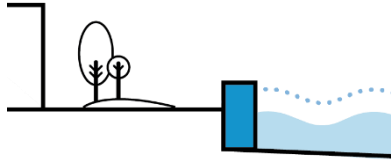


# New Seawall In-Place

## Flood Adaptation Measure



### PHYSICAL INFRASTRUCTURE



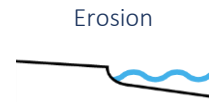
### SHORELINE LOCATION:



Artist Impression of proposed Embarcadero improvements © CMG

|                                  |                            |   |                                 |
|----------------------------------|----------------------------|---|---------------------------------|
| <b>DESIGN LIFE</b><br>100+ years | <b>ADAPTABILITY</b><br>Low | <b>IMPACT ON THE WATERFRONT</b><br>Major Intervention | <b>CONSTRUCTION COST</b><br>TBD |
|----------------------------------|----------------------------|---|---------------------------------|

### COASTAL FLOOD HAZARDS MITIGATED:



|                                      |                                      |  |                            |                      |                       |
|--------------------------------------|--------------------------------------|--|----------------------------|----------------------|-----------------------|
| <b>MEASURES COMPATIBILITY:</b>       |                                      | <b>ECOSYSTEM SERVICES:</b> Measure may affect these shoreline values |                            |                      |                       |
| Flood                                | Seismic                              | —  | —                          | —                    | —                     |
| Tidal Gates, Elevated Wharf and Pier | Drilled Shafts, Super Bulkhead Wharf | <b>Aquatic Habitat</b>   | <b>Terrestrial Habitat</b> | <b>Water Quality</b> | <b>Carbon Storage</b> |
|                                      |                                      | —  | —                          | —                    | —                     |

### DESCRIPTION:

The existing historic bulkhead wall along the shoreline can be rebuilt to a higher elevation to provide flood protection for assets landside of the its locations. This would be similar to a levee or berm, but uses the foundations of the existing seawall. The new seawall could be constructed in numerous ways, such as a steel sheet piles with a concrete cap, a concrete "t-wall" supported on piles, and other means, each with their own unique costs and construction methods.

### CONSIDERATIONS:

- Requires coordination with existing structures and uses along shoreline.

### ADVANTAGES:

- Minimal bay fill, which should improve ability to permit this measure.
- Has some seismic co-benefit.

### DISADVANTAGES:

- Highly disruptive to Promenade users, and some Port bulkhead or shed tenants.
- Difficult constructability through the existing rock dike.

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- Long design life, with robust foundation expected to last many years.
- Passive flood protection solution, so no operational cost to deploy.

### CONSTRUCTION IMPACTS TO THE PUBLIC:

- Will have significant construction impact along the promenade and at bulkhead buildings.
- Based on similar experience in Seattle, the bulkhead and promenade within given project limits (say 1000LF) would be shut down on the order of 1 to 2 years (perhaps intermittently allowed to reopen).

### SEA LEVEL RISE ADAPTATION OPPORTUNITIES:

- Adaptation of seawalls is possible, though it is costly and disruptive.
- Increased foundation capacity can be constructed to accommodate future sea levels.
- Measures such as elevated wharves, elevated pathways, and floodwalls could provide additional sea level rise protection.

### CASE STUDIES:

- Thames River, London, UK

### DESIGN OPPORTUNITIES:

#### Ecological Enhancements

- Ecological concrete structures can be applied to the waterside face of the new seawall to provide habitat.

#### Urban Design

- Improvements to the public realm of the shoreline can be integrated into the new shoreline design.

#### Form

- New shoreline will be similar to existing shoreline, but raised up.

### DESIGN CONSIDERATIONS:

- When building the new seawall, the old bulkhead wall would need to be removed or encapsulated behind the new wall.
- Being in a relatively high seismic hazard alignment along the waterfront, any new wall would need to accommodate potential ground movement during a seismic event, consistent with USACE seismic standards.

### SITE-SPECIFIC CONSIDERATIONS:

- Existing wharves and bulkhead buildings create a challenge where the seawall bulkhead lies below them.
- Wastewater outfall locations will add challenges but not impossible to work around.

### URBAN DESIGN CONSIDERATIONS:

- The rebuilding of the wall, provides some opportunity for urban design improvements with the same footprint put back in place.

### INSTALLATION AND CONSTRUCTABILITY CONSIDERATIONS:

- Driving or drilling foundation elements through the existing rock dike will be a challenge, adding expense and time to the project.
- Will have significant construction impact along the promenade and at bulkhead buildings.

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- Based on similar experience in Seattle, the bulkhead and promenade within given project limits (say 1000LF) would be shut down on the order of 1 to 2 years (perhaps intermittently allowed to reopen).

### ARCHITECTURAL CONSIDERATIONS:

- ADA transitions and access across the elevated stretch of wall/berm would require good urban design and accessibility layout.

### HISTORICAL RESOURCE CONSIDERATIONS:

- Performing this work at or near bulkhead buildings will require significant consultation. In some locations this could be done without impacting the building (i.e. where building and shed are set 10+ feet back from the existing wall), while other places the building straddles the wall and would need to be dismantled, stored and re-assembled when the project is complete.
- The seawall bulkhead wall is a contributing resource to the Embarcadero Historic District.

### OPERATION AND MAINTENANCE CONSIDERATIONS:

- This solution is expected to have lower operations and maintenance costs than others.