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CITY OF BOSTON PUBLIC WORKS DEPARTMENT

CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES

for protection of public rights-of-way

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FLOOD VULNERABILITIES – NOW & FUTURE



CONCEPTS FOR FLOOD PROTECTION



Source: Kleinfelder-Stoss-One-WHG

NEED FOR GUIDANCE



Take incremental action while planning long-term solutions



Manage projects with multiple jurisdictions and private owners



Maintain mobility and access, protect critical transportation

GUIDELINES GOALS

Climate Resilient Design Standards and Guidelines Goals:

Establish **resilience design guidelines** for discrete priority projects and for segmental adaptation projects to achieve **flood protection by 2070**, with the option to add an additional 2 ft. of protection in the future

Translate the Climate Ready Boston concepts into **feasible engineering and operational solutions** that focus on **protecting public right-of-way from flooding** due to tidal and storm surge events

Provide a menu of **sample flood protection options** with engineering **design considerations**, preliminary cost estimates, as well as **operations and maintenance guidance**

SAMPLE FLOOD BARRIERS



VEGETATED BERMS



HARBORWALK FLOOD BARRIER

RAISED ROADWAYS



TEMPORARY FLOOD BARRIERS



Note: All samples assumed a barrier height of 4 ft. for 2070 flood protection

CLIMATE RESILIENT FLOOD BARRIER DESIGN

CONCEPT FOR FLOOD BARRIER DESIGN

Design

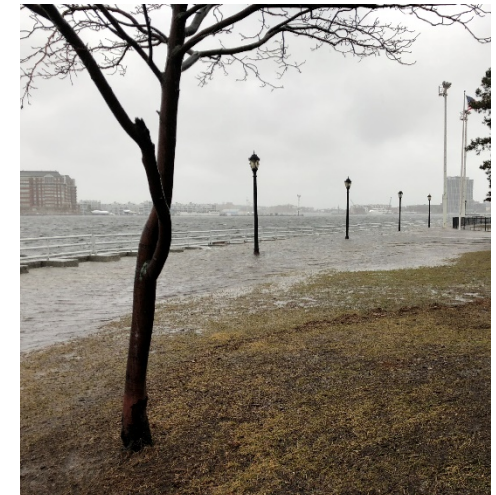
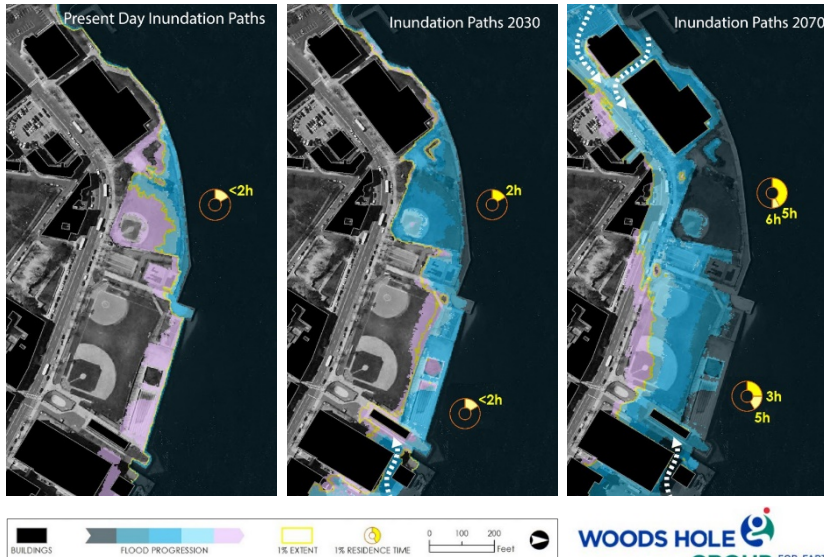
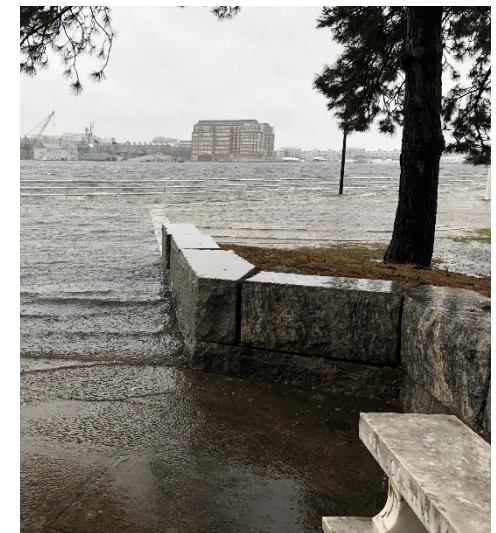
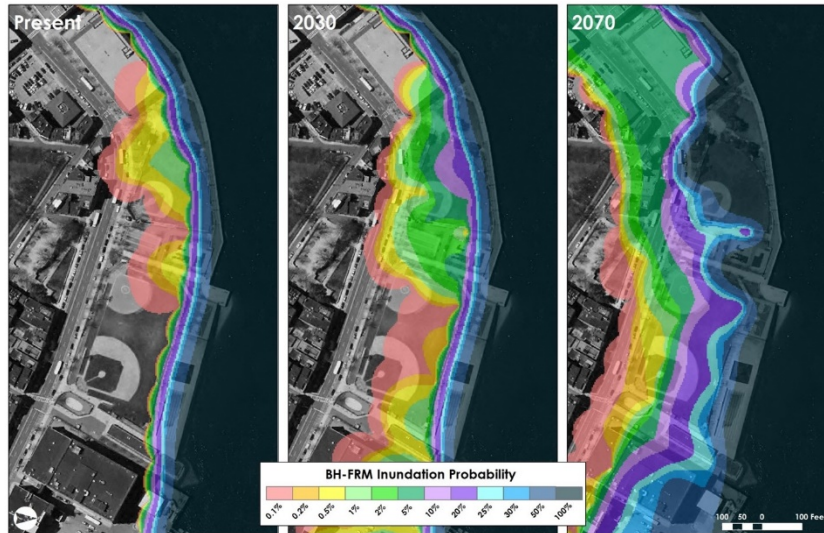
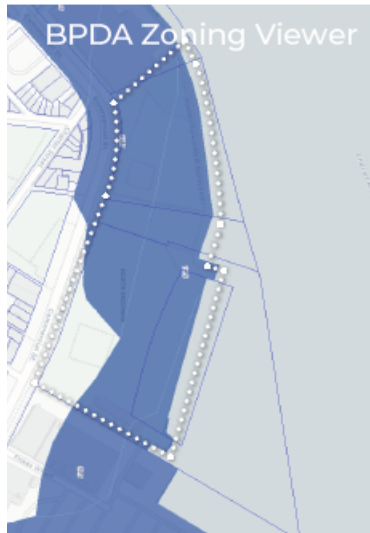
O&M

Cost

Barrier
Selection

- ▶ permitting strategy
- ▶ additional feasibility studies
- ▶ increase reliability
- ▶ incremental adaptation and timeline
- ▶ value creation, social impact, equity, & co-benefits

CLIMATE DESIGN ADJUSTMENTS



Flooding during the March 2, 2018 Nor'easter at Langone Park & Puopolo Playground



DESIGN CONSIDERATIONS

Climate Design
Adjustments and
Timeline

Site Specific and
Boundary
Constraints

Stormwater
Considerations

Geotechnical
Considerations

Structural
Considerations

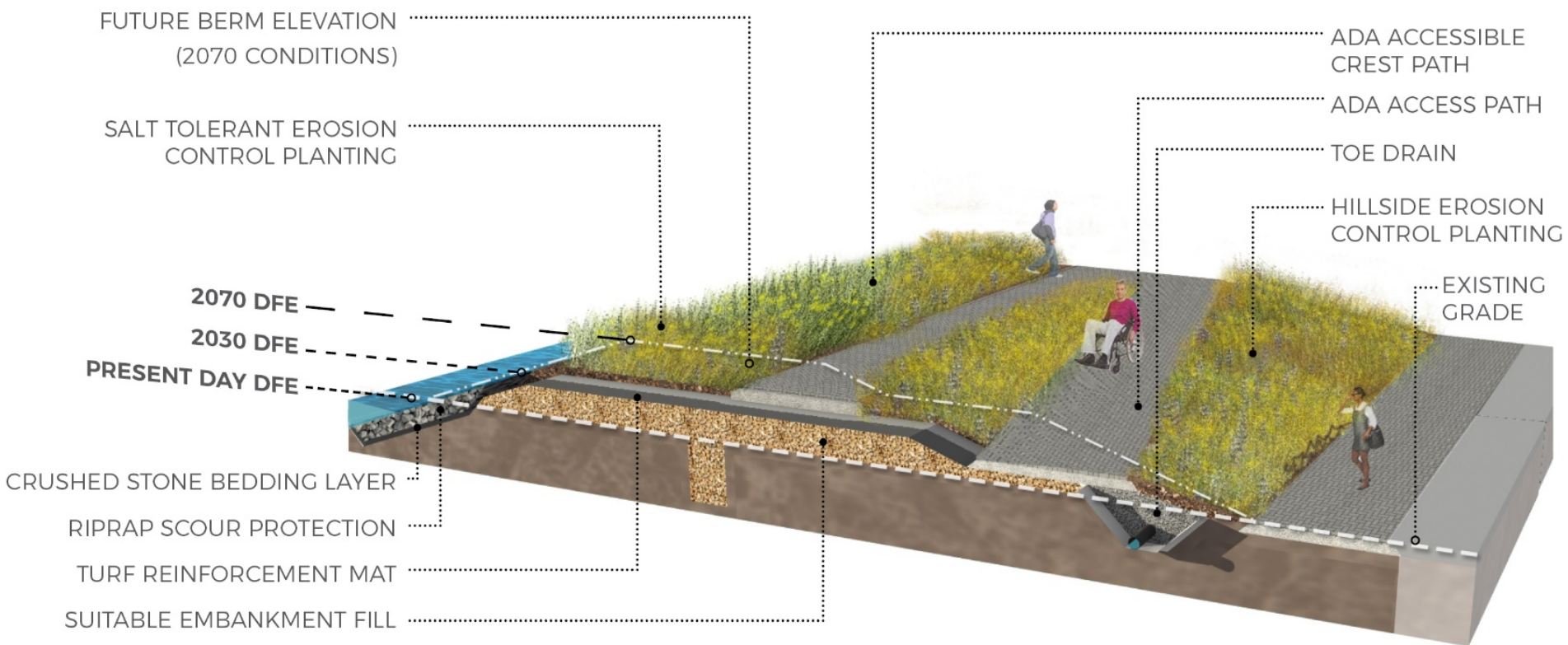
Utility
Considerations

Accessibility and
Transportation
Considerations

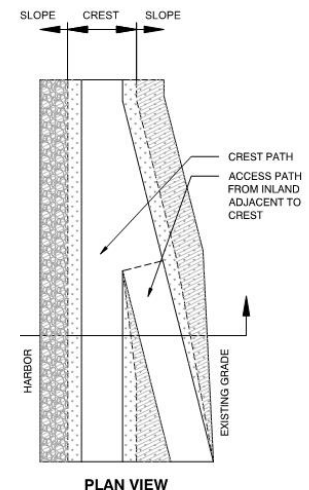
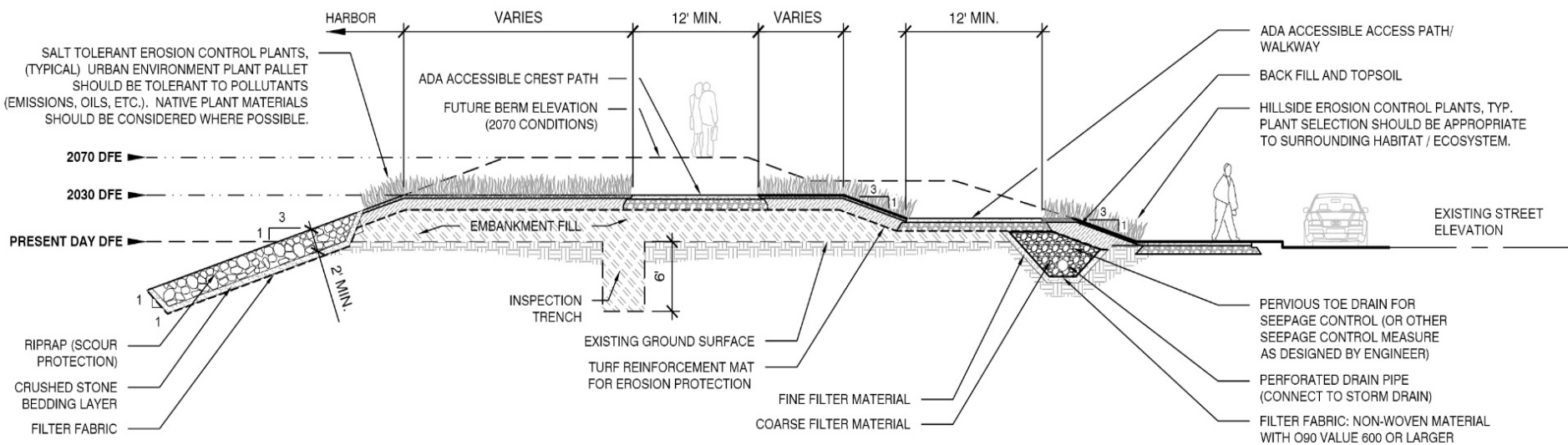
Groundwater
Considerations

Vegetative
Considerations

SAMPLE VEGETATED BERM BARRIER



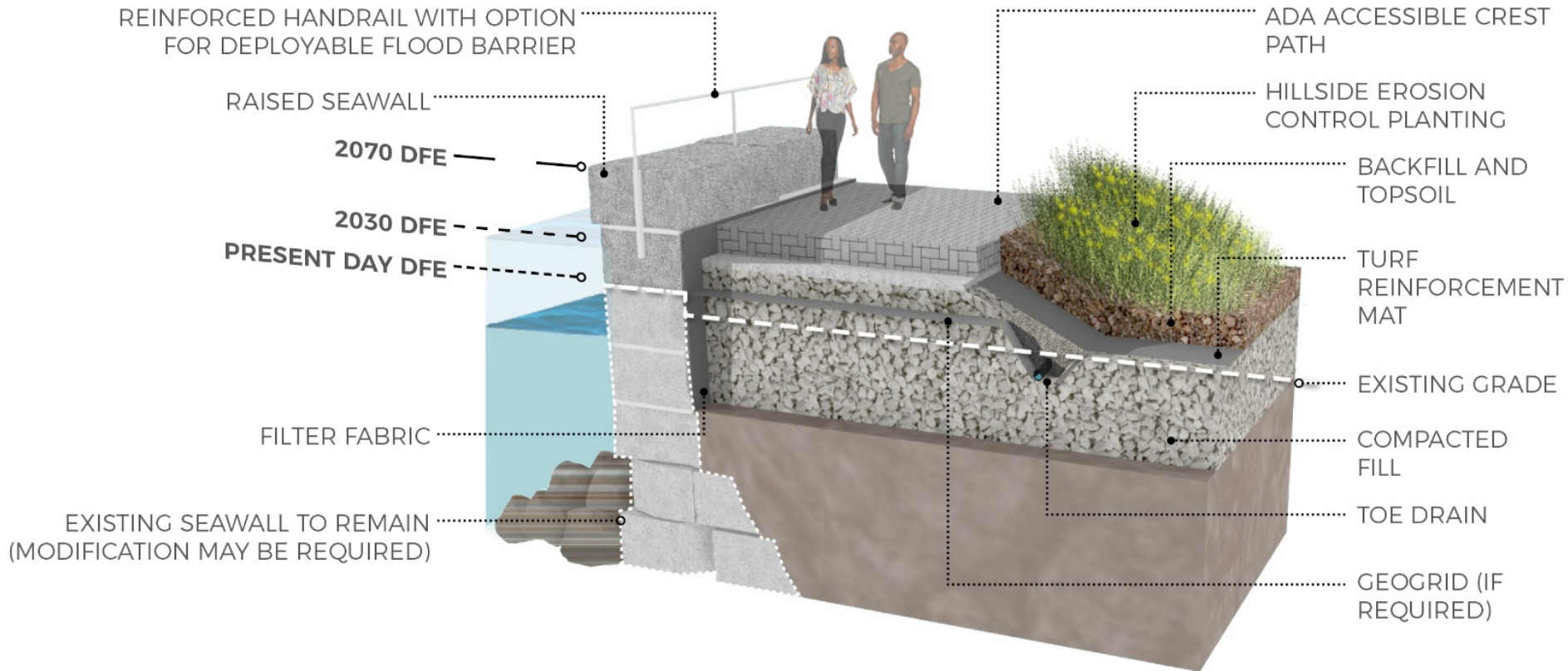
SAMPLE VEGETATED BERM BARRIER



CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

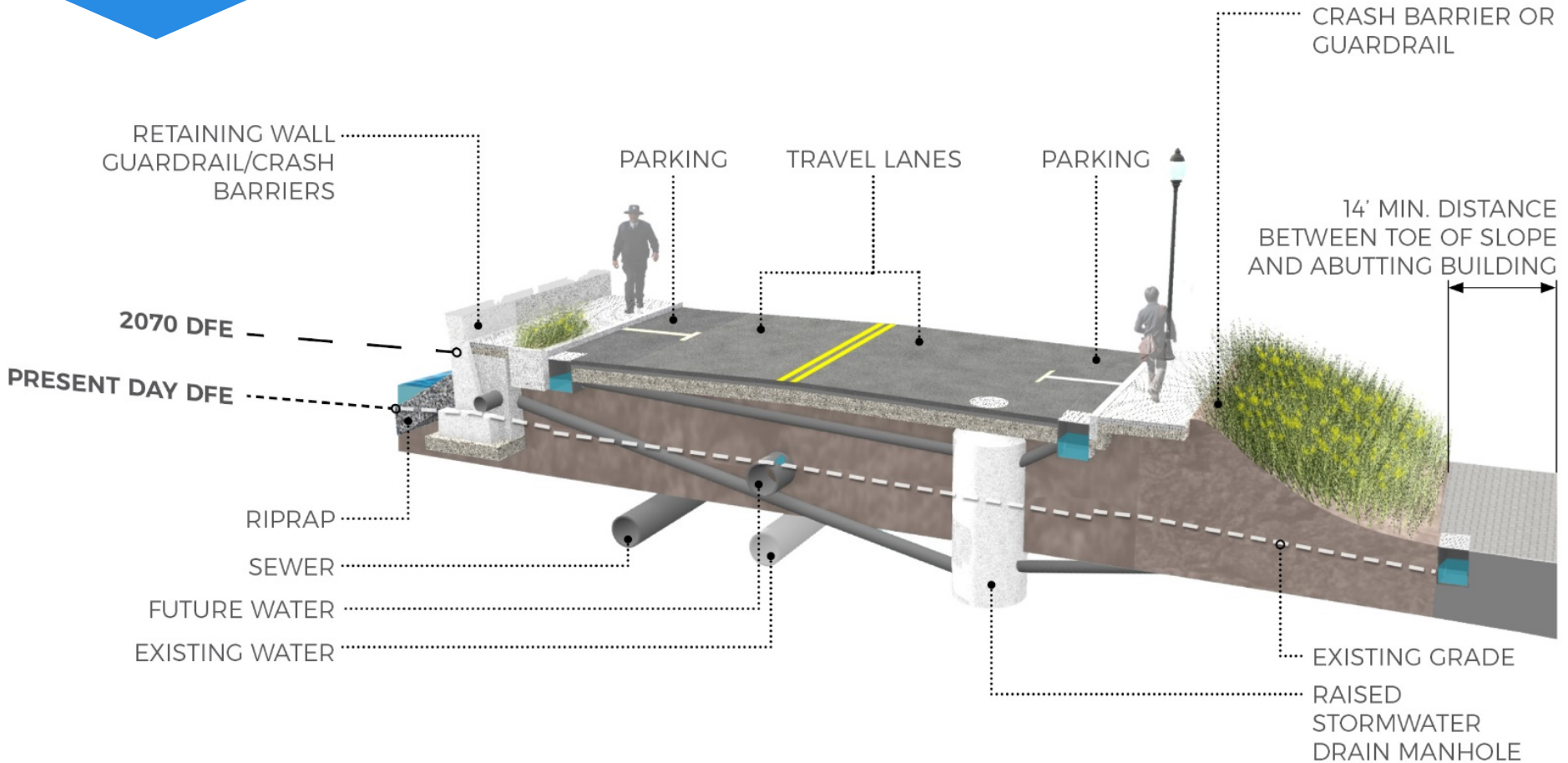
B.1 VEGETATED BERM BARRIER

SAMPLE HARBORWALK (SEAWALL) BARRIER



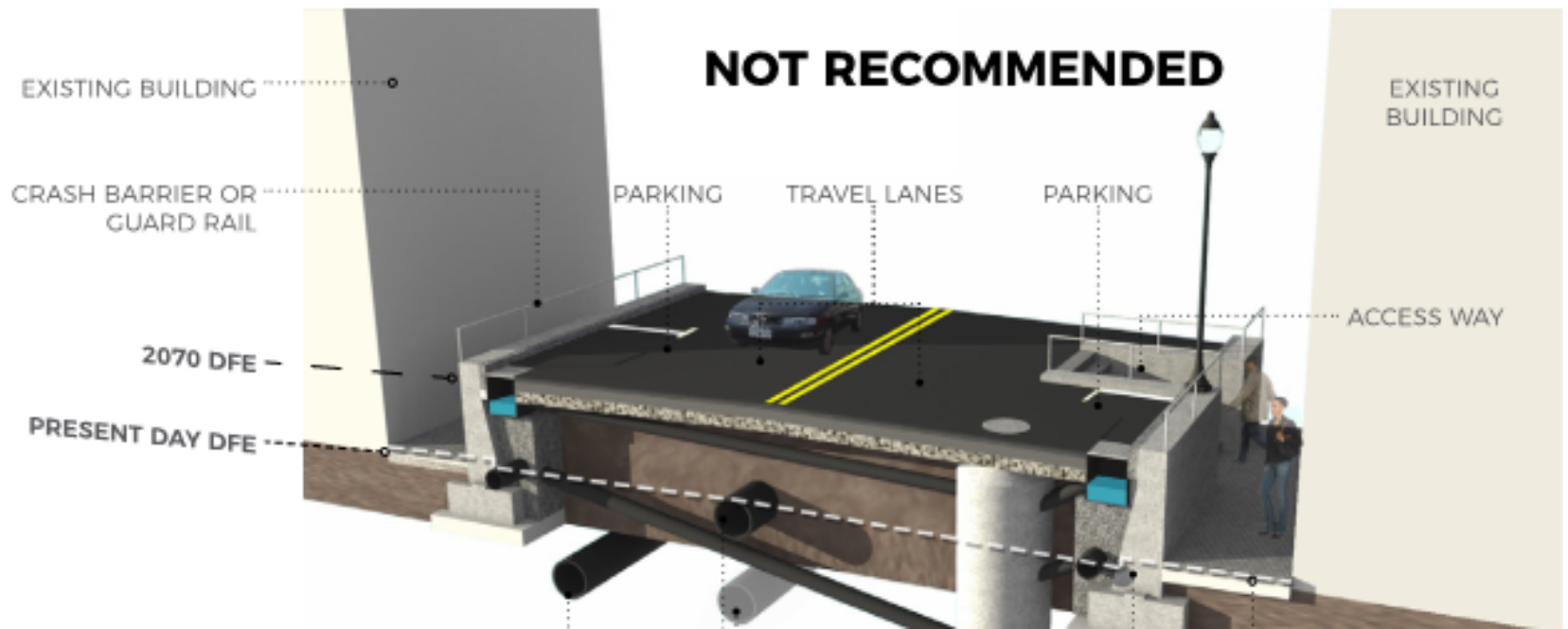
SAMPLE RAISED ROADWAY BARRIER

Option 1



Consider options to reduce to one-way traffic and add bike lanes, meet Complete Streets Standards

SAMPLE RAISED ROADWAY BARRIER

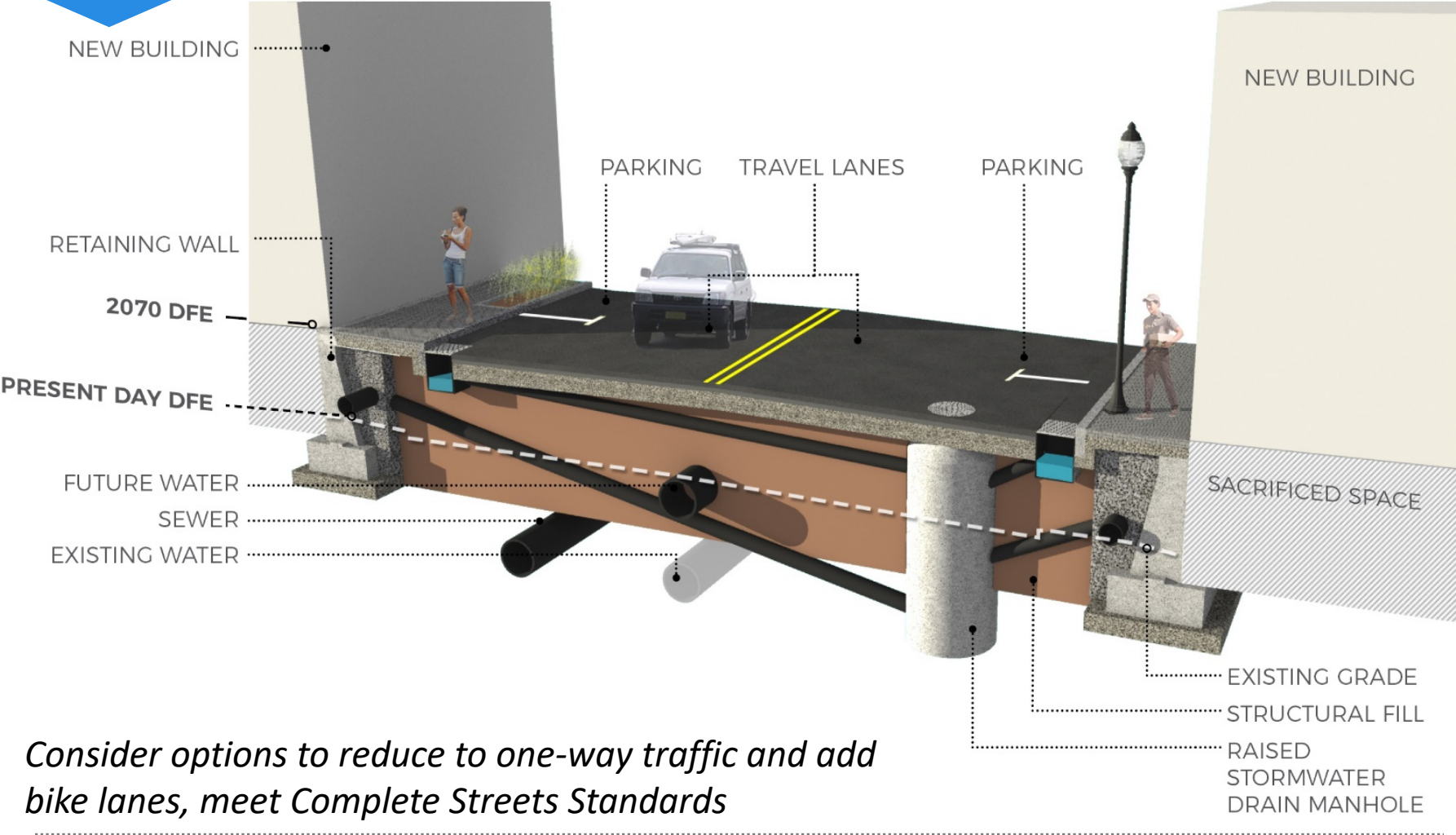


- ▶ Sidewalk gutters (debris, stormwater runoff)
- ▶ Snow removal problems
- ▶ Poor lighting and personal safety
- ▶ Accidents more deadly

- ▶ Vehicle emission pipes at head level of pedestrians (poor air quality)
- ▶ ADA compliance
- ▶ Emergency accessibility
- ▶ Business and community health

SAMPLE RAISED ROADWAY BARRIER

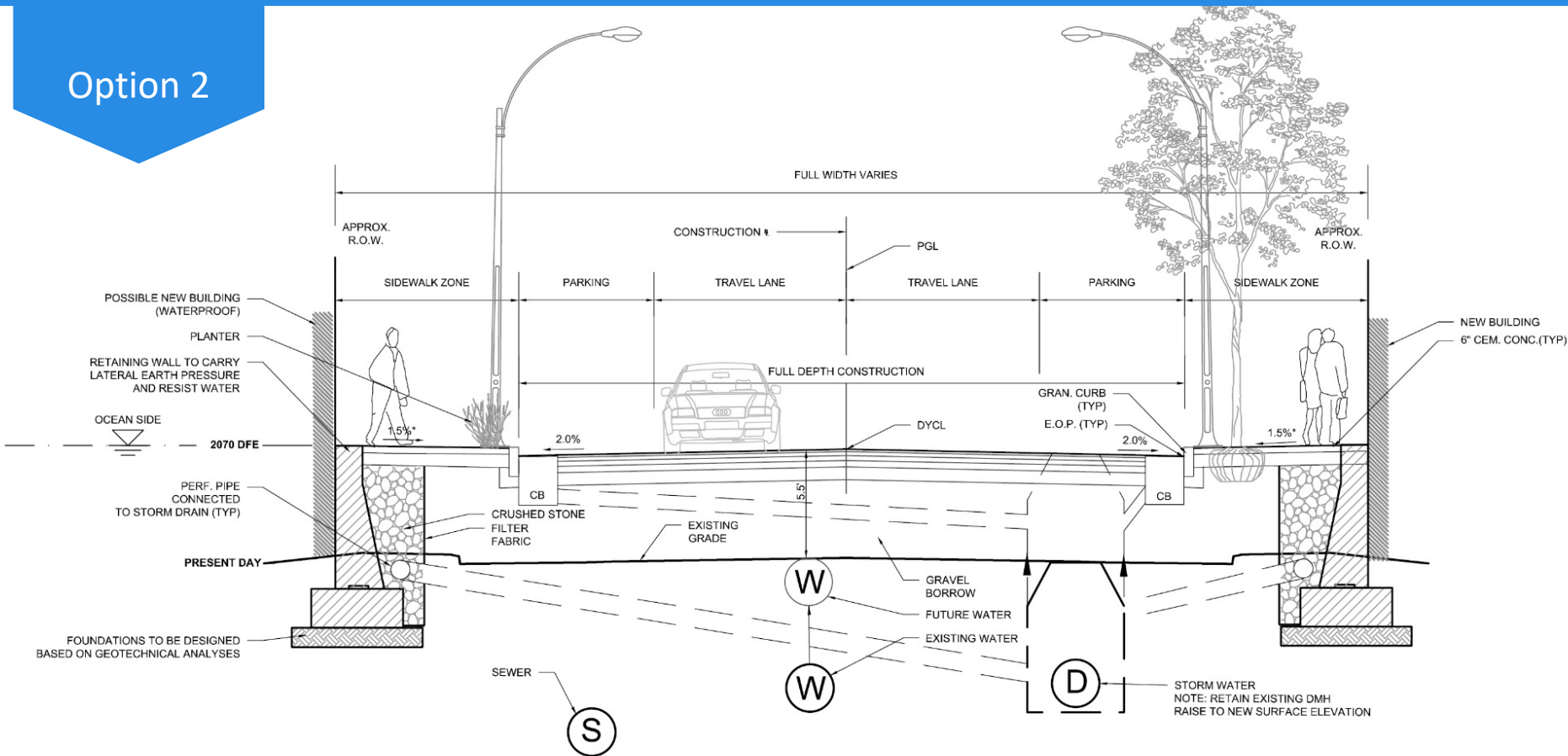
Option 2



Consider options to reduce to one-way traffic and add bike lanes, meet Complete Streets Standards

SAMPLE RAISED ROADWAY BARRIER

Option 2



SAMPLE SECTION

CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

B.4 RAISED ROADWAY - OPTION 2 RAISED ROADWAY & SIDEWALKS WITH NEW DEVELOPMENT

DEPLOYABLE FLOOD BARRIER

Design Considerations for the Site

- ▶ Barrier extent/connection to site
- ▶ Available open space (deployment or storage)
- ▶ Accessibility
- ▶ Terrain conditions
- ▶ Offsite impacts

Design Considerations for the Product

- ▶ Physical Characteristics
- ▶ Structural Properties
- ▶ Operational Requirements
- ▶ Industry Warranty, Certification, Testing

OPERATIONAL CAPACITY

PRIVATE PROPERTY PROTECTION & THE PUBLIC RIGHT OF WAY



DEPLOYABLE FLOOD BARRIER

Type	Product	PHYSICAL CHARACTERISTICS									
		Barrier Type	Product Dimensions		Adjustable/Height Can Increase During Service?	Mobility	Material Information		Pre-Installation Site Modification	Average Design Life	Cost
		Description	Height Range	Width Range	Yes/No	Wheels/Cart	Material Type	Resistant to Environmental and Chemical Exposure	(Slight/Moderate/Extensive) *Not including retrofitting existing structures	Number of Years/Uses	Up Front Cost
ENTER TYPE	ENTER PRODUCT FOR COMPARISON	Barrier type and description	As provided by product manufacturer	As provided by product manufacturer	Applicable if additional barrier modifications are available for increased protection height	Applicable if product is designed with wheels, or cart-compatible	As provided by product manufacturer	As provided by product manufacturer	As provided by product manufacturer	As provided by product manufacturer	Custom pricing may be available, as well as unit based costs
Modular Barriers											
Rigid/Panel	Aquaforce	Modular Barrier: Rigid panels that are placed together to form one cohesive barrier.	4 ft. to 9 ft.	Limitless (current longest stretch is 5100 ft.)	Potentially (Product available)	Yes	Marine grade laminate, stainless steel, aluminum, reinforced PVC canvas	Yes	Slight - Anchor installation for best performance (Varies by site)	50+ years	\$315/ft. - 4 ft. Height \$415/ft. - 5 ft. Height \$575/ft. - 6 ft. Height \$650/ft. - 7 ft. Height \$750/ft. - 8 ft. Height (Additional \$10/ft. for anchors)
Rigid/Panel	FB33 Adjustable Lift-Out Barrier	Modular Barrier: Rigid adjustable panels that can be used as single units or in multiples	6 in. increments from 1.5 ft. to 4 ft.	Dependent on barrier height	No	Yes	Carbon steel (stainless steel option available), neoprene, carbon steel mechanical tubing, closed-cell foam, mastic epoxy painted finishes	Yes	Slight - Optional removable mullions for multi-panel installation (Varies by site)	25+ years	Custom pricing based on required width and height
Rigid/Stop Log	CGSL Stop Log	Modular Barrier: Stop log style barrier with customizable width and height	2:1 factor of safety based on material yield strength. Can increase height in 6 in. and 8 in. increments		Yes	Yes	6063-T5 aluminum panels, aluminum, low carbon steel, neoprene seals (Viton and other materials available)	Yes	Moderate - sill/conversion frame installation will require site work (Varies by site)	25+ years	Custom pricing based on required height, width, and jamb type
Rigid/Stop Log	FastLoos Stop Logs	Modular Barrier: Stop log style barrier with customizable width and height	2:1 factor of safety based on material yield strength. Can increase height in 6 in. increments		Yes	Yes	M18-finish aluminum, steel (primed with one coat rust inhibitive, lead free, red primer), high density closed cell neoprene sponge	Yes	Moderate - frame/jamb installation will require site work (Varies by site)	25+ years	Custom pricing based on required height, width, and jamb type
Rigid/Hinged	PS Flood Barriers Hinged Flood Barrier (Single)	Modular Barrier: Hinged door barrier with customizable width and height	2:1 factor of safety based on material yield strength		No	Yes	Steel, stainless steel, 6063 aluminum, 6061 aluminum, EPDM rubber	Yes	Moderate - frame/jamb/sill installation will require site work (Varies by site)	25+ years	Custom pricing based on required width and height
Rigid/Sliding	PS Flood Barriers Sliding Flood Barrier	Modular Barrier: Sliding door barrier with customizable width and height	2:1 factor of safety based on material yield strength		No	Yes	Steel, stainless steel, 6063 aluminum, EPDM rubber	Yes	Moderate - frame/jamb/sill installation will require site work (Varies by site)	25+ years	Custom pricing based on required width and height
Membrane Barriers											
Flexible	JLC Dover Vertically Deployed Flex Wall	Membrane Barrier: Flexible wall with rapid vertical deployment for building and equipment protection	Ideal height for constructability and deployment time is a DFE of 4 ft. above grade or less. Higher heights are possible with the addition of braces to the posts	With intermittent deployable posts, no real limit to span (10 ft. to 12 ft. between posts or connection points)	No	N/A	Kevlar webbings, PVC coated polyester, metal (stainless steel, etc.), H2O covers	Yes	Extensive - excavation efforts (1.5 ft. trench) are necessary for barrier installation (Varies by site)	20 years	Custom pricing based on required width and height; estimated cost range of \$350-550/sf.
Flexible	JLC Dover Side Deployed Flex Wall	Membrane Barrier: Flexible wall with rapid horizontal deployment for building and equipment protection	DFE heights of 1 ft. to 10 ft. above grade (typically, but can go higher)	6 ft. to 60 ft. with deployable or permanent posts	No	N/A	Kevlar webbings, PVC coated polyester, metal (stainless steel, etc.), H2O covers	Yes	Moderate - structural supports may be needed for barrier installation (Varies by site)	19 years	Custom pricing based on required width and height; estimated cost range of \$350-550/sf.
Passive Barriers											
Automatic	Self-Closing Flood Barrier (SCFB)	Membrane Barrier: Self-rising floodgate. Rises automatically as floodwaters approach	Up to 12 ft. Design should be verified by structural calculations.	Limitless but requires vertical supports	No	N/A	PUR foam core, fiberglass, gaskets, galvanized steel	Yes	Extensive - excavation efforts are necessary for barrier installation (Varies by site)	25+ years	Custom pricing based on required width, height, loadings needed, and FEMA zones
Automatic	FloodBreak Gate	Membrane Barrier: Self-rising floodgate. Rises automatically as floodwaters approach	No practical limit. Design validated by structural engineer to 39 ft. height (multiple 12 ft. tall gates installed)	Limitless with no stanchions or vertical stops. (100 ft. length gates are installed without stanchions across highways)	No	N/A	Marine grade aluminum, stainless steel fittings, and EPDM rubber gaskets	Yes	Extensive - excavation efforts are necessary for barrier installation (Varies by site)	Decades of service life with minimal maintenance. Recommend to change gaskets every 10 years	Custom pricing based on required width and height

Notes:
1. The types and products provided are not endorsed by the City of Boston and do not indicate a preference for one barrier type over another. The list is not comprehensive and does not reflect all possible products on the market. As products are identified for possible use, they should be entered into this table to compare and contrast with other products. The products should comply with City of Boston policies, zoning, and regulations.
2. Product manufacturers should be contacted to provide content in this table and be able to provide back-up documentation for submittals.
3. The following framework is based on the methodology developed for "Temporary and Demountable Flood Protection Guide." (Ogunyemi, Fola, Richard Stevens, and Scott Underwood, 2011).

O&M AND COST CONSIDERATIONS

NOT JUST BARRIER OPERATIONS AND MAINTENANCE CONSIDERATIONS!



Elevated roads and pump station

Case Study: Stormwater management for raised roadways in Sunset Harbor, Miami Beach, FL

- ▶ energy costs for pump stations and system redundancy
- ▶ reassigned or new staff (or contractors) to maintain the new pump stations, generators, treatment systems, and utilities associated with stormwater management
- ▶ new O&M equipment needed for stormwater management
- ▶ operations management support
- ▶ staff training

O&M AND COST CONSIDERATIONS



NOT JUST WATER! SNOW & ICE!

Source: Boston_January 2015_Shutterstock_Svitlana Pimenov

CLIMATE RESILIENT FLOOD BARRIER DESIGN

Please visit the Boston Public Works Department Website for more information, including:

- ▶ general engineering and design considerations
- ▶ sample design drawings and specifications
- ▶ opinion of probable costs for sample barriers (construction and annual)
- ▶ operations and maintenance guidance.



<https://www.boston.gov/departments/public-works/climate-resilient-design-standards-and-guidelines>

thank you

westonandsampson.com