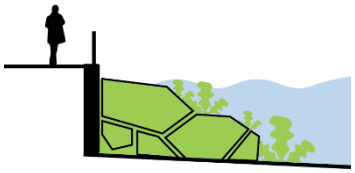
Measure Profile

Stepped Slopes

Flood Adaptation Measure

ECOLOGICAL INFRASTRUCTURE



WATER LEVEL RANGE:

Intertidal to supratidal

SHORELINE LOCATION:

Shoreline

Avila Beach, California ©RRM Design Group

DESIGN LIFE	ADAPTABILITY	IMPACT ON THE WATERFRONT	CONSTRUCTION COST
Decades	Medium	Major Intervention	TBD

COASTAL FLOOD HAZARDS MITIGATED:

Enhancements can provide flood protection when combined with other physical infrastructure

Sea Level Rise	Storm Surge	Groundwater	Waves	Erosion
				

MEASURES COMPATIBILITY:

Flood	Seismic
Seawalls, Beaches	All

ECOSYSTEM SERVICES: Measure may affect these shoreline values

Aquatic Habitat	Terrestrial Habitat	Water Quality	Carbon Storage
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DESCRIPTION:

Stepped slopes can offer a visually attractive alternative to more traditional types of revetments. Constructed at the water edge, they can provide public access to the water and backshore erosion protection. Steps act as large roughness elements and, depending on design, can be comparable to or better than traditional rip-rap for reducing wave runup and overtopping. Compared to rip-rap revetments, stepped slopes are more expensive and can be prone to damage due to differential settlement and erosion of the toe.

CONSIDERATIONS:

- Should be designed to account for future anticipated sea level rise.
- Waves can scour and erode toe if not properly buried. Best

ADVANTAGES:

- Provides public access to the water
- Aesthetically attractive
- Steps act as large roughness elements which may reduce

DISADVANTAGES:

- High cost
- Susceptible to damage due to differential settlement
- Reduced habitat value
- Because maintenance is required to remove marine growth in

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performance and longevity in low wave energy environments. • Consideration should be given to geotechnical, seismic, wave, and water level conditions.	flooding due to wave overtopping • Flexible design can accommodate a wide variety of step shapes and elevations	intertidal steps, preferable at small tide range and low wave activity locations • Limited adaptability to higher than design water levels

CONSTRUCTION IMPACTS TO THE PUBLIC:

- Landside access necessary. Access to the shoreline will be constricted due to construction, and may impact parts of the Promenade.

SEA LEVEL RISE ADAPTATION OPPORTUNITIES:

- Functional within a wide range of water levels, but once built limited adaptability to water level higher than design.

CASE STUDIES:

- None cited

DESIGN OPPORTUNITIES:

Ecological Enhancements

- Opportunity to encourage habitat growth using ecological concrete where public access is restricted. Vegetation and terrestrial habitat can be incorporated in planters.

Urban Design

- Given sufficient safety precautions, stepped slopes can be incorporated into other flood mitigation measures at the shoreline to enhance public access to the bay

Form

- Design is flexible and can accommodate a wide variety of step shapes and elevations, plus other amenities like benches, planters, etc.

DESIGN CONSIDERATIONS:

- Requires a good foundation to prevent damage due to differential settlement.
- Toe should be sufficiently buried and/or otherwise protected to prevent erosion of fill due to wave scour.

HISTORICAL RESOURCE CONSIDERATIONS:

- Should not obstruct access or views to historic structures and be compatible with the character of the structure.

SITE-SPECIFIC CONSIDERATIONS:

- Waves, water levels, geotechnical, seismic and propeller wash conditions.

URBAN DESIGN CONSIDERATIONS:

- Will attract users close to the water's edge. Hazardous activities need to be prevented.
- For areas with beach access, can provide areas for people to sit or place belongings out of the sand.

INSTALLATION AND CONSTRUCTABILITY CONSIDERATIONS:

- Steps can be fabricated offsite or poured in place.
- Requires grading of existing soil.
- Fill should be well compacted.
- Requires a stable foundation to prevent failure due to differential settlement.

OPERATIONS AND MAINTENANCE CONSIDERATIONS:

- Operation needs are generally low and depend on public use. Maintenance required to remove marine growth in intertidal steps.