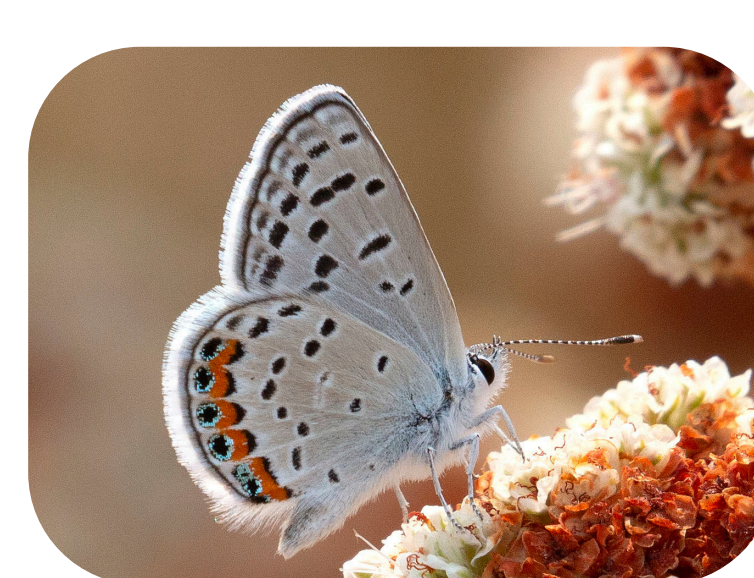
Yellow Sand Verbena



Coastal Sagewort



American Dunegrass



Acmon's Blue Butterfly

## Why put dunes on Main Beach?

- Suitable beach width
- Stable under wave conditions and San Lorenzo river mouth migration
- Mutually beneficial with current sand management strategies and other projects
- Pilot enables evaluation of benefits

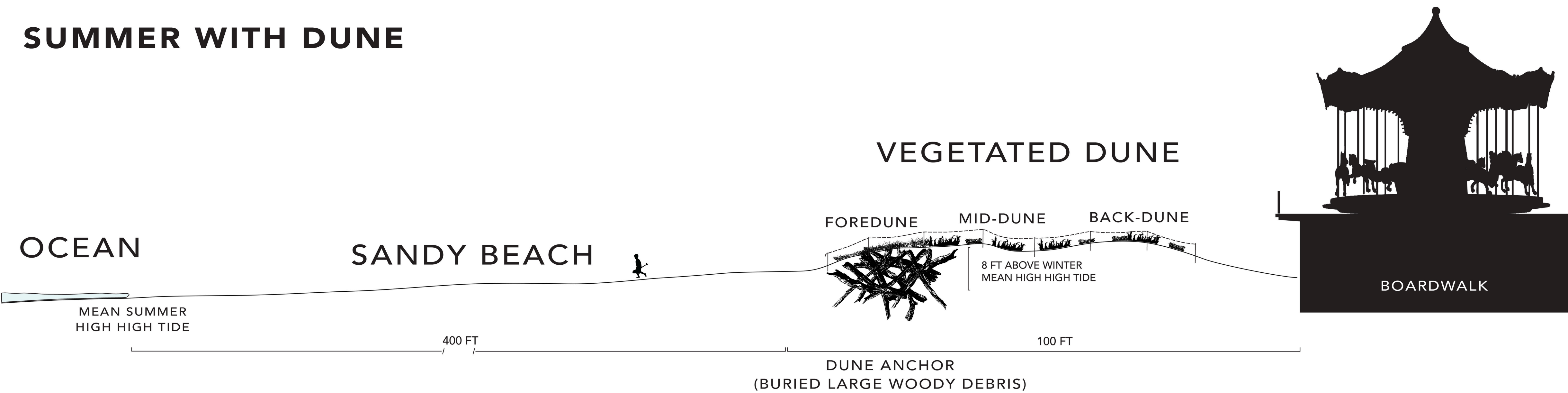
## Local Example at Seabright State Beach



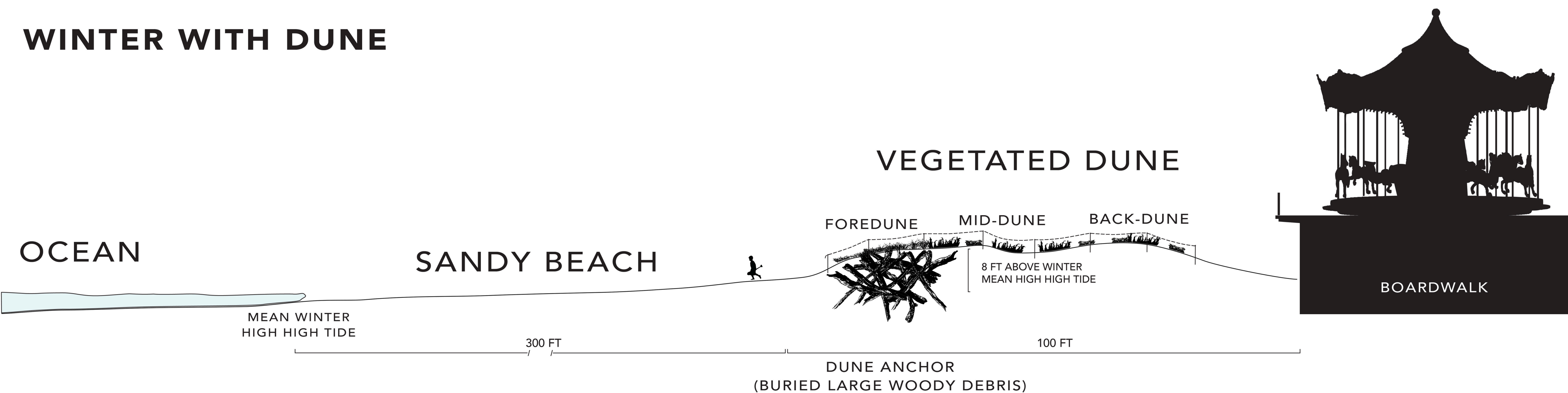


# VEGETATED DUNE PROFILE

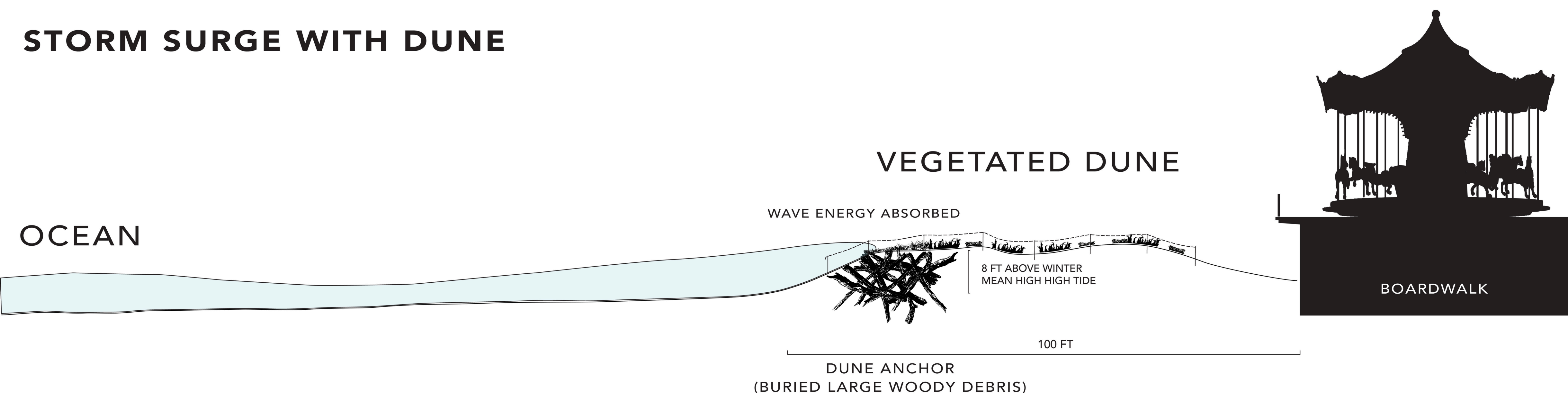
SUMMER WITH DUNE



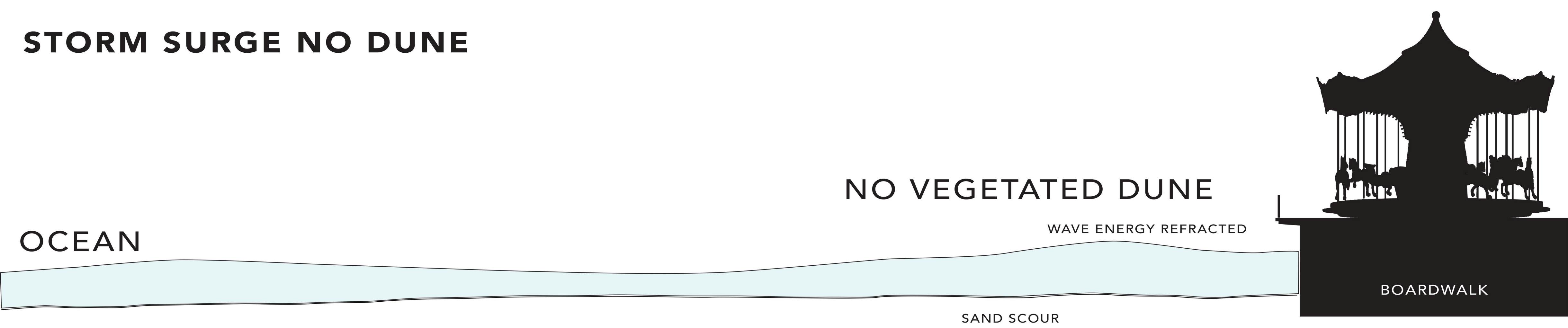
WINTER WITH DUNE



STORM SURGE WITH DUNE



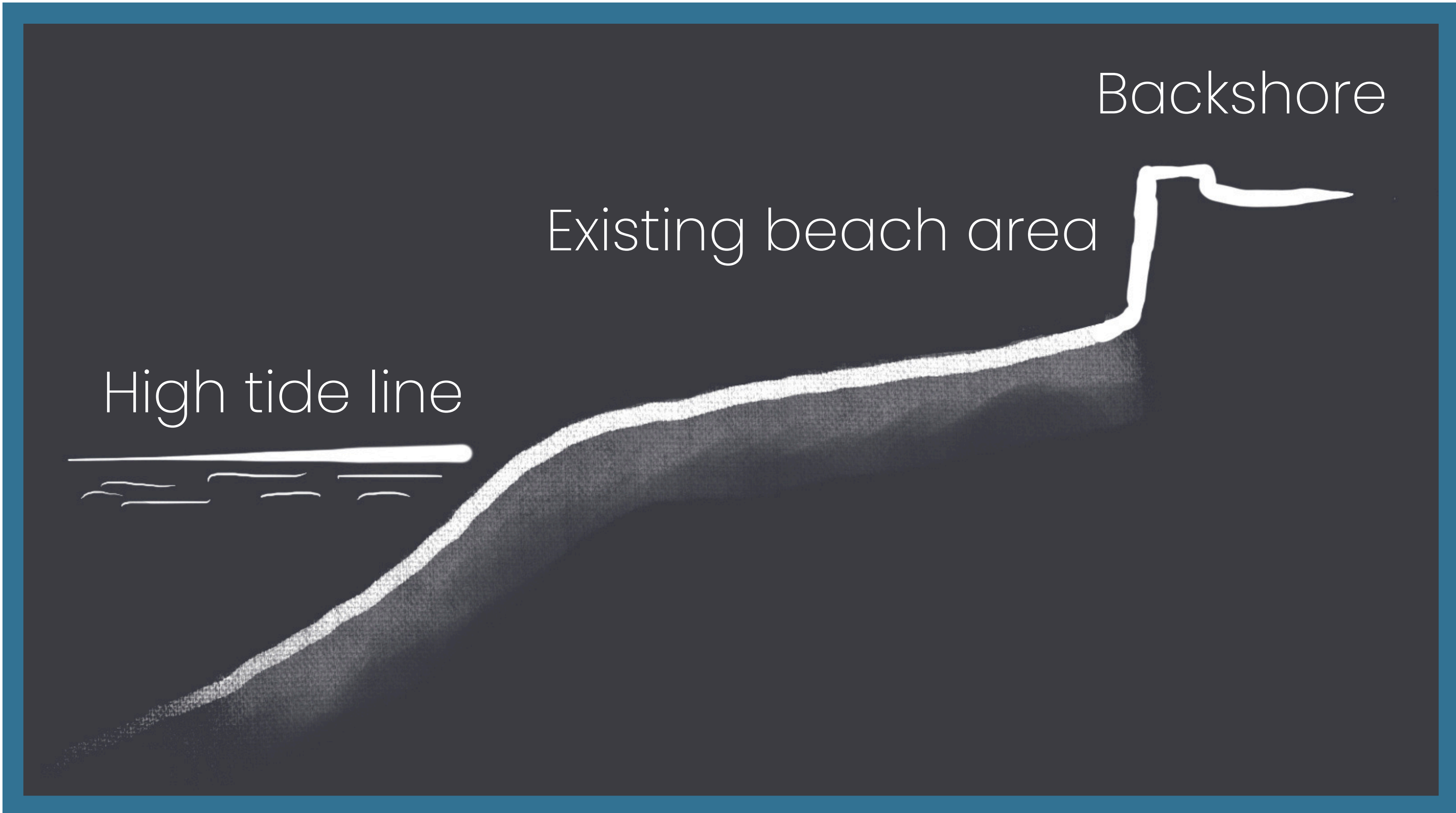
STORM SURGE NO DUNE



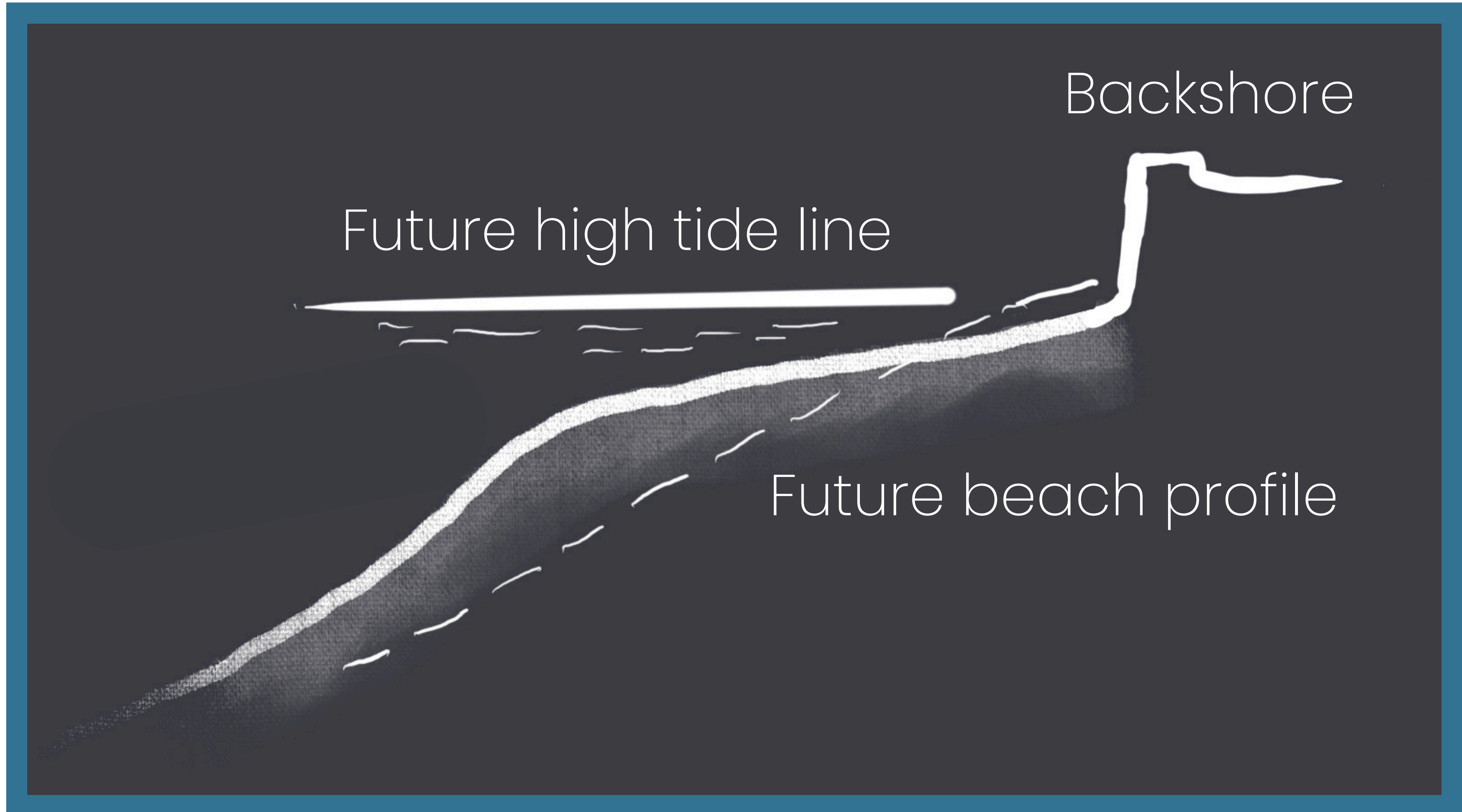


# VEGETATED DUNE WITH SEA LEVEL RISE

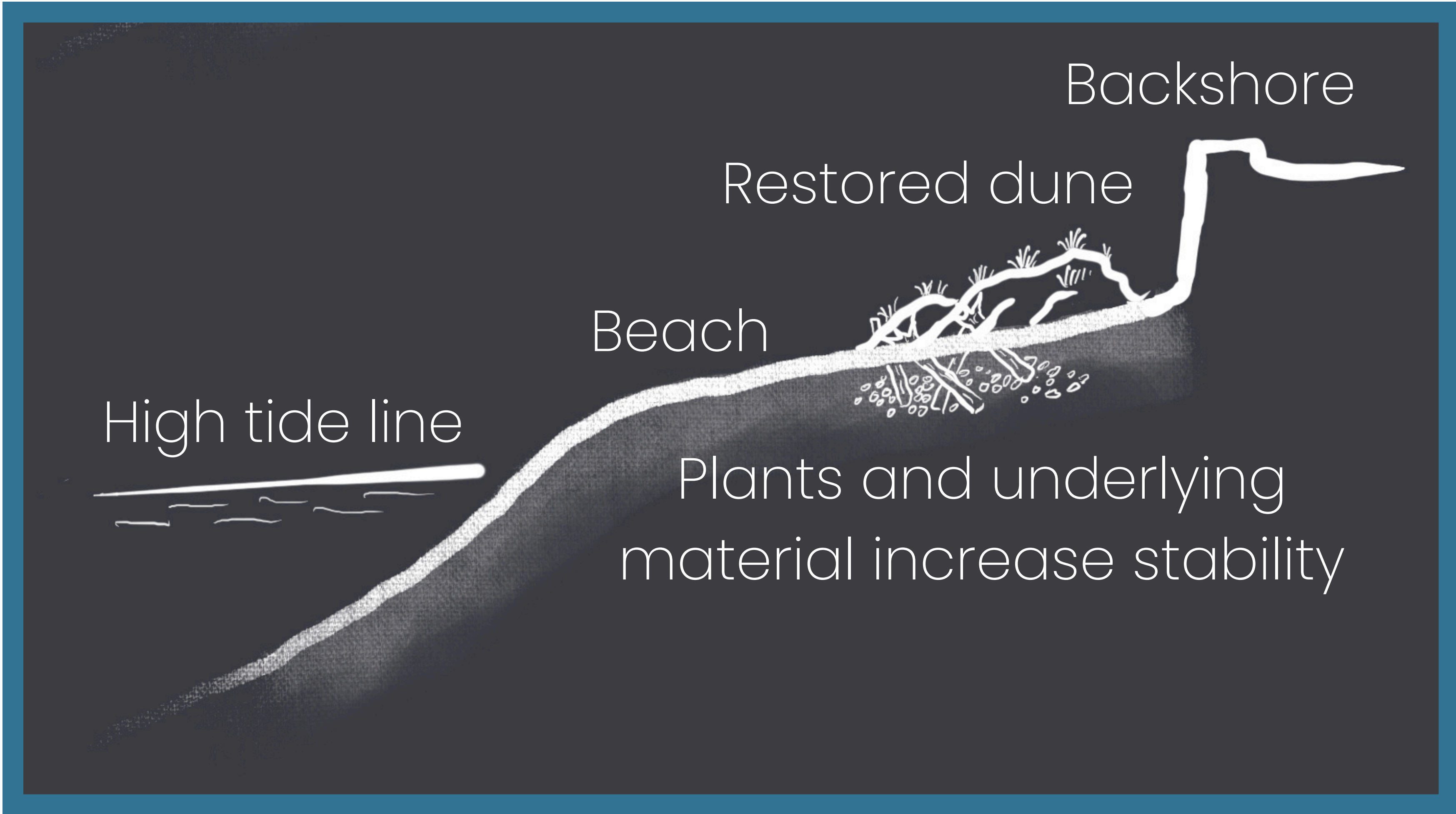
EXISTING CONDITIONS  
WITHOUT DUNE



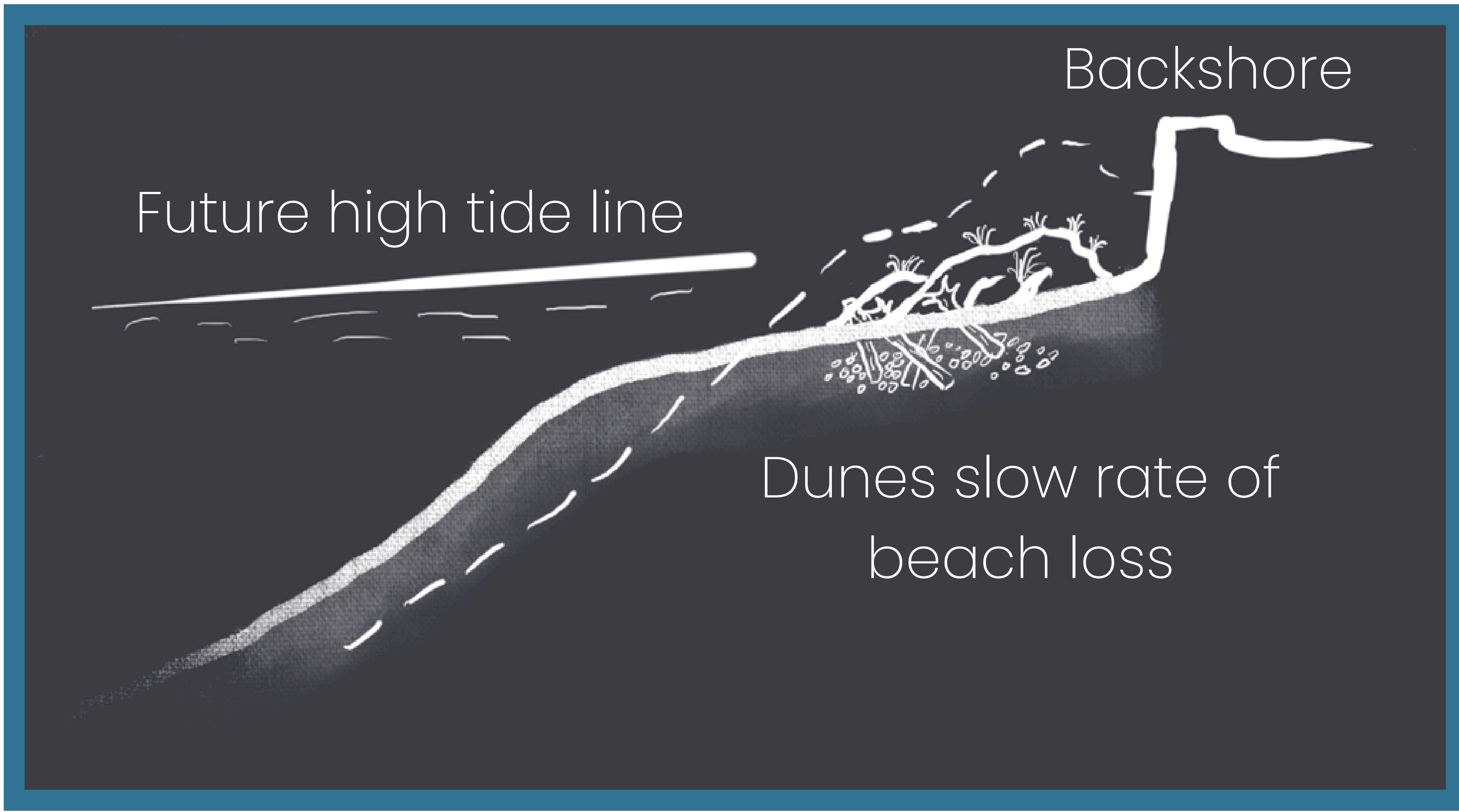
FUTURE CONDITIONS  
WITHOUT DUNE



EXISTING CONDITIONS  
WITH DUNE



FUTURE CONDITIONS  
WITH DUNE





# WHAT COULD THE VEGETATED DUNE LOOK LIKE?





# WEST CLIFF RECOMMENDATIONS

## SITE 2: WEST END OF ITS BEACH

Lighthouse  
Field State  
Beach

### What are recommendations?

Recommendations are options that can be designed and implemented in the near-term without further evaluation.

WEST CLIFF DRIVE  
ROAD MICROREALIGNMENT

**Stormwater Improvements** in  
Lighthouse Field could look like:

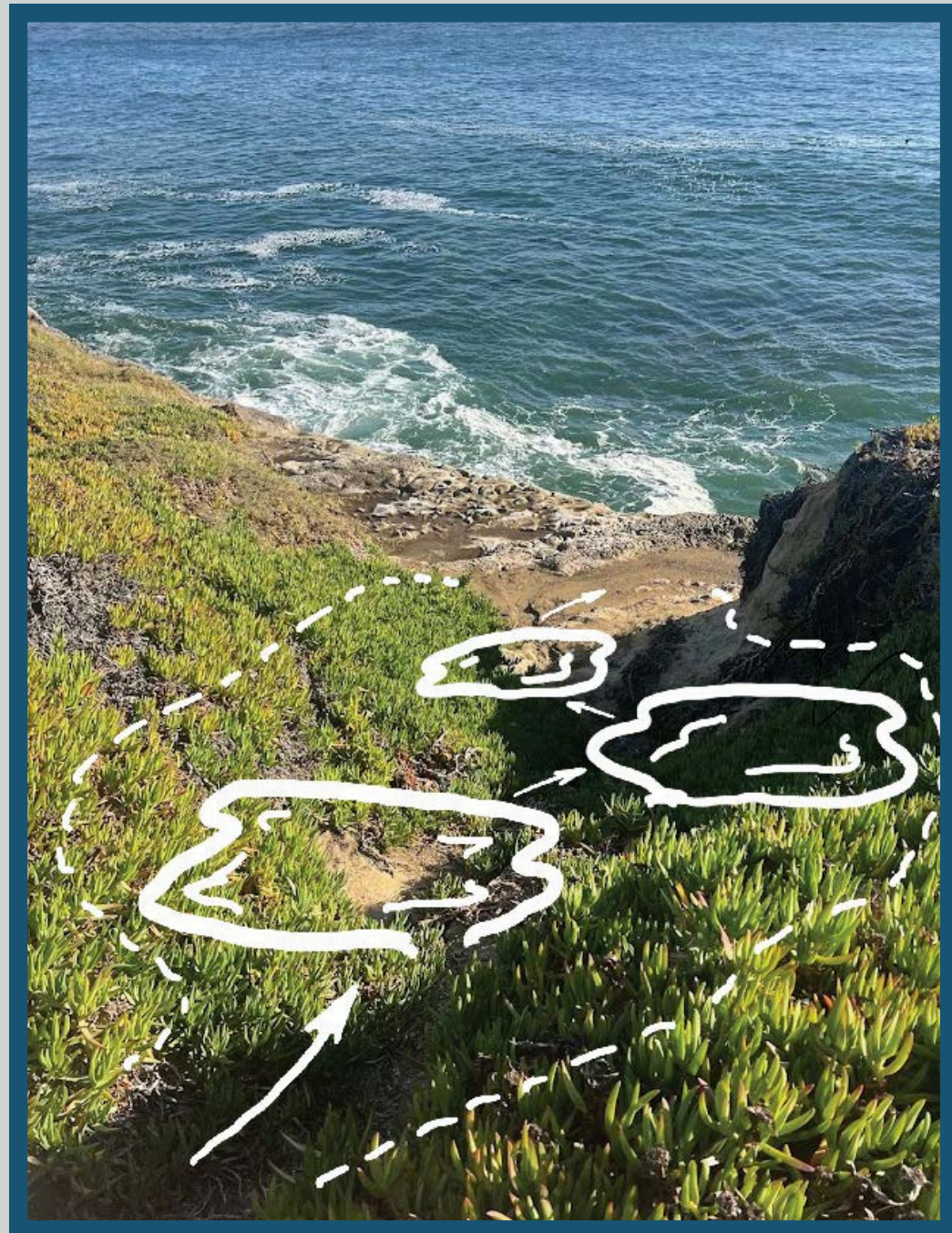


WETLAND AND POLLINATOR HABITAT  
ENHANCEMENT ON WEST SIDE OF FIELD

**Stormwater Improvements** along the  
shoreline could look like:



REPLACEMENT OF ICE PLANT  
WITH NATIVE PLANTS



STEPPED POOLS AND  
INFILTRATION BASINS

Lighthouse  
Point



# WEST CLIFF RECOMMENDATIONS

## SITE 3: MITCHELL'S COVE

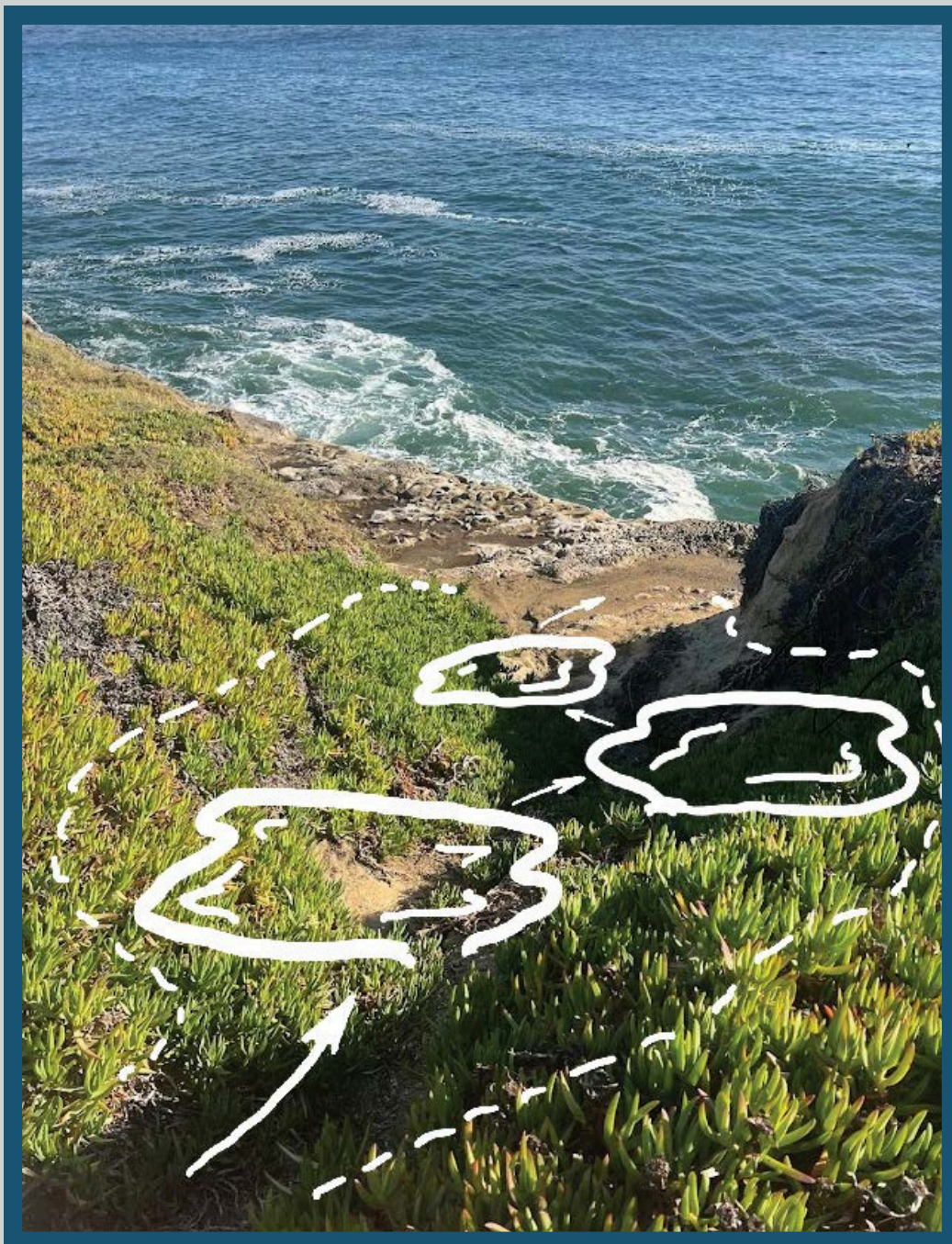
**What are recommendations?**  
Recommendations are options that can be designed and implemented in the near-term without further evaluation.



**Stormwater Improvements**  
could look like:



REPLACEMENT OF ICE PLANT  
WITH NATIVE PLANTS



STEPPED POOLS AND  
INFILTRATION BASINS

**Revetment Improvements**  
could look like:



TIDE POOL ARMOR BLOCKS



# SITE 2 ITS BEACH FUTURE CONSIDERATIONS

## GREEN-GREY OPTIONS



1  
Modify existing riprap and add tide pool features.



2  
Remove and replace riprap with buried wall and add tide pool features.



3  
Reuse fugitive riprap from the shoreline into a micro-intertidal reef.

## What are future considerations?

Future considerations are options that require further evaluation and discussion with the community, other jurisdictions, or regulatory agencies.



## GREEN STORMWATER MANAGEMENT AT LIGHTHOUSE FIELD STATE PARK

Seasonal ponds to reduce the flow of stormwater on the western side of the field.

## LOCATIONS OF FUTURE CONSIDERATIONS





# SITE 3 MITCHELL'S COVE FUTURE CONSIDERATIONS

## GREEN-GREY OPTIONS



Place a buried wall and reuse riprap for a nearshore micro-intertidal reef.



Remove and replace riprap with buried wall with natural surfacing and tide pool features.



Modify existing riprap to offer better habitat for aquatic species. For example, adding surface roughness, cobble or other materials, or replacing some riprap with tide pools.

### What are future considerations?

Future considerations are options that require further evaluation and discussion with the community, other jurisdictions, or regulatory agencies.

## LOCATIONS OF FUTURE CONSIDERATIONS





# Educational Opportunities at NBS Sites

What do you think is most important for the community and visitors to know about these coastal attributes at each site location? Please add a sticky note noting site number and/or add a star next to any comments you agree with.

*Site 1 (Main Beach), Site 2 (West End of Its Beach), Site 3 (Mitchell's Cove)*



Indigenous History and Culture

Local Ecology

Coastal Hazards

Surfing History

Connection to Nature

Other?