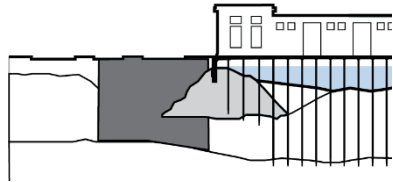


Landside Buttress

Seismic Adaptation Measure



SHORELINE STABILIZATION



TYPE: Geotechnical

SHORELINE LOCATION:



Landside



A landside buttress to stabilize the shoreline would be accomplished by deep mixing of in situ soils with cement as shown here - San Francisco, CA © Fugro

DESIGN LIFE

100+ years

ADAPTABILITY

Medium

IMPACT ON THE WATERFRONT

Major Landside Intervention

CONSTRUCTION COST

Very High

SEISMIC HAZARDS MITIGATED:

Lateral Spreading



Liquefaction



SEISMIC PERFORMANCE IMPROVED:

Structures



Utilities and Transportation



MEASURES COMPATIBILITY:

Flood

Floodwalls | Levees (Raised Roadway)

Seismic

Bulkhead Wharf Retrofit | Utility Replacements

DESCRIPTION:

Strengthen a deep block of weak soil landside of the existing bulkhead to stabilize the shoreline, reduce earthquake induced lateral spreading, and eliminate liquefaction of Embarcadero fill resulting in a stable and earthquake resilient foundation. The improved soils would also mitigate liquefaction-induced settlements within its footprint.

CONSIDERATIONS:

- Width of buttress defined by depth of Young Bay Mud which varies along the waterfront.
- Very effective in areas of deep Young Bay Mud.

ADVANTAGES:

- Mitigates both lateral spreading and liquefaction-induced settlement.
- Provides stable zone to raise the roadway or build flood protection.
- Waterfront buildings can likely remain occupied during construction.
- No in-water work.

DISADVANTAGES:

- Most construction impact to the Embarcadero.
- Requires full replacement of surface infrastructure & utilities.
- Long construction duration
- Aging Bulkhead wall and wharves still need rehabilitation and some earthquake strengthening.

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CONSTRUCTION IMPACTS TO THE PUBLIC:

- Construction would require lengthy closure of northbound Embarcadero and Promenade.
- Southbound Embarcadero may be changed to one lane in each direction.
- MUNI light rail may need to be closed to provide traffic/bike/pedestrian circulation space.

SEA LEVEL RISE ADAPTATION OPPORTUNITIES:

- The new engineered land could serve as a foundation for a future levee in the form of a raised roadway to protect the City from sea level rise.
- 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 improved soil 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 improved soil would vary.

SITE-SPECIFIC CONSIDERATIONS:

- Areas with a high concentration of utilities and/or large sewer structures would interrupt the buttress and may compromise its effectiveness.
- The width of improved soil between Pier 3 and Pier 19 would likely be controlled by the location of the transport storage box.

URBAN DESIGN CONSIDERATIONS:

- Construction work to demolish surface infrastructure and to relocate utilities may provide an opportunity to rebuild the Embarcadero and promenade following a new design.

HISTORICAL RESOURCE CONSIDERATIONS:

- This measure would not impact any historic buildings and marine structures.

INSTALLATION AND CONSTRUCTABILITY CONSIDERATIONS:

- This measure would require extensive utility relocation work and demolition and restoration of northbound Embarcadero and promenade.
- More than one ground improvement technique may be required due to the rock dike versus fill. Large construction footprint would be required.