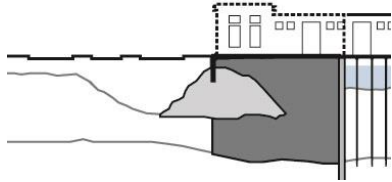


# Nearshore Buttress

## Seismic Adaptation Measure



### SHORELINE STABILIZATION



**TYPE:** Geotechnical

### SHORELINE LOCATION:



Nearshore



Example of sheet pile and filling operations @Jacobs

#### DESIGN LIFE

100+ years

#### ADAPTABILITY

Very High

#### IMPACT ON THE WATERFRONT

Major Waterside Intervention

#### CONSTRUCTION COST

Very High

#### SEISMIC HAZARDS MITIGATED:

Lateral Spreading



Liquefaction



#### SEISMIC PERFORMANCE IMPROVED:

Structures



Utilities and Transportation



#### MEASURES COMPATIBILITY:

Flood

Floodwalls | Levees |  
Seawalls

Seismic

Liquefaction Mitigation | Utility Retrofit

### DESCRIPTION:

Replace existing pile-supported bulkhead wharves with an improved soil buttress and bayward seawall to stabilize the shoreline and reduce lateral ground displacements that would otherwise damage the Embarcadero, the promenade, the light rail, utilities, and waterfront structures.

#### CONSIDERATIONS:

- Minimum width of buttress defined by depth of Young Bay Mud which varies along the waterfront.
- Very Effective in areas of deep Young Bay Mud.
- Specialized marine construction equipment and contractors.

#### ADVANTAGES:

- Minimizes construction impact to the Embarcadero and utilities.
- Replaces deteriorated and seismically vulnerable bulkhead wall & wharf structures.
- Provides earthquake stable and settlement resistant foundation for future sea level rise protection and room for grade changes.

#### DISADVANTAGES:

- Temporary building relocations.
- Major impacts to Pier tenants
- Long construction duration.
- Creates new Bay Fill
- Demolishes historic bulkhead & wharves and change from.
- Does not mitigate Embarcadero liquefaction.

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### CONSTRUCTION IMPACTS TO THE PUBLIC:

- Construction would require vacating and temporary relocation of waterfront building when the work occurs at an occupied pier.
- Impacts would be most noticeable to the occupants of the affected pier.
- Most construction work would be done from the water-side of the seawall.
- Impacts to users of the promenade and the Embarcadero would be limited.

### SEA LEVEL RISE ADAPTATION OPPORTUNITIES:

- The new engineered land could serve as a foundation for a future levee to protect the Embarcadero and the City from sea level rise
- The new land provides more room to physically adapt to the higher flood protection elevations needed long term.
- Also, the new land would provide an inherent barrier to limit the influence of rising sea levels on groundwater elevations.

### DESIGN CONSIDERATIONS:

- The width of added land necessary to effectively buttress the existing seawall would depend upon the depth from the ground surface to the competent soil layers below. As this depth varies along the waterfront, the width of the added shoreline would vary.

### SITE-SPECIFIC CONSIDERATIONS:

- Special procedures would be required in the Fisherman’s Wharf area since contaminated soils below the water surface would be disturbed by construction operations.
- Extension of existing outfalls through the added land would be required in some locations

### URBAN DESIGN CONSIDERATIONS:

- The added shoreline could provide additional open spaces on the waterfront for users of the Embarcadero and promenade.
- The added shoreline would separate the promenade from the waters edge.

### HISTORICAL RESOURCE CONSIDERATIONS:

- Demolition of historic bulkhead wharves and portion of piers is required, loss of resources.
- Configuration of waterfront form from a pile supported bulkhead wharf to vertical wall, with bulkhead buildings now on land.
- Historic pier-supported buildings would need to be removed temporarily during construction and replaced once the work is complete.

### INSTALLATION AND CONSTRUCTABILITY CONSIDERATIONS:

- Mixing of the soil below the water surface with cement to strengthen it would require controls to protect water quality.
- Soil mixing would be accomplished by barge-supported equipment.
- Existing piles would need to be removed to ensure proper mixing of the soil with cement.
- Timber piles could be salvaged and repurposed.
- Construction sequence to prevent settlement of adjacent land is very important.
- In-water work requires measures to protect water quality.