→ **Brett Vivyan PE**
Civil Engineer - Maritime & Coastal

Battelle Innovations in Climate Resilience

Welcome

Natural Shoreline Infrastructure:

Adapting to the Future with Innovative Approaches to Shoreline Resiliency

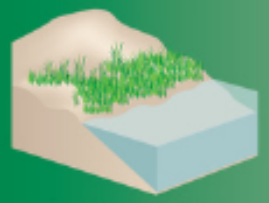
Natural ecological systems or processes to reduce vulnerability to climate change related hazards while increasing the long-term adaptive capacity of coastal areas by perpetuating or restoring ecosystem services” (Newkirk, 2018)

Green vs Gray

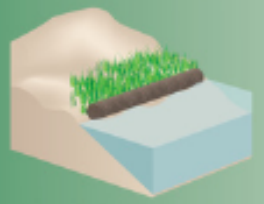
HOW GREEN OR GRAY SHOULD YOUR SHORELINE SOLUTION BE?

GREEN - SOFTER TECHNIQUES ⟷ **GRAY - HARDER TECHNIQUES**

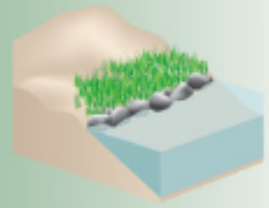
Living Shorelines



VEGETATION ONLY - Provides a buffer to upland areas and breaks small waves. Suitable only for low wave energy environments.

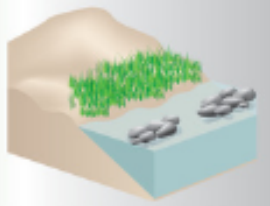


EDGING - Added structure holds the toe of existing or vegetated slope in place.

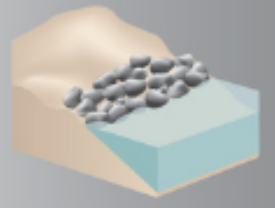


SILLS - Parallel to existing or vegetated shoreline, reduces wave energy, and prevents erosion. Suitable for most areas except high wave energy environments.

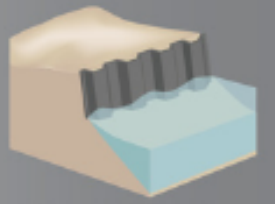
Coastal Structures



BREAKWATER - (vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action, and encourage sediment accretion. Suitable for most areas.



REVETMENT - Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with pre-existing hardened shoreline structures.



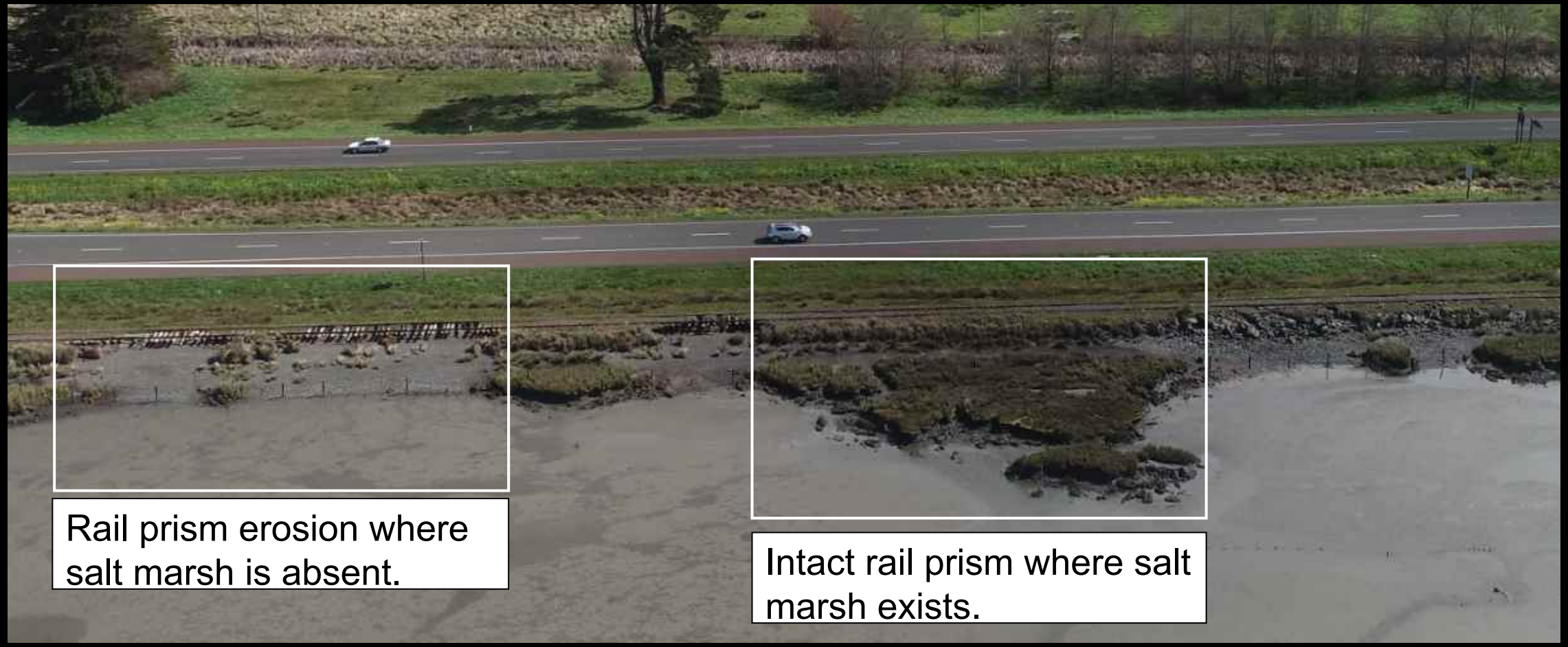
BULKHEAD - Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for areas highly vulnerable to storm surge and wave forces.

Technical, Economic, Regulatory & Social Feasibility

EXISTING CONDITIONS

FUTURE CONDITIONS

Erosion & Flood Risk Reduction

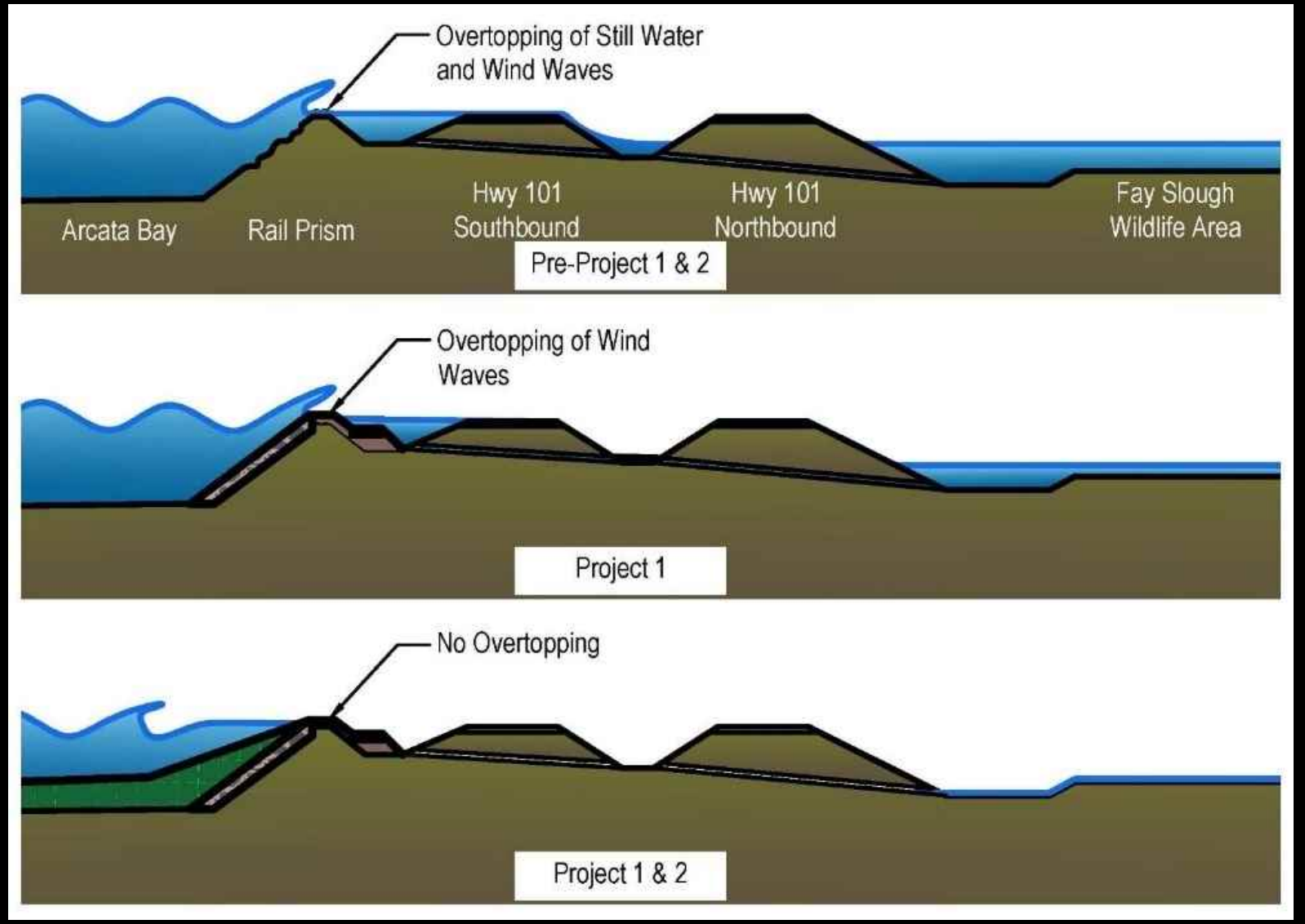


Rail prism erosion where salt marsh is absent.

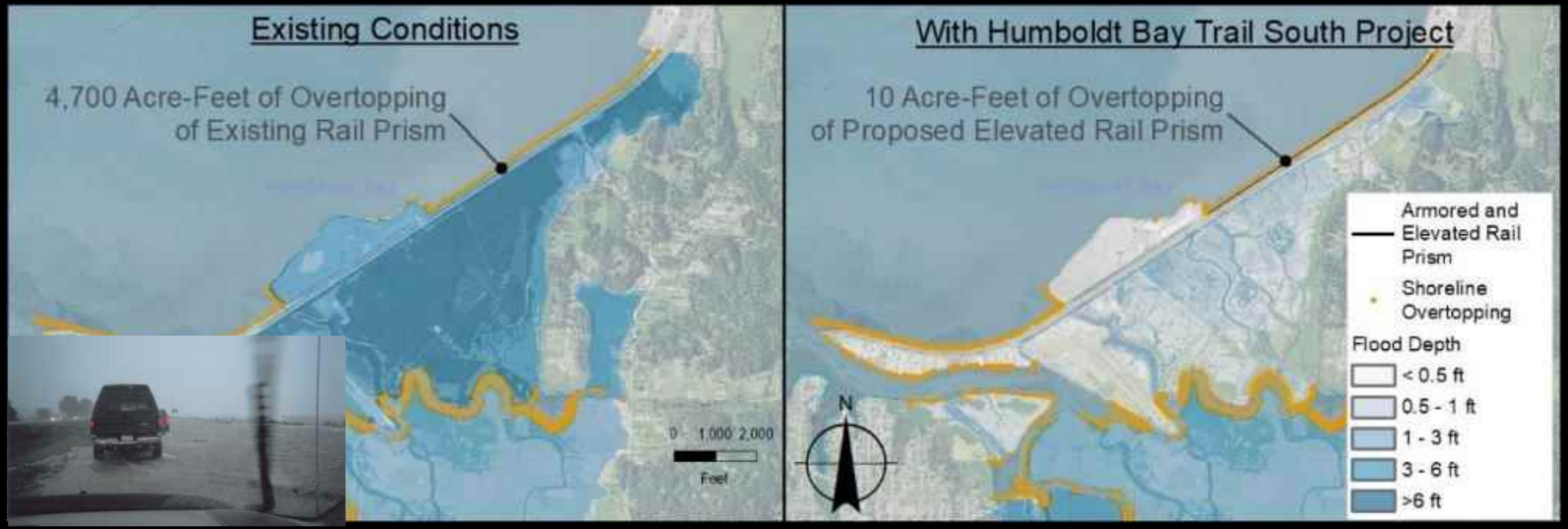
Intact rail prism where salt marsh exists.

Erosion & Flood Risk Reduction

Flood Risk Reduction

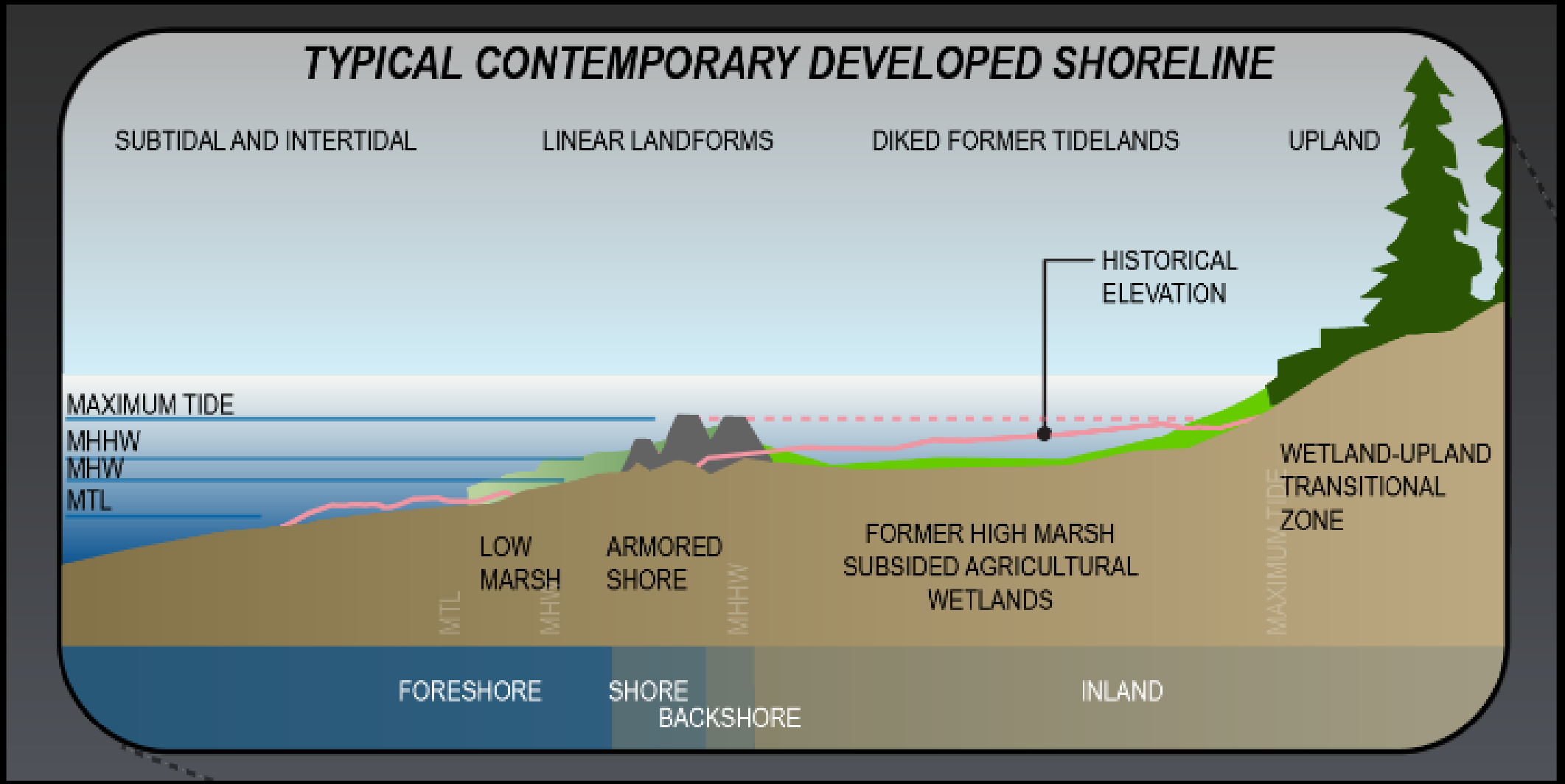


Flood Risk Reduction



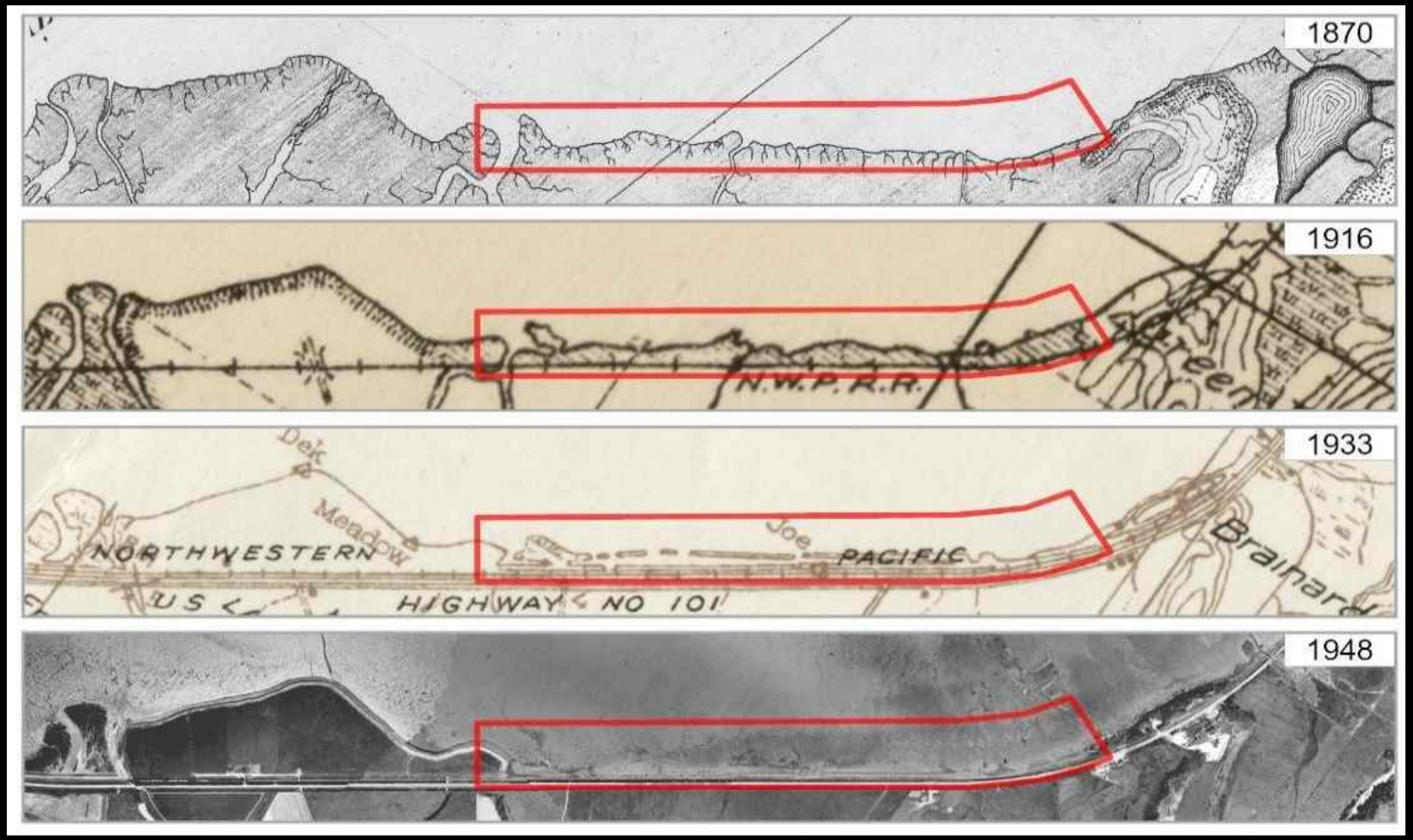
Site Characterization

Existing Physical Conditions



Site Characterization

Historical Conditions



Site Characterization

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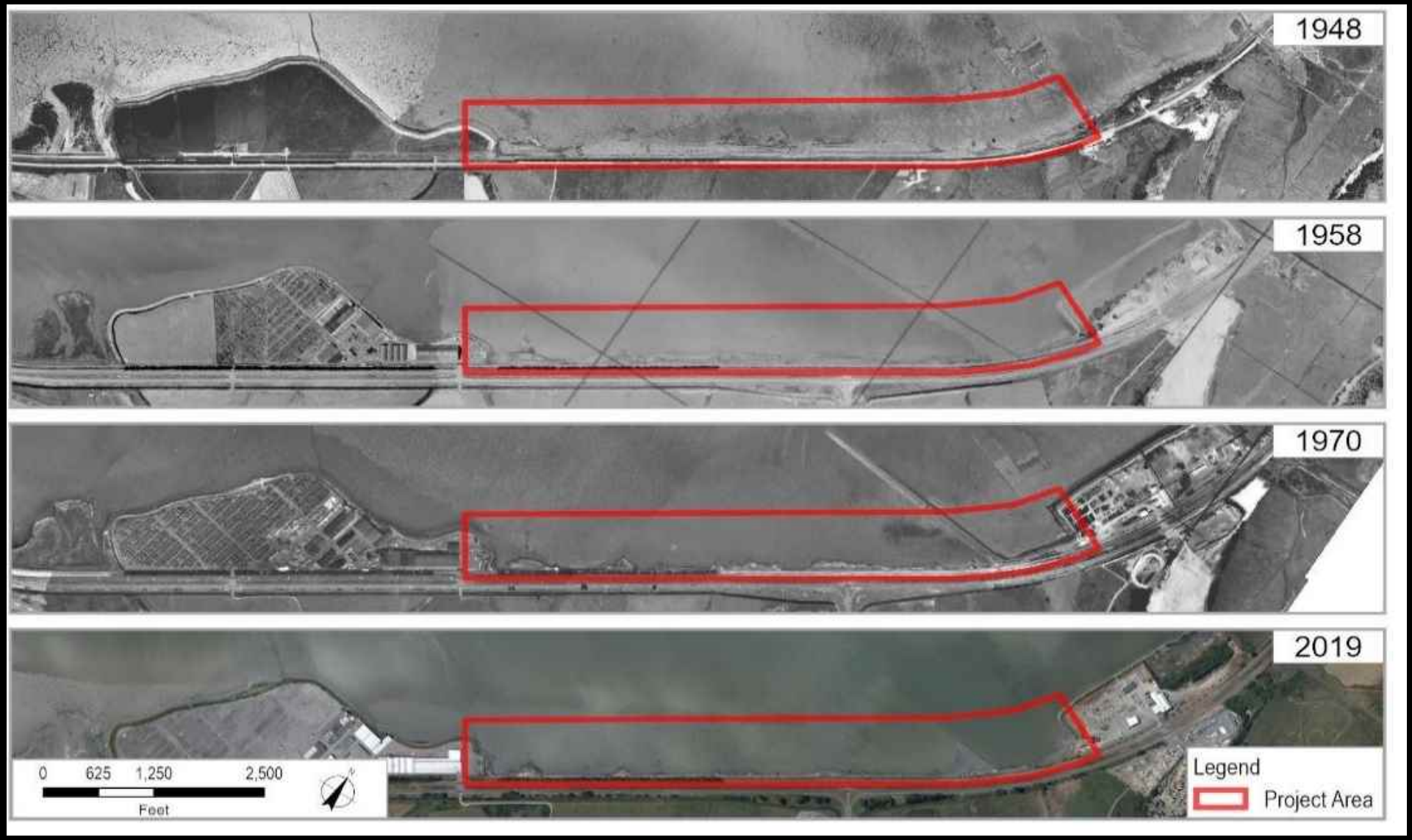
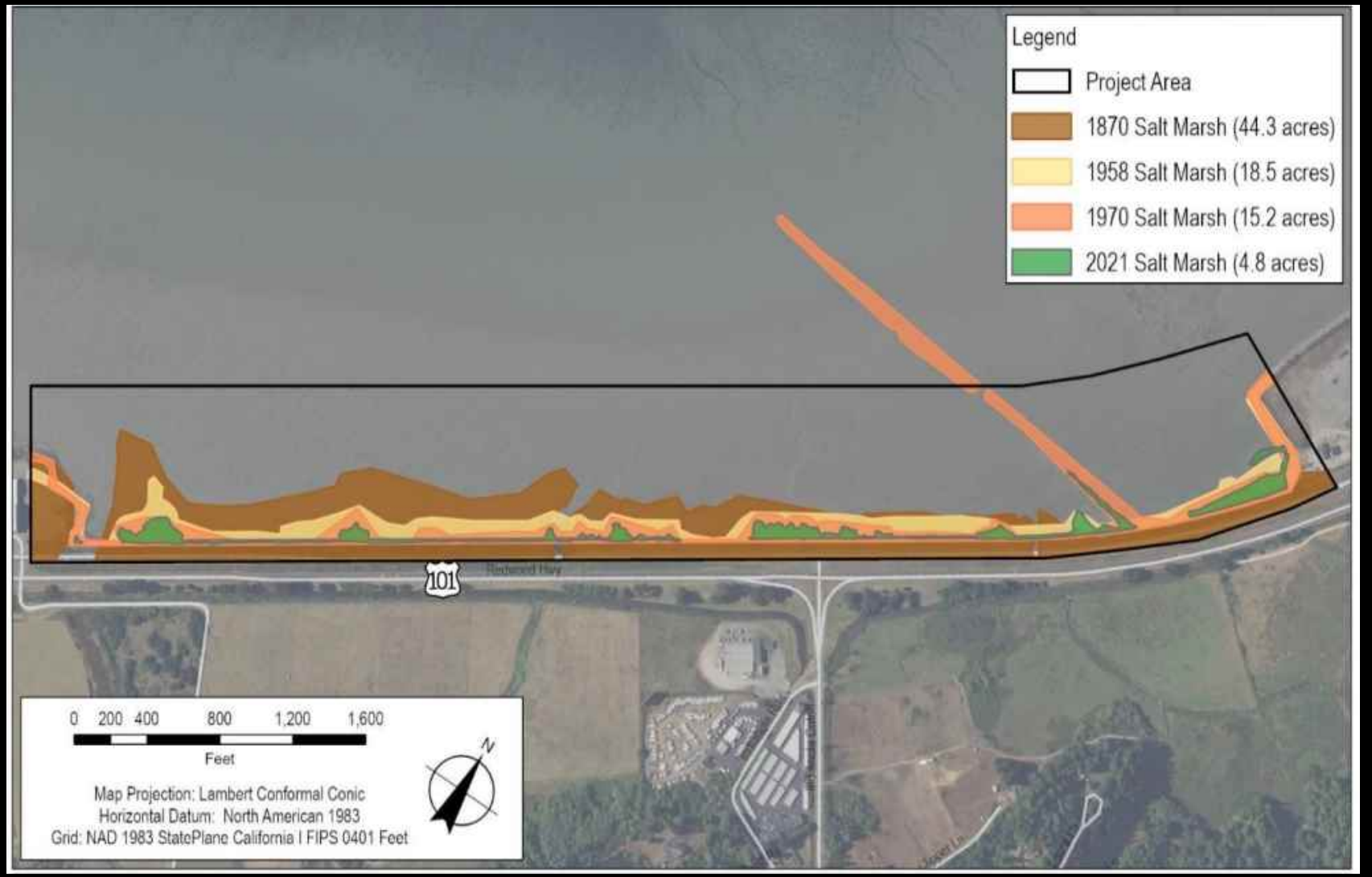


Site Characterization

Historical Conditions

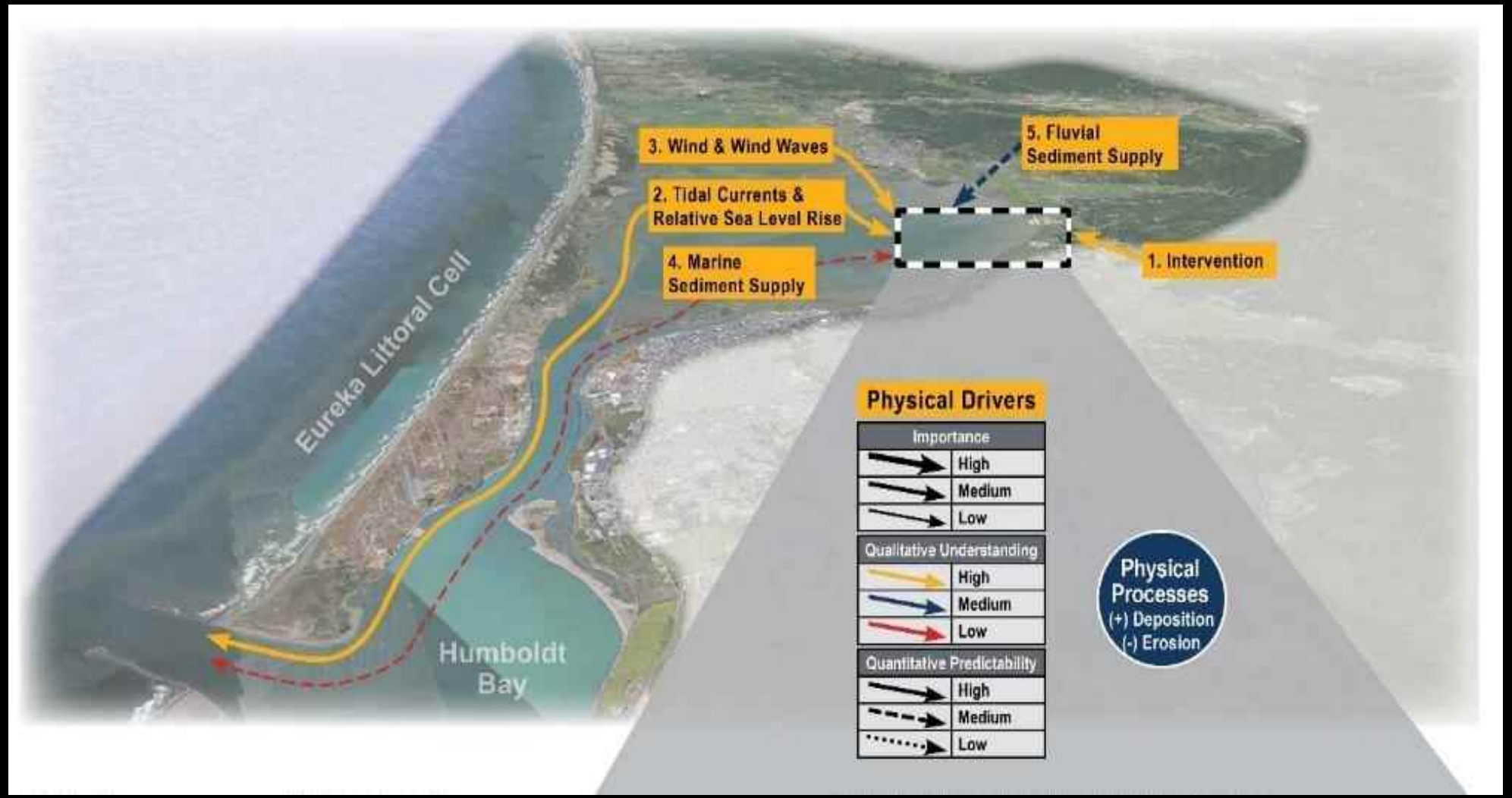


Site Characterization

Biological Habitats and Communities

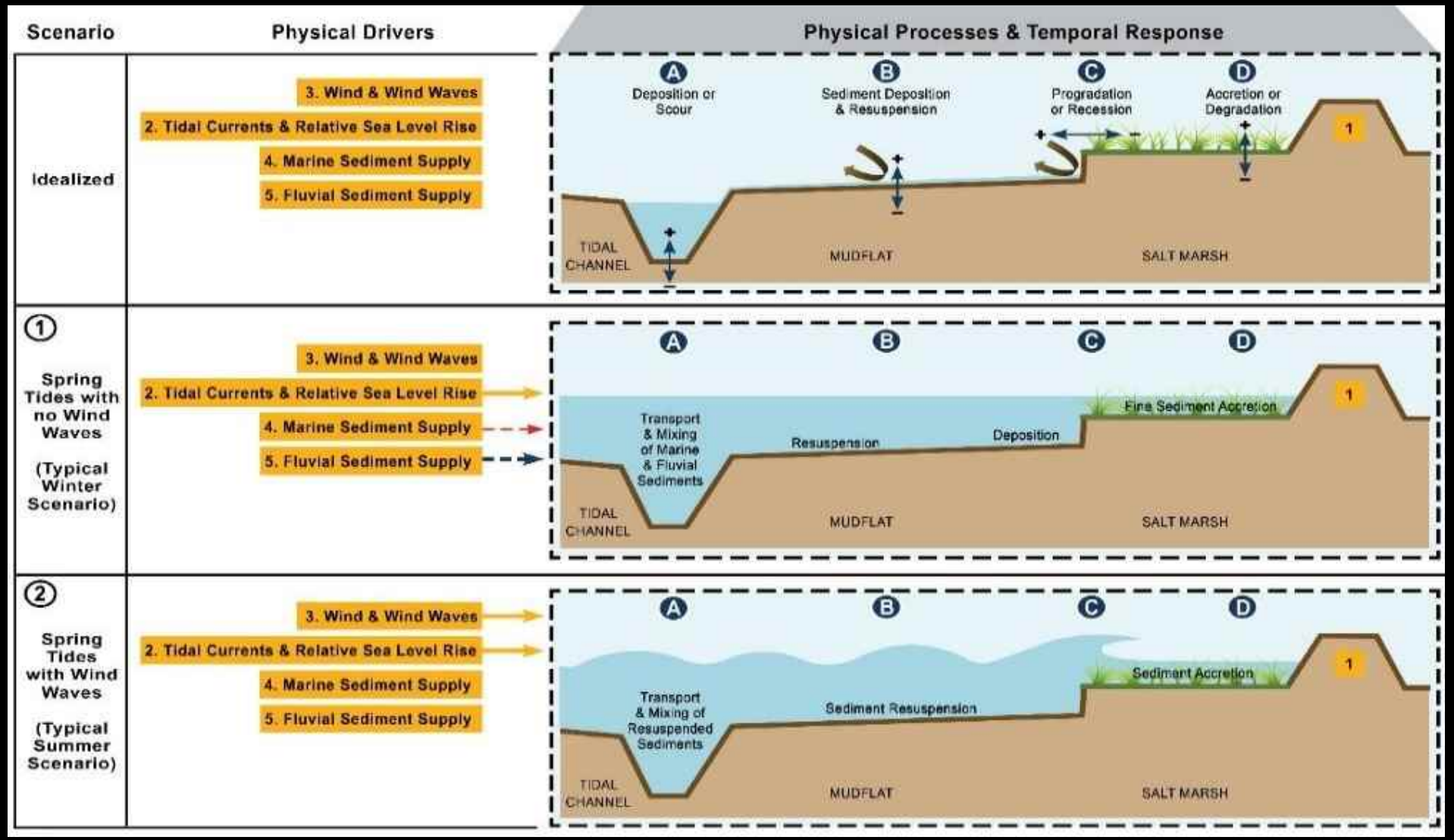
Site Characterization

Geomorphic Assessment



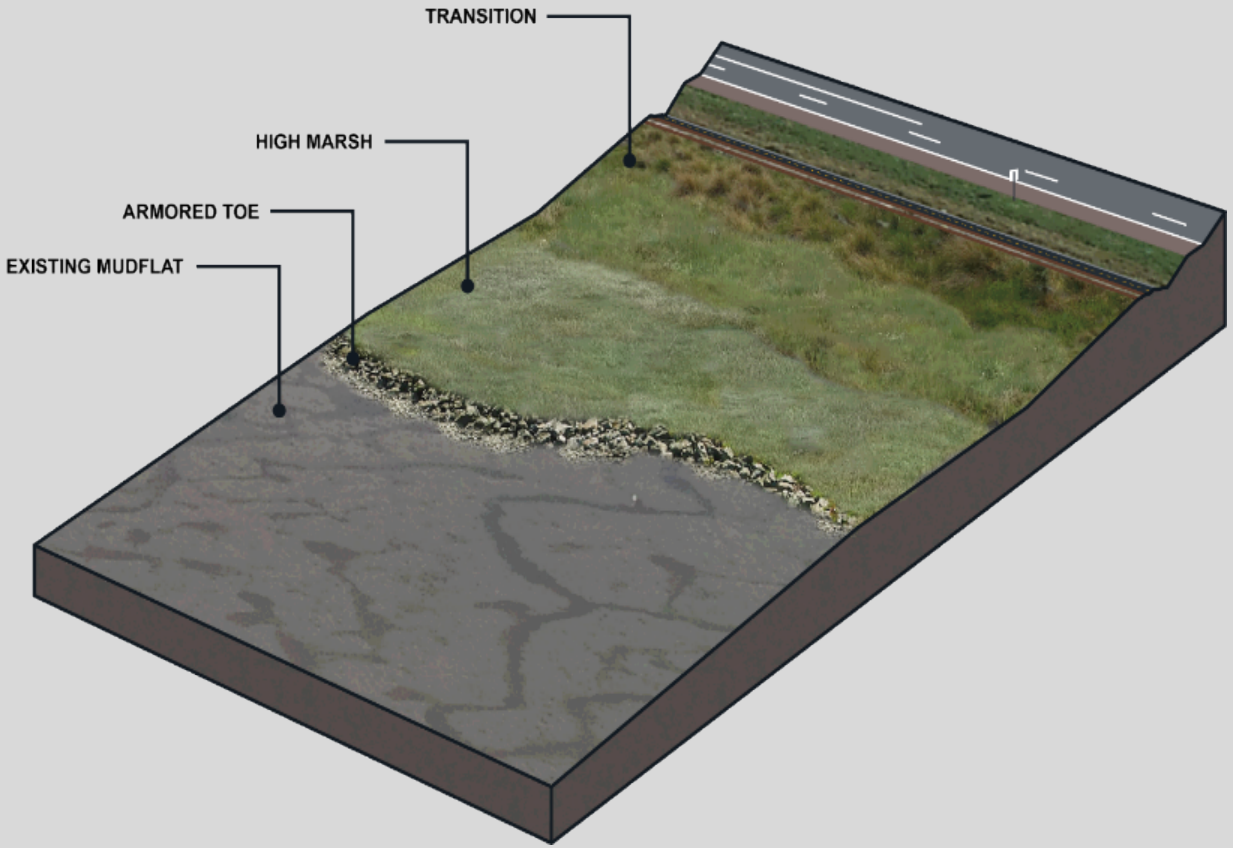
Site Characterization

Geomorphic Assessment



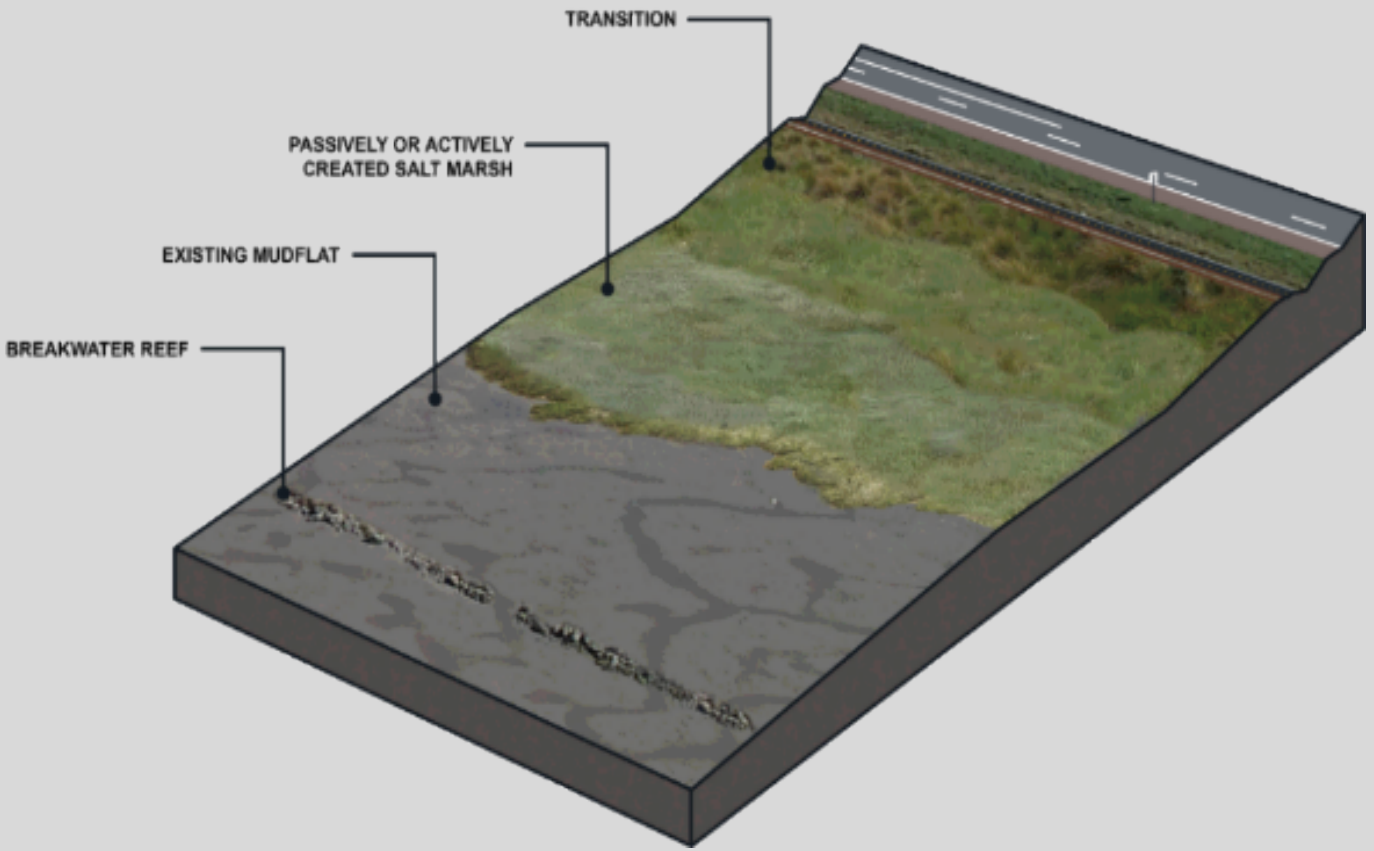
Preliminary Design - Alternatives

Horizontal Levee: High Salt Marsh with or without Armored Toe



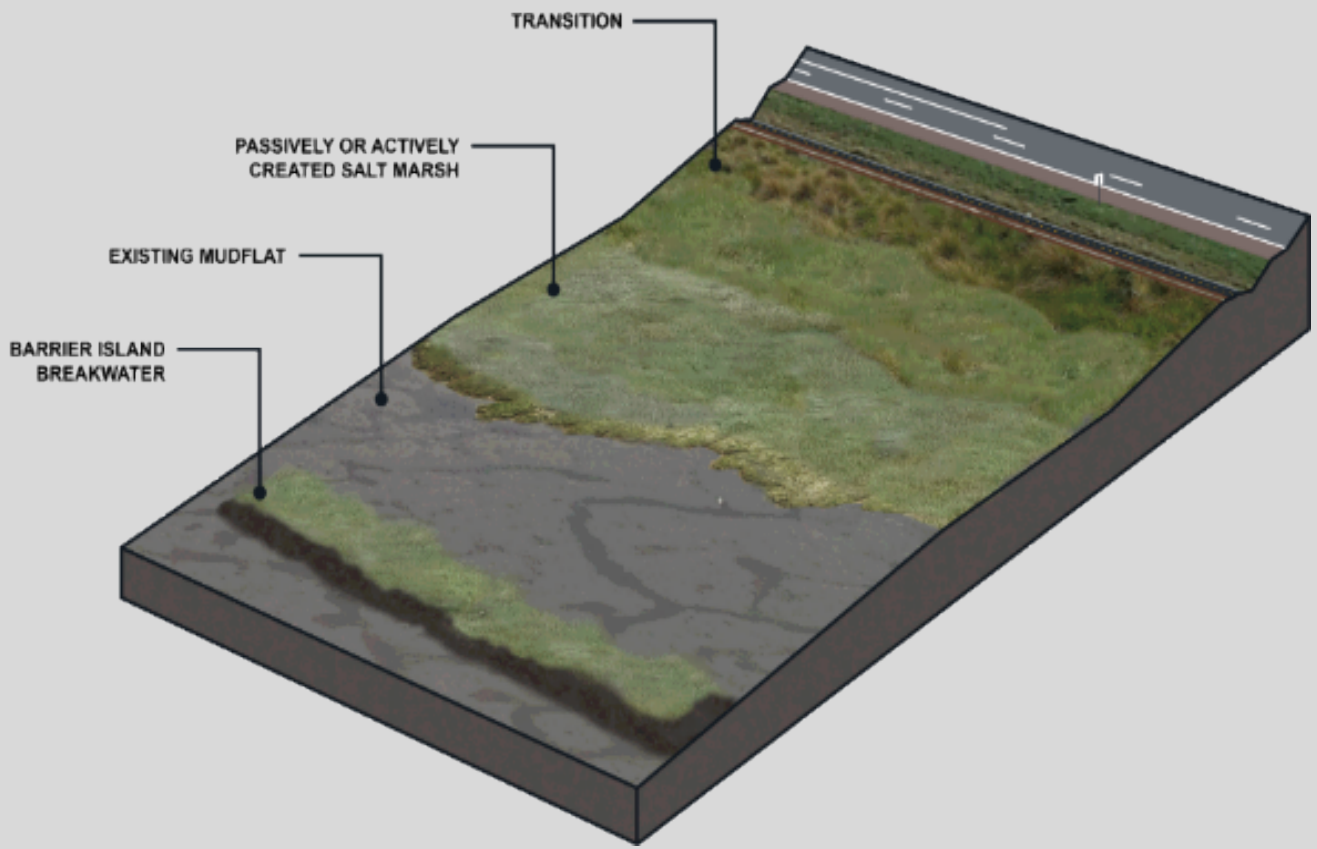
Preliminary Design - Alternatives

Breakwater Reef with Passive and Active Salt Marsh



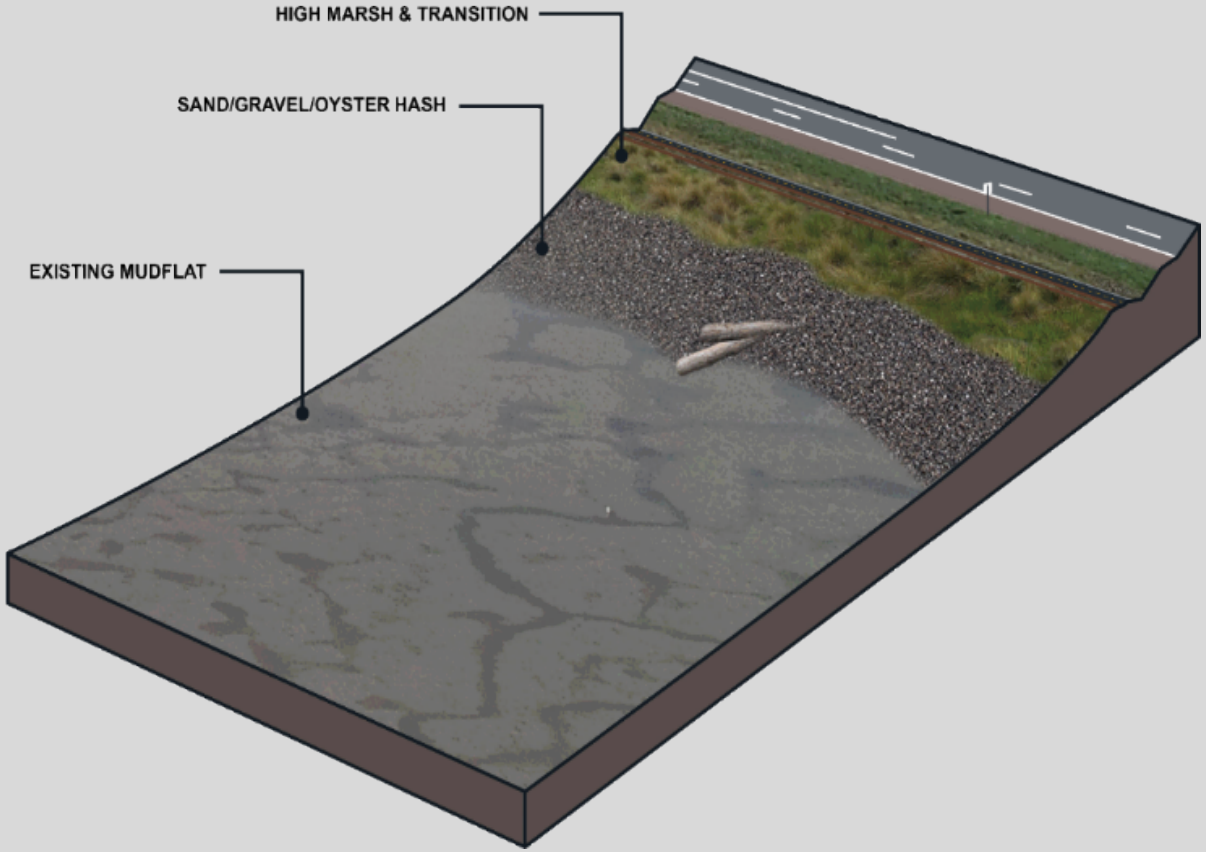
Preliminary Design - Alternatives

Barrier Island Breakwater with Passive and Active Salt Marsh



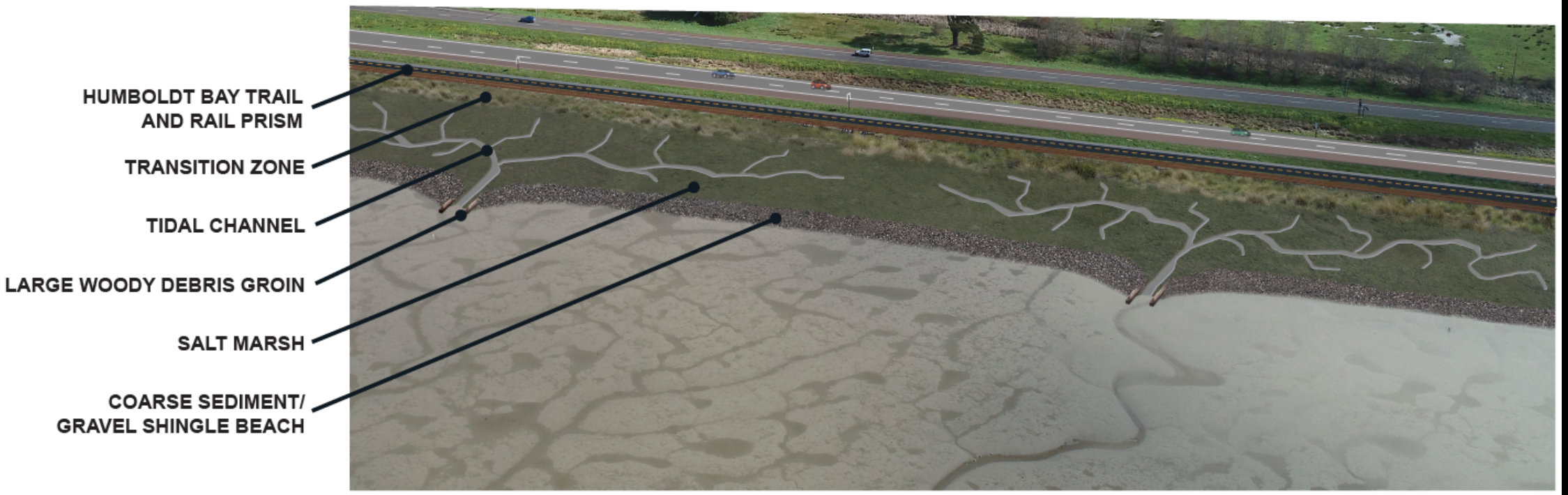
Preliminary Design - Alternatives

Coarse Sediment Shore (sand/gravel/oyster hash)



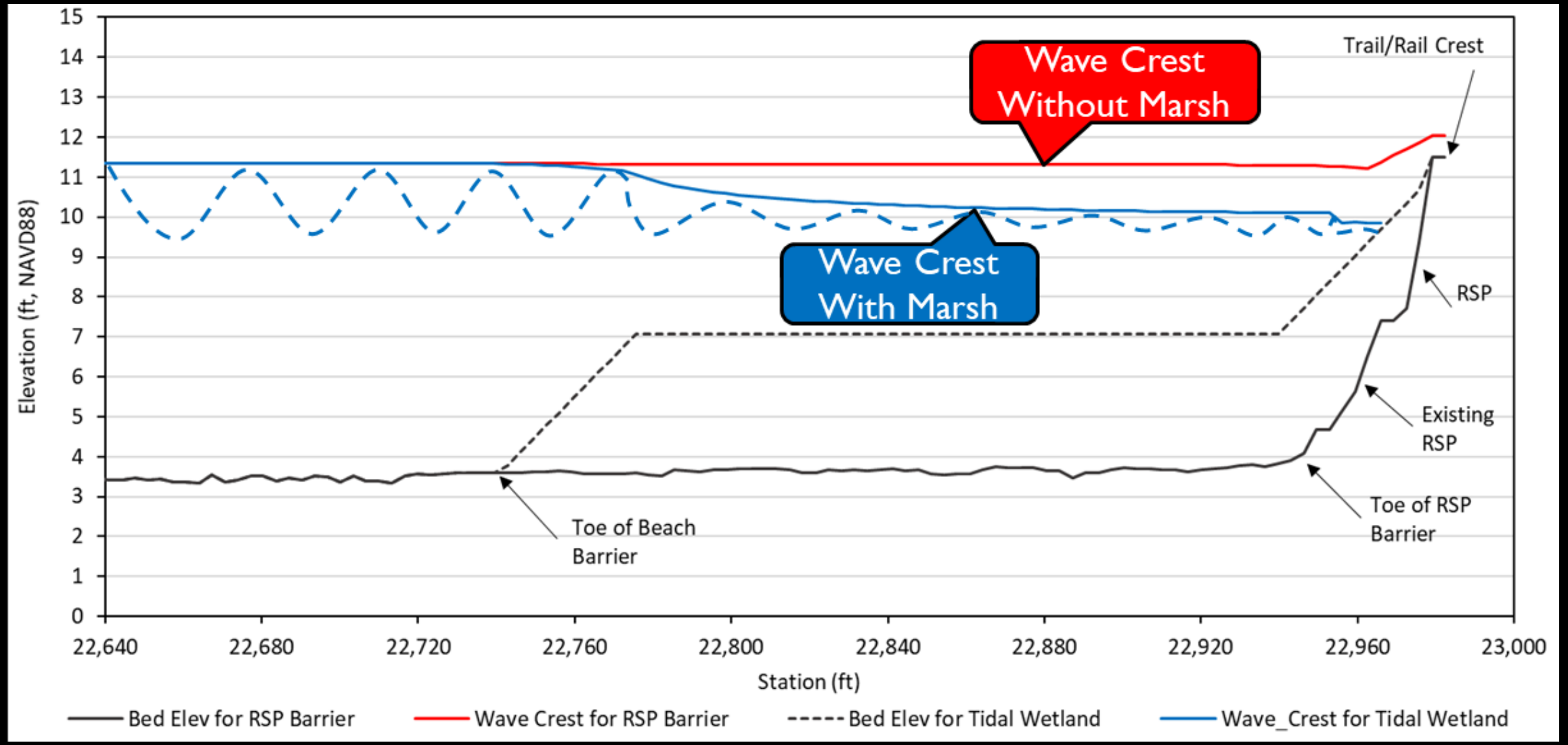
Preliminary Design - Alternatives

Selected Concept Design



Preliminary Design - Benefits

Flood & Erosion– Wave Reduction



Preliminary Design - Benefits

- Increased habitat diversification
- Improved carbon sequestration
- Enhanced water quality through nutrient removal

Preliminary Design – Phase 1

Preliminary Design – Phase 1

* Thank You

> Brett.Vivyan@ghd.com