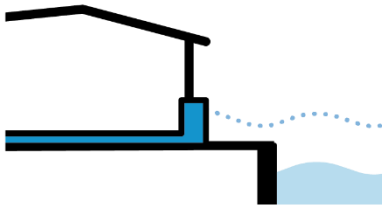
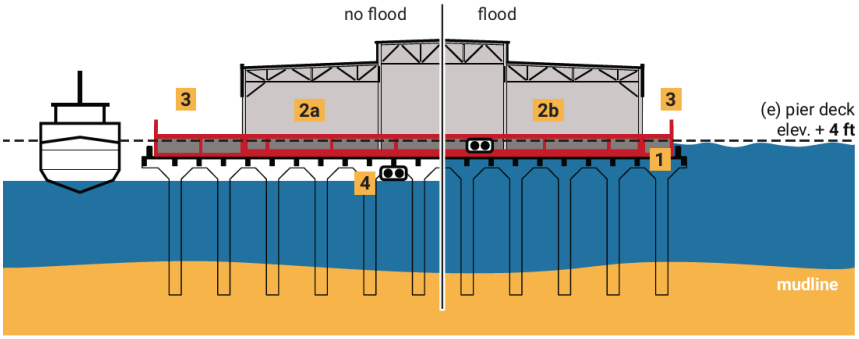
Measure Profile

# Structure Elevation

## Flood Adaptation Measure

### PHYSICAL INFRASTRUCTURE

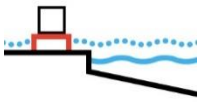





*Building interior elevation scheme on pier shed and apron.*
*©Port of San Francisco*

1. Protect and dry floodproof exterior walls and surfaces below flood elevation.
2. Elevate pier shed interior floor. Crawlspace to be infilled with lightweight material. Note reduced interior clearance.
3. Provide berthing capacity, and pedestrian access and egress (SFBC, life-safety and ADA requirements) via new raised apron.
4. Protect in place or relocate utilities.

### SHORELINE LOCATION:



Asset Specific

| DESIGN LIFE | ADAPTABILITY | IMPACT ON THE WATERFRONT | CONSTRUCTION COST |
|---|---|---|---|
| N/A | Low | Living with Water | TBD |

### COASTAL FLOOD HAZARDS MITIGATED:

Sea Level Rise

Storm Surge

Groundwater

Waves

Erosion

### MEASURES COMPATIBILITY:

| Flood | Seismic |
|---|---|
| All | All |

### ECOSYSTEM SERVICES: Measure may affect these shoreline values

Aquatic Habitat — Terrestrial Habitat — Water Quality — Carbon Storage

### DESCRIPTION:

For new construction, elevating structures can be achieved by elevating the entire site (i.e., via fill) or elevating the structure on piles above a design flood elevation to lift future development and transportation assets out of the flood zone. For existing structures, elevation may entail extending the walls upward and raising the lowest floor; converting the existing lower area into non-habitable space; or lifting the entire building, with the slab attached, and building a new elevated foundation.

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### CONSIDERATIONS:

- Elevating puts the onus for protection on individual property owners, which could be cost prohibitive and leave renters at risk if the building owner does not implement the strategy.

### ADVANTAGES:

- Elevating the height of land for new buildings or other uses can flood-proof a site for a designed flood elevation, plus a margin of safety (also known as freeboard).
- Site elevaton can ready low-lying, underutilized areas for new development and new uses in places that would otherwise be flood-prone.
- It might also bring noncompliant structures (once they are replaced or rebuilt at a higher grade) into compliance with the National Flood Insurance Program.

### DISADVANTAGES:

- Site elevation is hard to modify over time and, like super levees, would require a significant amount of clean dirt or fill.
- Some areas would not be practical to elevate, or are so densely developed and used that the structures cannot be modified for a raised grade.
- Land elevation is not a flexible strategy and may only work over the short-term, depending on how fast sea levels rise and how much the land is elevated.

### CONSTRUCTION IMPACTS TO THE PUBLIC:

- Site-specific construction closures would be required.

### SEA LEVEL RISE ADAPTATION OPPORTUNITIES:

- Wet proofing could provide additional flood protection.
- Limited adaptability after initial construction.

### CASE STUDIES:

- Arverne-by the-Sea, a neighborhood in the Rockaways in Queens, New York, where the entire 120 acre site was raised 8 ft with new fill to enable the construction of 2,000 new townhomes more resilient to sea level rise and hurricane-related storm surge.

### DESIGN OPPORTUNITIES:

#### Ecological Enhancements

- Could be supplemented with ecological marine structures.

#### Urban Design

- Opportunity to integrate with adjacent shoreline elevation changes.

#### Form

- TBD

### DESIGN CONSIDERATIONS:

- Raising elevations in a patchwork pattern may make it hard to maintain connectivity of transportation and drainage networks in existing urbanized areas.
- Open foundations are less preferable e when active uses at grade are desired, such as along a retail corridor; however, the addition of at-grade parking below the structure may be beneficial in some locations.
- Innovative ideas for the use of the space below the design flood elevations, such as pop-up retail, in order to maintain active, safe, and engaging ground floor uses, should be explored.

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### SITE-SPECIFIC CONSIDERATIONS:

- Placement of large quantities of fill can lead to compaction and subsidence as well as disturbance to adjacent unfilled areas, especially on baylands soils.
- Small sites may not have enough space to grade up to higher design flood elevations, and large sites may require a substantial amount of fill, which increases costs. Accordingly, this strategy is most likely to be cost-effective for large lots with low design flood elevations or sites with some existing topography. For small, infill sites, the elevation of the lowest occupiable floor with a wet floodproofed crawlspace is probably more feasible than elevation on fill.
- When elevating on piles, uses below the design flood elevation are limited to minor storage, parking, and building access.

### URBAN DESIGN CONSIDERATIONS:

- Accessibility from the street and sidewalk is a challenge which may result in additional costs to provide for ADA access and may pose urban design issues. The extent of necessary ramping increases as the height of the design flood elevation increases.
- When a site is large enough to move the building back from the street, elevation on fill allows room for landscaping which can create a gradual transition in grade changes, provide a usable open space, and mitigate the impact of a raised ground floor on the streetscape.

### INSTALLATION AND CONSTRUCTABILITY CONSIDERATIONS:

- Construction would cause significant disruption to existing land uses, and likely require their temporary or permanent relocation.
- Any construction that modifies land near the shoreline, including its elevation, requires a permit from the Water Board. Permits could also be required from BCDC, USACE, and state and federal wildlife managers. Construction would likely trigger CEQA and an environmental impact study. New land uses would be designated and regulated under zoning, subdivision, and other development regulations.
- Elevating sites more than three feet is not recommended, as it may channelize flood waters and could exacerbate flooding of adjacent sites. • Structural fill is not allowed in V zones by FEMA standards due to the potential for scour in the event of a storm, but elevation on piles is permitted.
- Pile-driving requires specialized machinery that is expensive. It may also be more difficult in areas with extensive subgrade infrastructure networks or soil conditions. Site access for piling equipment may pose challenges for small sites and narrow streets with limited accessibility for the necessary machinery. In addition, pile-driving must consider the potential for vibration and damage to adjacent structures.

### HISTORICAL RESOURCE CONSIDERATIONS:

- Elevating historic structures to protect them from flooding is being embraced by more communities around the country; however, special consideration of how to maintain the architectural qualities of the structure/neighborhood is essential.
- Additionally, the modifications should be consistent throughout a neighborhood. New Jersey has example Design Guidelines for elevating historic homes.