

DRAFT WATERFRONT ADAPTATION STRATEGIES

Northern Advisory Committee Meeting

January 18, 2023



TODAY'S AGENDA

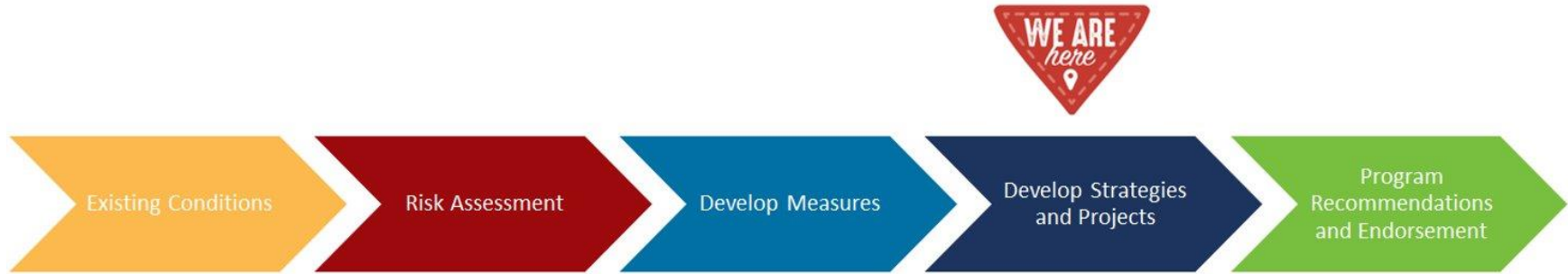
Presentation Overview



- Understanding the Risks
 - *What we're facing*
- Waterfront Resilience Program
 - *What we're doing*
- Community Priorities
 - *What we've heard*
- Range of Possibilities
 - *What we're considering*
- Draft Waterfront Adaptation Strategies in the Embarcadero
- Next Steps
- Q&A

DRAFT WATERFRONT ADAPTATION STRATEGIES

Presentation Overview



The Port of San Francisco has developed seven high-level Draft Waterfront Adaptation Strategies through a collaborative interagency process and over five years of public engagement.

The draft Strategies are ready for public feedback, with a goal of reaching a Draft Waterfront Adaptation Plan by Summer 2023.

DRAFT WATERFRONT ADAPTATION STRATEGIES

Port-led, City of San Francisco Agencies, and USACE Partnered in Development Process



Understanding the Risks *What We're Facing*



CLIMATE CHANGE HAS GLOBAL IMPACTS

Including Here In San Francisco



San Francisco Chronicle

S.F.'s Embarcadero needs to be raised as much as 7 feet to prepare for sea level rise, city says

John Rhee
Nov. 3, 2019 | Updated Nov. 3, 2019 6:05 p.m.



RISING TO THE CHALLENGE

San Francisco Faces Urgent Seismic, Coastal, and Inland Flood Risks Today

SEISMIC RISKS



San Francisco, 1906



Marina, 1989

COASTAL FLOODING

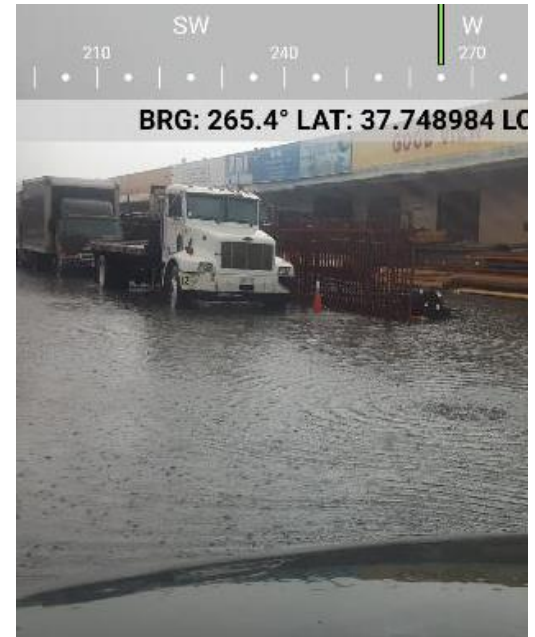


Recology



The Embarcadero

INLAND FLOODING



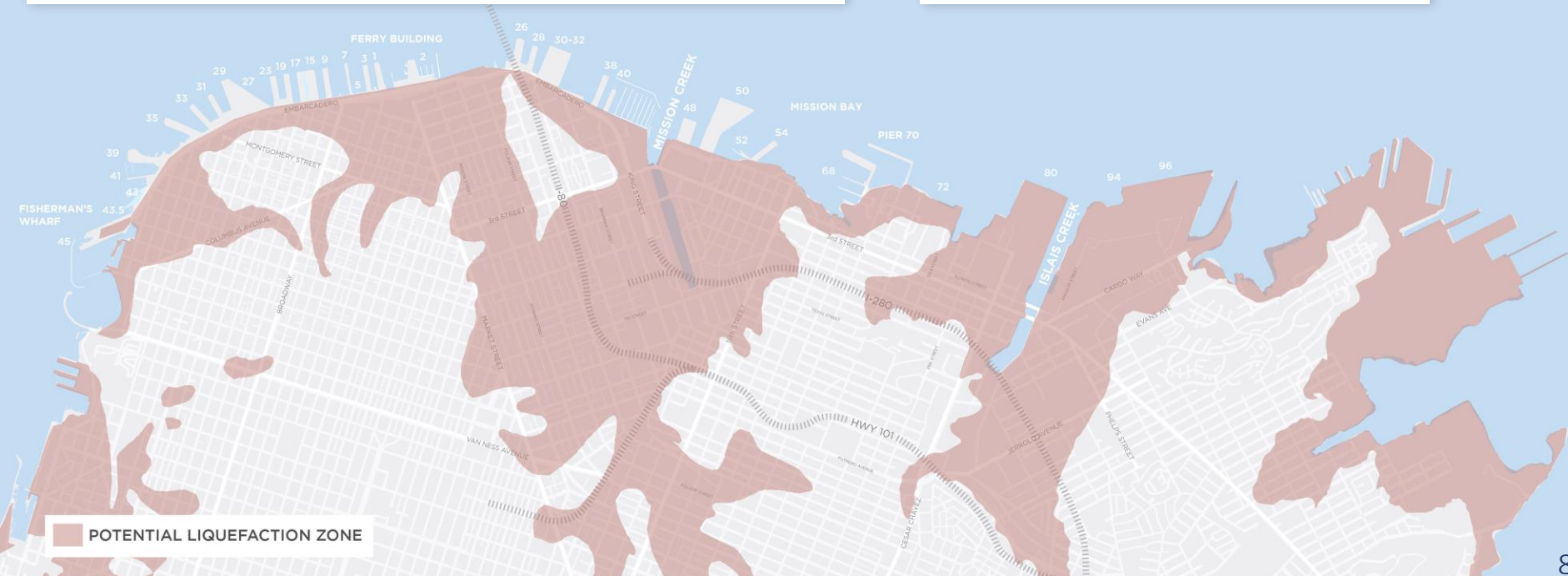
Isais Creek outfall and Marin St.

WATERFRONT WIDE EARTHQUAKE HAZARDS

Very High Earthquake “Liquefaction” Risk

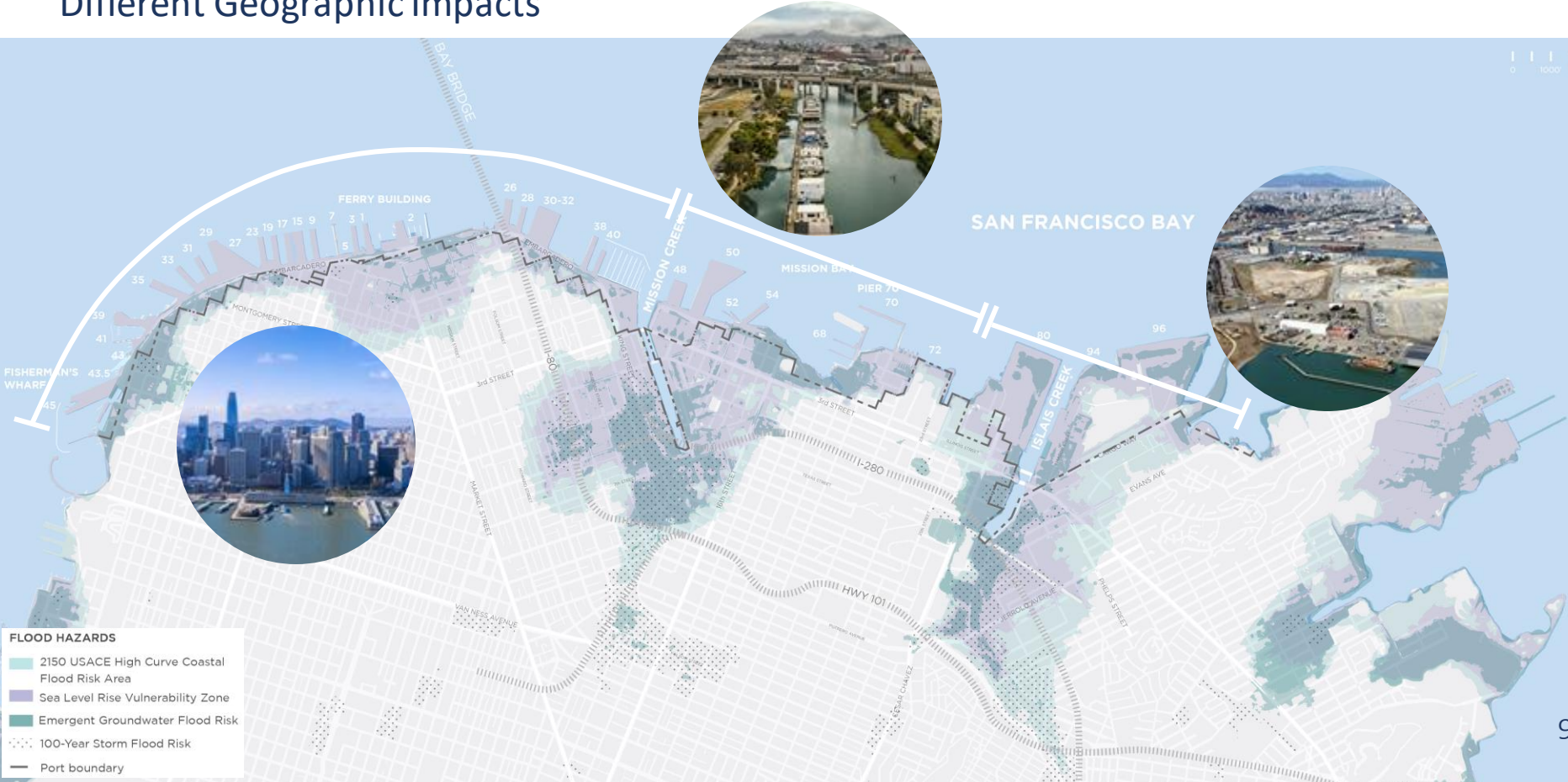
Liquefaction occurs when water-saturated sediment (like sand) temporarily loses strength and acts as a fluid

Various levels of lateral spreading risk along the shoreline



COASTAL AND INLAND FLOOD RISK

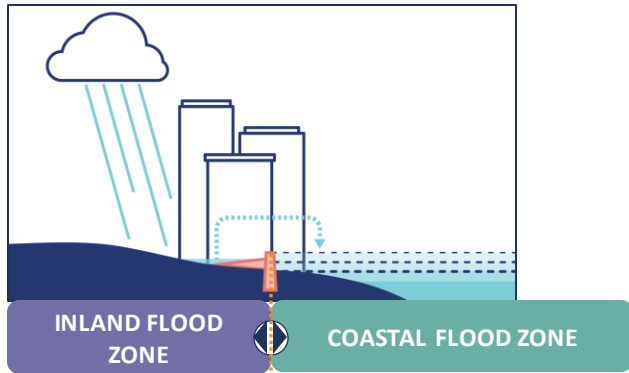
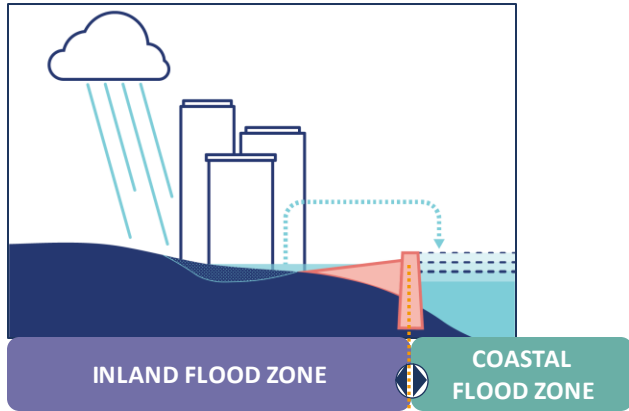
Different Geographic Impacts



FLOOD HAZARDS

- 2150 USACE High Curve Coastal Flood Risk Area
- Sea Level Rise Vulnerability Zone
- Emergent Groundwater Flood Risk
- 100-Year Storm Flood Risk
- Port boundary

COASTAL/ INLAND FLOODING, AND SEISMIC RISKS



Any solution endorsed by the City of San Francisco will aim to address **all three risks**:
seismic risks, **coastal flooding**
and **inland flooding**.

Two related forms of flooding



Waterfront Resilience Program

What We're Doing



WATERFRONT RESILIENCE PROGRAM VISION STATEMENT

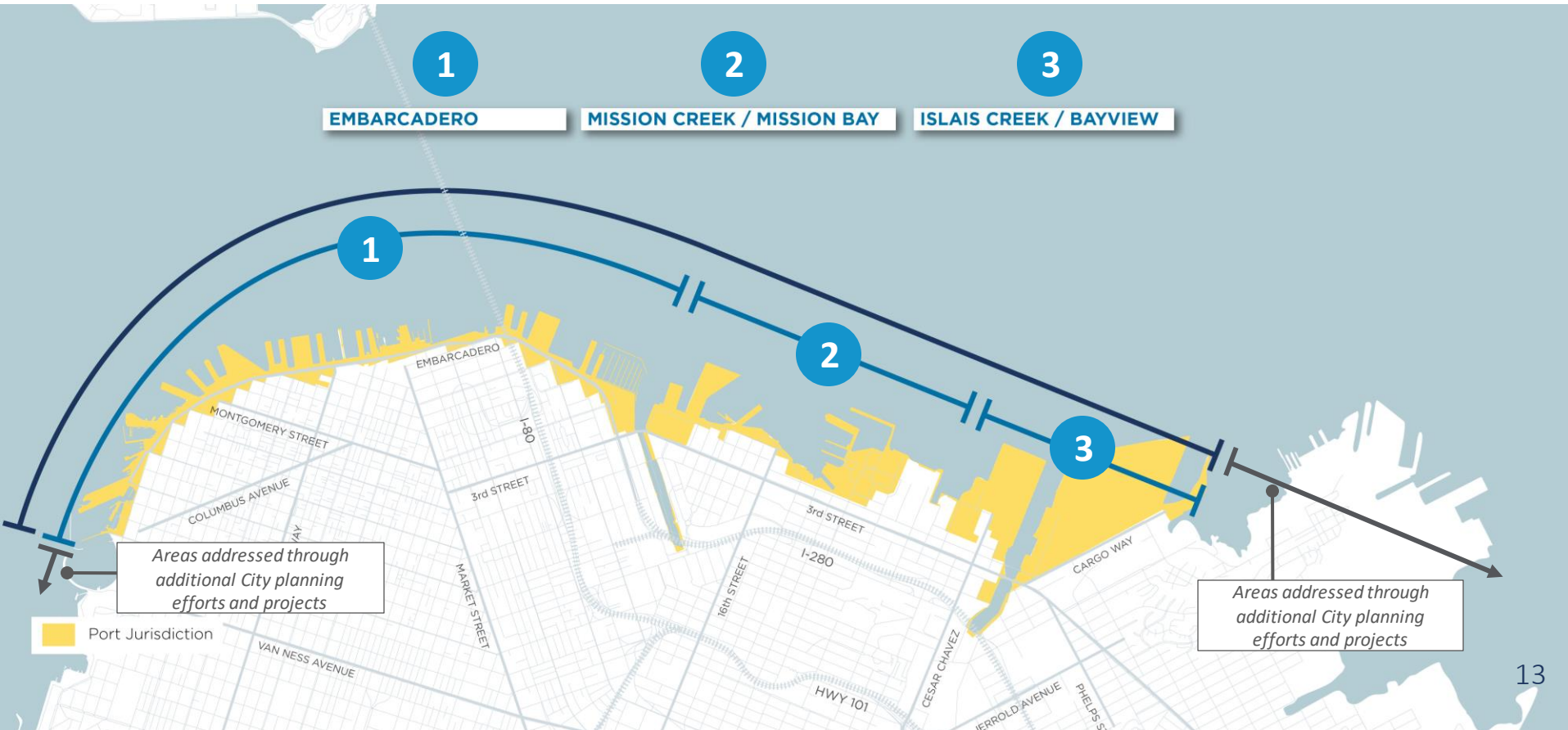
Affirmed through Robust Community Engagement

The Port's Waterfront Resilience Program will take actions to **reduce seismic and climate change risks** that support a safe, equitable, sustainable, and vibrant waterfront.



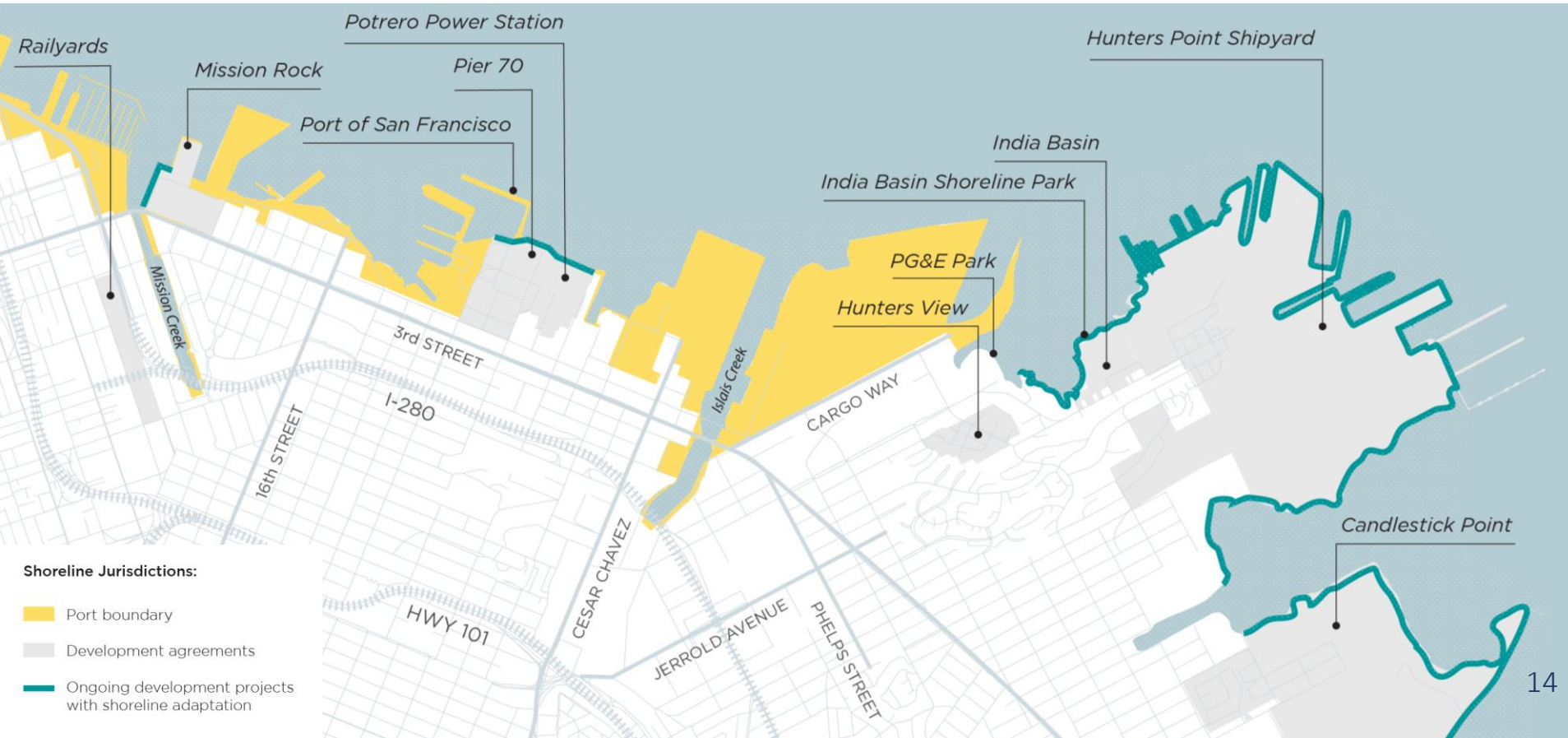
PROGRAM AREA

Focus is Conceptual-Level Strategies Within the Port's Jurisdiction



OTHER CITY ADAPTATION PROJECTS

Outside Port jurisdiction





Community Priorities

What We've Heard



DRAFT WATERFRONT ADAPTATION STRATEGIES

Community Input Helped Define the WRP

1

Focus on life safety & emergency response

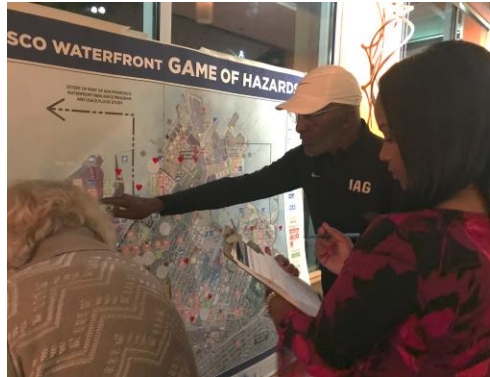
2

Prioritize assets most loved by the community and most important to the city

3

Put people first

Assets and services most prioritized: housing, disaster recovery facilities, utilities, transportation and businesses



WHAT WE HEARD – EMBARCADERO SPECIFIC

Community Input Helped Define the WRP



- Key community-prioritized assets include: Muni Tunnel, Ferry Building, Exploratorium, Fisherman’s Wharf
- Increased transportation options, open space and parks, and more family friendly activities
- Preserve and enhance jobs and diversity of jobs along the Embarcadero
- The Embarcadero Promenade is viewed as a critical asset and there is a strong desire to preserve and enhance it

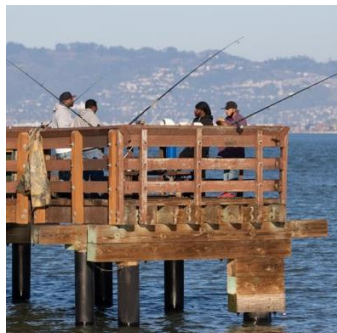
NATURE BASED SOLUTIONS

Prioritize Nature and Healing the Bay



PUBLIC SPACES

Expand Open Spaces and the City's Connection to the Waterfront



EQUITY

Center Racial and Social Equity and Environmental Justice

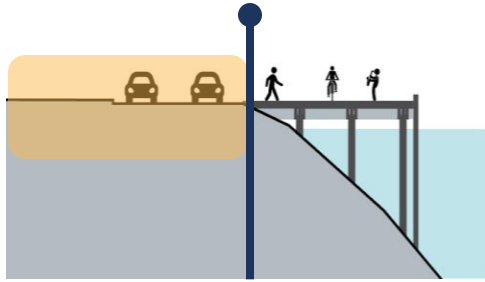




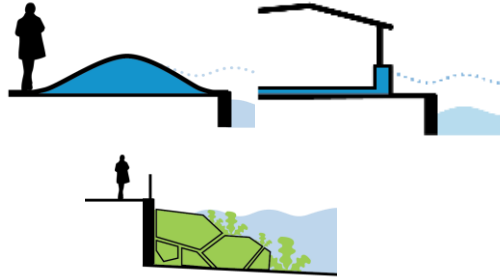
Range of Possible Solutions
What We're Considering

DRAFT WATERFRONT ADAPTATION STRATEGIES

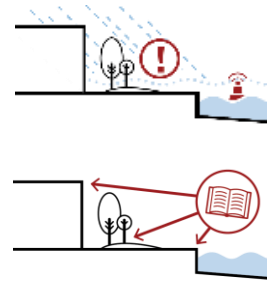
Key Components



**Coastal Flood Defense
Location + Height**
*And area of elevation
change*



Physical Changes
*Such as earthquake-
resilient berms,
floodproofing, and
nature-based features*



Policy Changes
*Such as resilient codes,
warning systems, and land
use changes*

USACE SAN FRANCISCO WATERFRONT COASTAL FLOOD STUDY

Driving Questions

What if...
we **did not adapt**
to mitigate the
risks?

What if...
we adapted by
floodproofing
and **moving**
buildings and assets,
without coastal flood
structures?

What if...
we address flooding
at a **lower rate** of
sea level rise?

What if...
we address flooding
at a **higher rate** of
sea level rise,
as recommended by
CA and SF guidance?

USACE SAN FRANCISCO WATERFRONT COASTAL FLOOD STUDY

Draft Waterfront Adaptation Strategies

What if...
we **did not adapt**
to mitigate the
risks?

STRATEGY A

What if...
we adapted by
floodproofing
and **moving**
buildings and assets,
without coastal flood
structures?

STRATEGY B

What if...
we address flooding
at a **lower rate** of
sea level rise?

STRATEGY C

STRATEGY D

What if...
we address flooding
at a **higher rate** of
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CA and SF guidance?

STRATEGY E

STRATEGY F

STRATEGY G

THE ROLE OF COMMUNITY FEEDBACK

Pathway to the Draft Waterfront Adaptation Plan





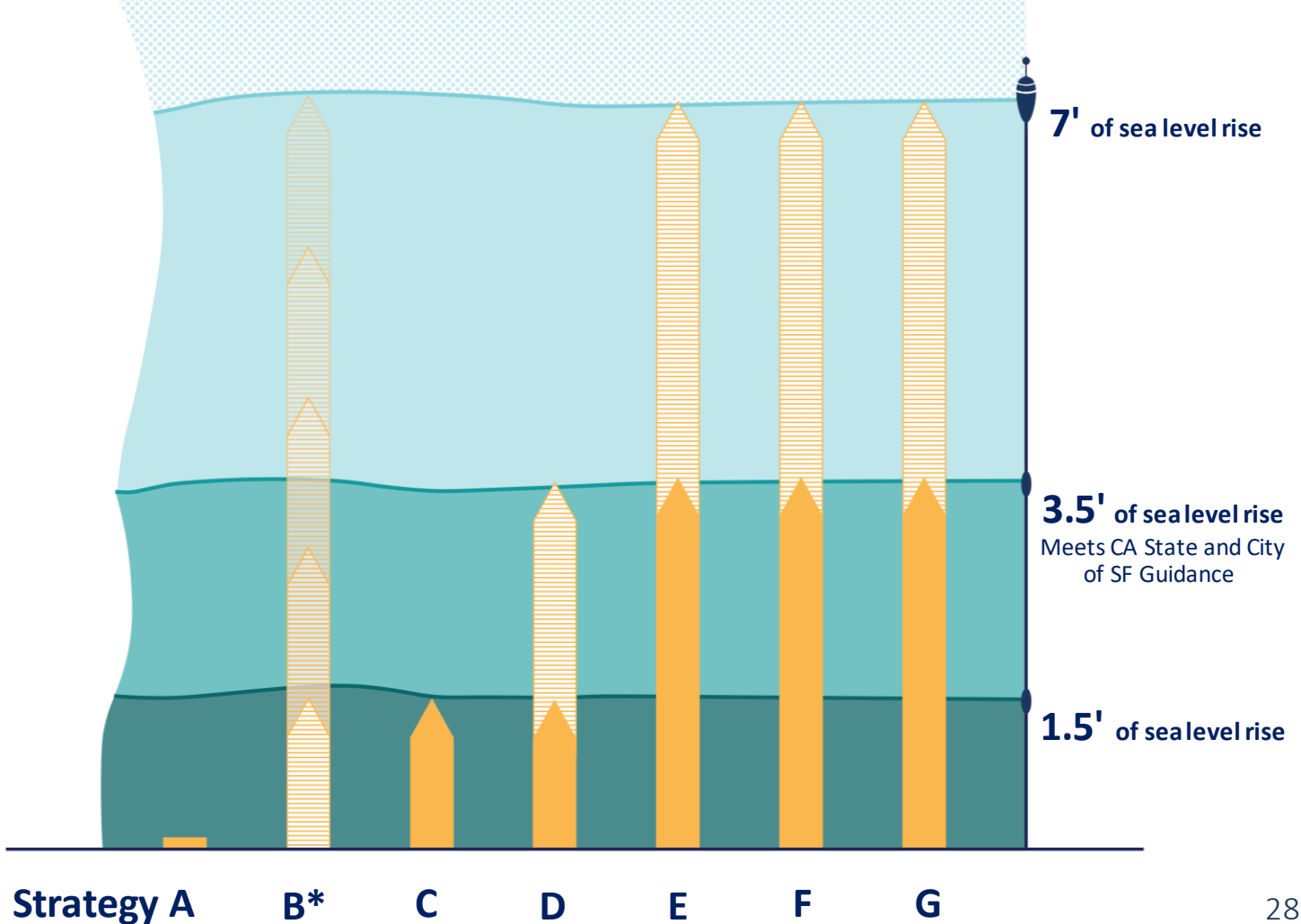
Draft Waterfront Adaptation Strategies in the Embarcadero

TIME HORIZONS



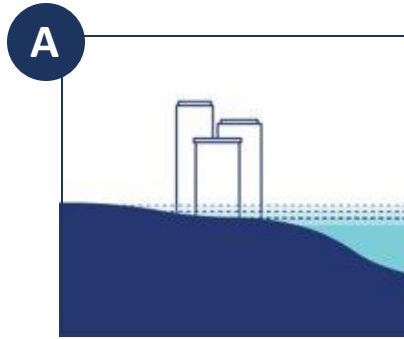
SEA LEVEL RISE

- Adaptable to
- Initially built to

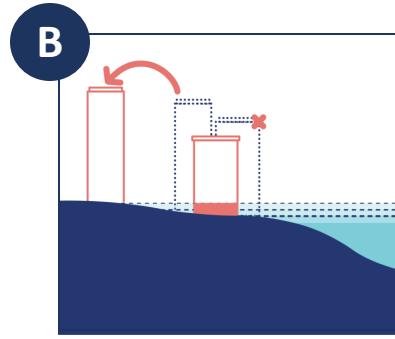


* Strategy i involves phased floodproofing and relocation of assets

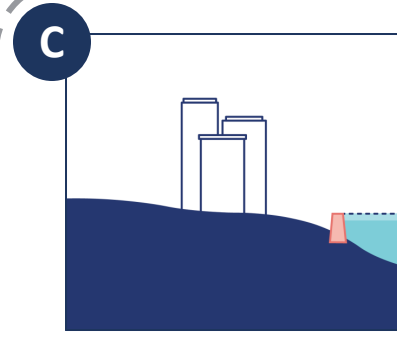
WATERFRONT DRAFT ADAPTATION STRATEGIES



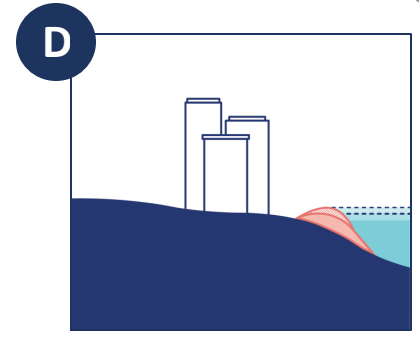
No Action



Non-Structural

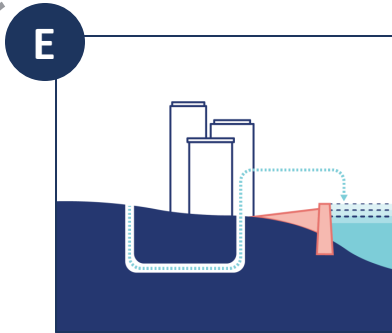


Lower Sea Level Rise

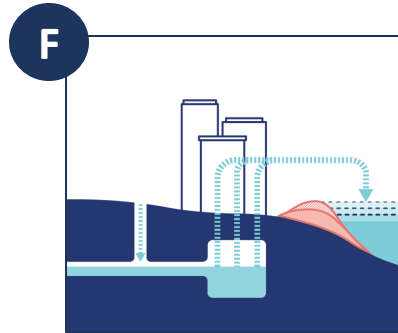


Adaptable

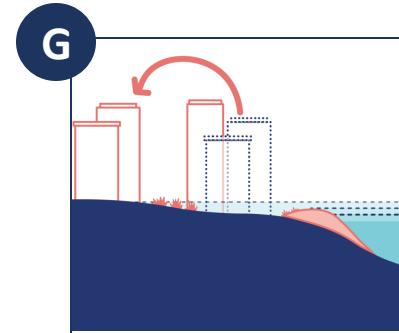
Lower Rate of Sea Level Rise



Hold The Line



Manage The Water



Align With Watersheds

Higher Rate of Sea Level Rise

In addition to coastal flood risks—addresses ground water, storm water, and seismic risks

USACE SAN FRANCISCO WATERFRONT COASTAL FLOOD STUDY

Focused on Strategies A-D

What if...
we **did not adapt**
to mitigate the
risks?

STRATEGY A

What if...
we adapted by
floodproofing
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without coastal flood
structures?

STRATEGY B

What if...
we address flooding
at a **lower rate** of
sea level rise?

STRATEGY C

STRATEGY D

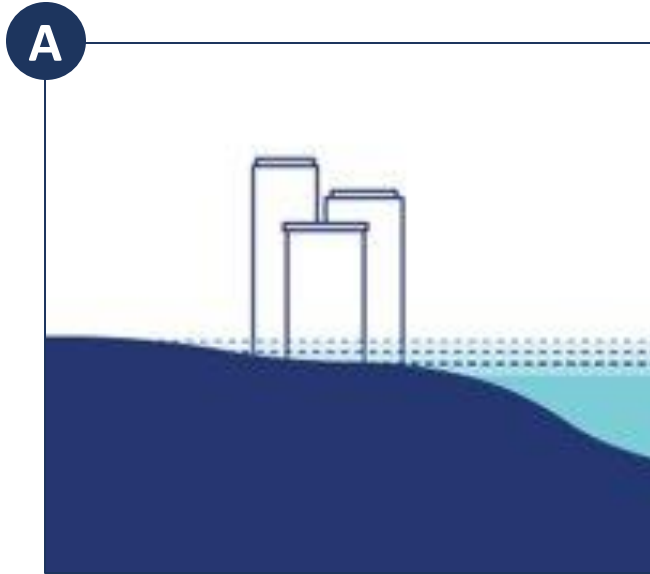
What if...
we address flooding
at a **higher rate** of
sea level rise,
as recommended by
CA and SF guidance?

STRATEGY E

STRATEGY F

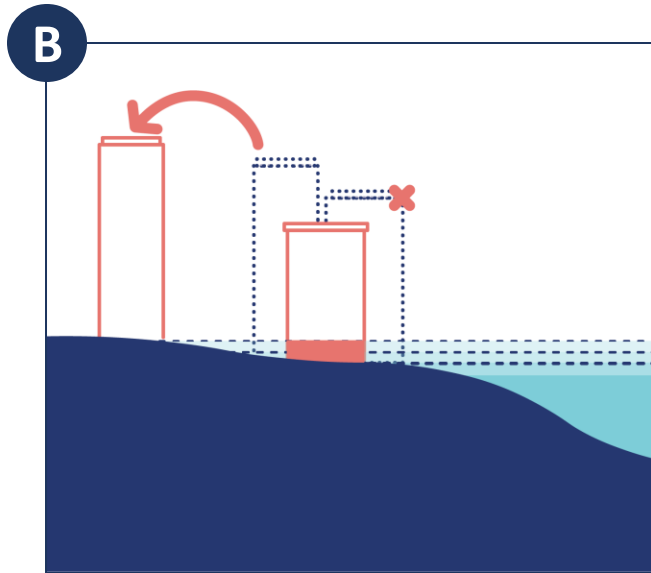
STRATEGY G

STRATEGY A – NO ACTION



This strategy takes no actions to reduce flood risks beyond projects that are already approved

STRATEGY B – NONSTRUCTURAL OPTION

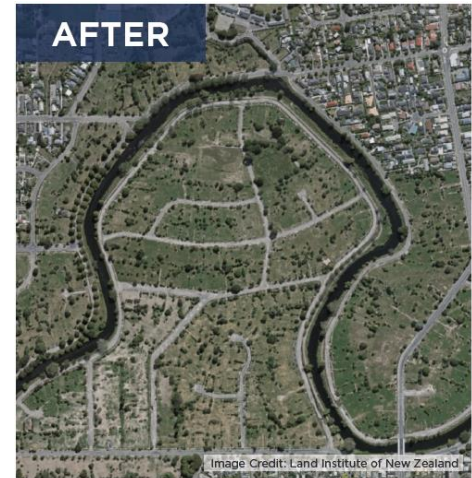
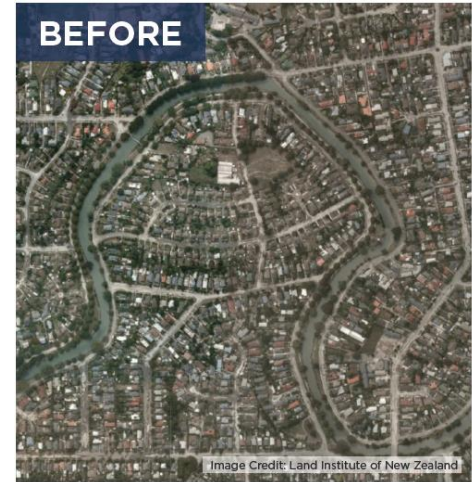


Moves people and assets away from the risk, uses nonstructural measures (such as floodproofing) to reduce risks, and allows water to go where it wants rather than constructing traditional structural solutions

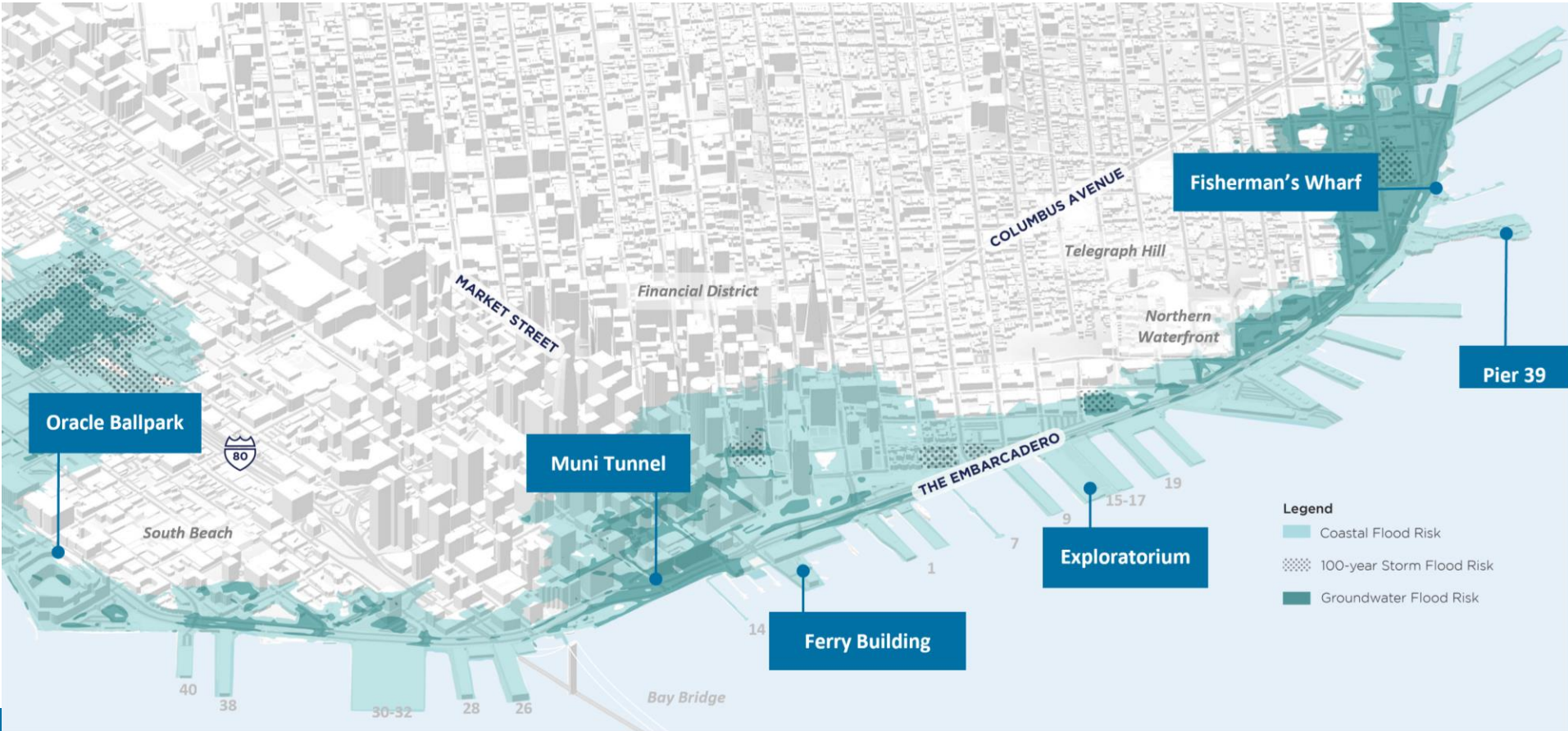
STRATEGY B – NONSTRUCTURAL OPTION

Examples

- Floodproofing
- Raising structure in place
- Floodable spaces
- Buyouts
- Warning systems



EMBARCADERO: ORIENTATION TO THE MAPS



ORIENTATION TO THE MAPS

Embarcadero Strategy E (2040)

Legend

-  Coastal Flood Defense
-  Inland Adaptation Zone
-  Coastal Adaptation Zone
-  Bay Fill

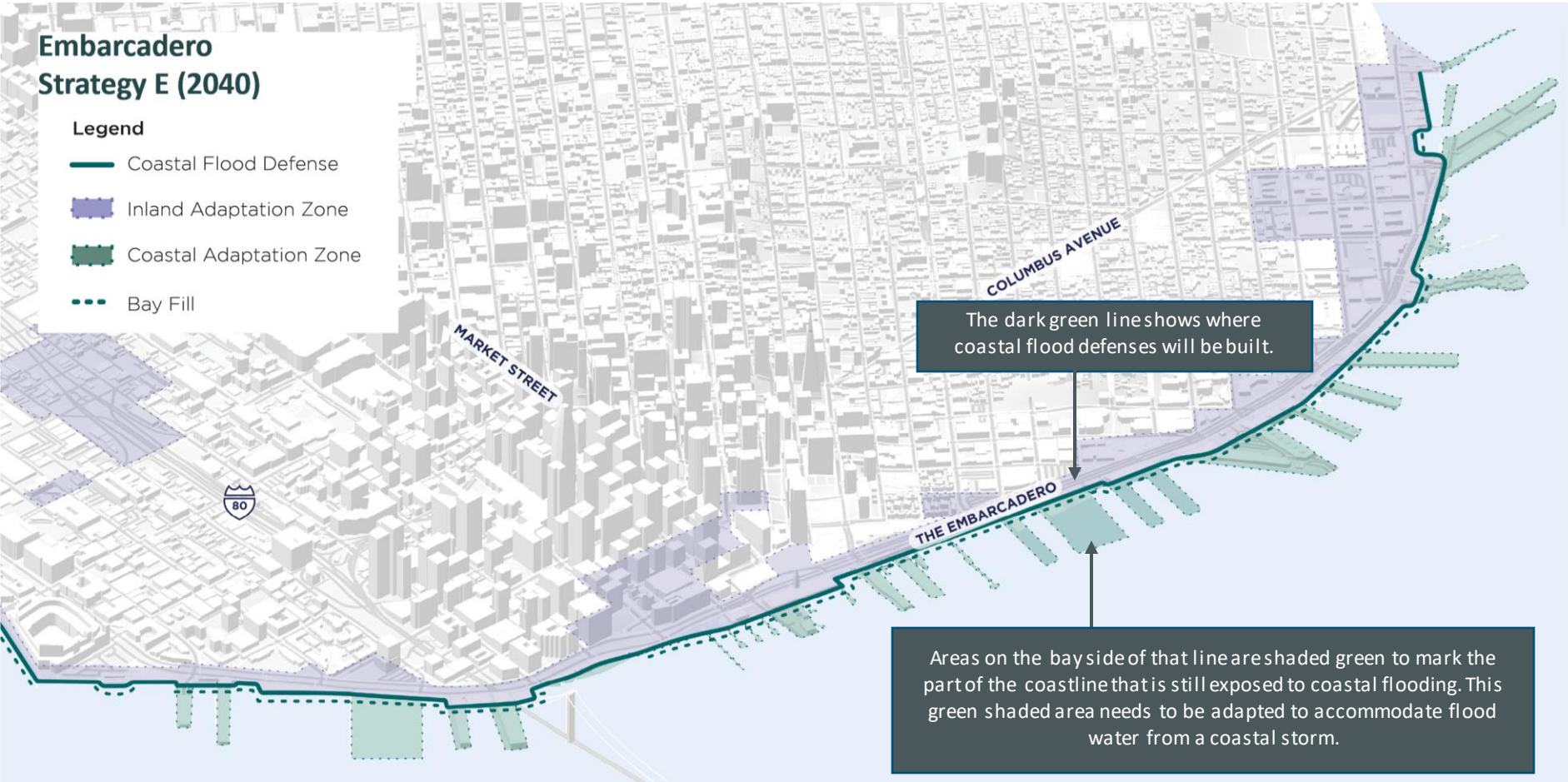


ORIENTATION TO THE MAPS

Embarcadero Strategy E (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- - - Bay Fill



The dark green line shows where coastal flood defenses will be built.

Areas on the bayside of that line are shaded green to mark the part of the coastline that is still exposed to coastal flooding. This green shaded area needs to be adapted to accommodate flood water from a coastal storm.

ORIENTATION TO THE MAPS

Embarcadero Strategy E (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- - - Bay Fill



The purple shading marks the area that is defended against coastal flooding but still needs adaptations to accommodate inland flooding.

The dark green line shows where coastal flood defenses will be built.

Areas on the bay side of that line are shaded green to mark the part of the coastline that is still exposed to coastal flooding. This green shaded area needs to be adapted to accommodate flood water from a coastal storm.

ORIENTATION TO THE MAPS

Embarcadero Strategy E (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- - - Bay Fill

The geographic locations, strategy name, and year will be shown here. Strategies have maps for what will happen in the 2040 timeframe, and what will happen later, in 2090.

The purple shading marks the area that is defended against coastal flooding but still needs adaptations to accommodate inland flooding.

The dark green line shows where coastal flood defenses will be built.

Areas on the bay side of that line are shaded green to mark the part of the coastline that is still exposed to coastal flooding. This green shaded area needs to be adapted to accommodate flood water from a coastal storm.



ORIENTATION TO THE MAPS

Embarcadero Strategy E (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- - - Bay Fill

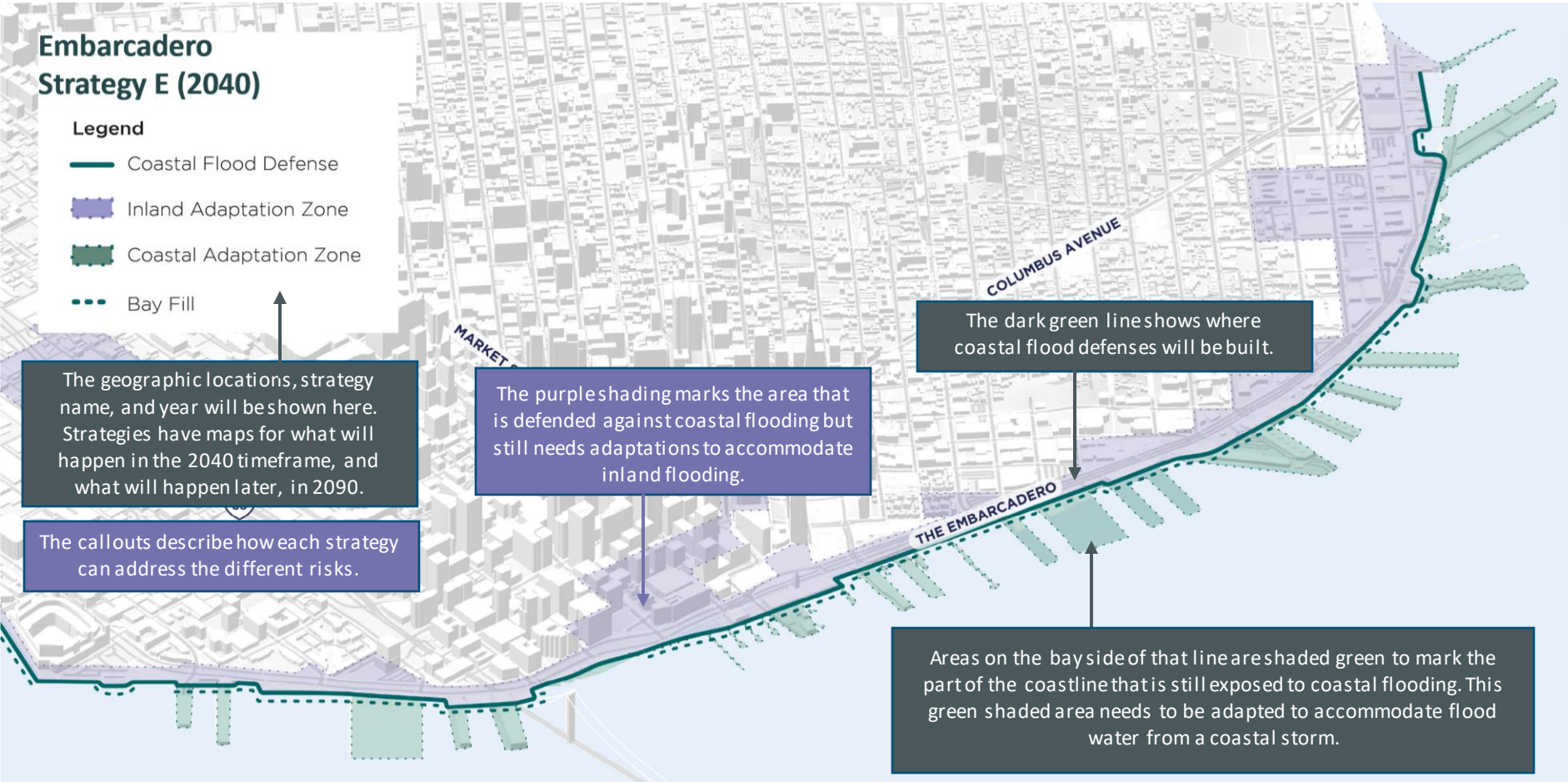
The geographic locations, strategy name, and year will be shown here. Strategies have maps for what will happen in the 2040 timeframe, and what will happen later, in 2090.

The callouts describe how each strategy can address the different risks.

The purple shading marks the area that is defended against coastal flooding but still needs adaptations to accommodate inland flooding.

The dark green line shows where coastal flood defenses will be built.

Areas on the bay side of that line are shaded green to mark the part of the coastline that is still exposed to coastal flooding. This green shaded area needs to be adapted to accommodate flood water from a coastal storm.



USACE SAN FRANCISCO WATERFRONT COASTAL FLOOD STUDY

Focused on Strategies A-D

What if...
we **did not adapt**
to mitigate the
risks?

STRATEGY A

What if...
we adapted by
floodproofing
and **moving**
buildings and assets,
without coastal flood
structures?

STRATEGY B

What if...
we address flooding
at a **lower rate** of
sea level rise?

STRATEGY C

STRATEGY D

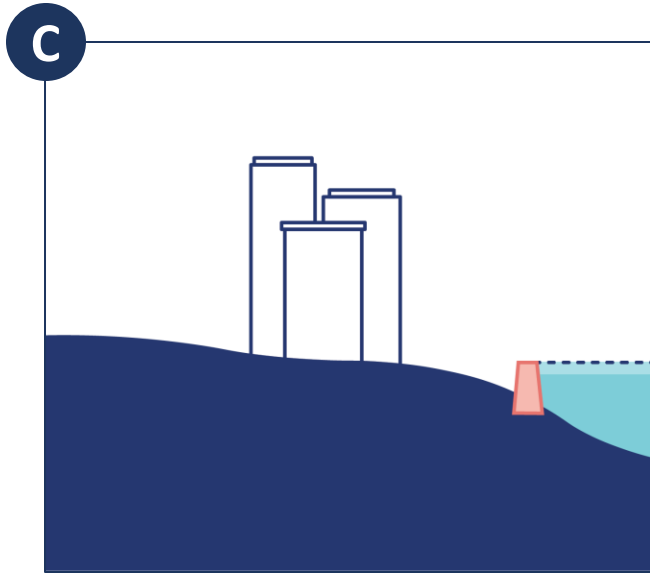
What if...
we address flooding
at a **higher rate** of
sea level rise,
as recommended by
CA and SF guidance?

STRATEGY E

STRATEGY F

STRATEGY G

STRATEGY C – LOWER SEA LEVEL RISE



Adapts the shoreline to withstand 1.5' of sea level rise by 2040 using a combination of structural and nonstructural measures

STRATEGY C – LOWER SEA LEVEL RISE

Embarcadero Strategy C (2040)

Legend

- Coastal Flood Defense
- ▨ Inland Adaptation Zone

Raise the bay shoreline and use deployable flood defense structures to protect against 1.5 feet of sea level rise from the Bay Bridge to Pier 7, and near Pier 45. Deployable structures will maintain maritime access and uses at some locations.



STRATEGY C – LOWER SEA LEVEL RISE

Embarcadero Strategy C (2040)

Legend

- Coastal Flood Defense
- ▨ Inland Adaptation Zone

Raise the bay shoreline and use deployable flood defense structures to protect against 1.5 feet of sea level rise from the Bay Bridge to Pier 7, and near Pier 45. Deployable structures will maintain maritime access and uses at some locations.



Although the floodwalls would consider seismic risks, consistent with state and local building codes, the seismic risks associated with the aging Embarcadero Seawall and other shoreline infrastructure would not be comprehensively addressed.

STRATEGY C – LOWER SEA LEVEL RISE

Embarcadero Strategy C (2040)

Legend

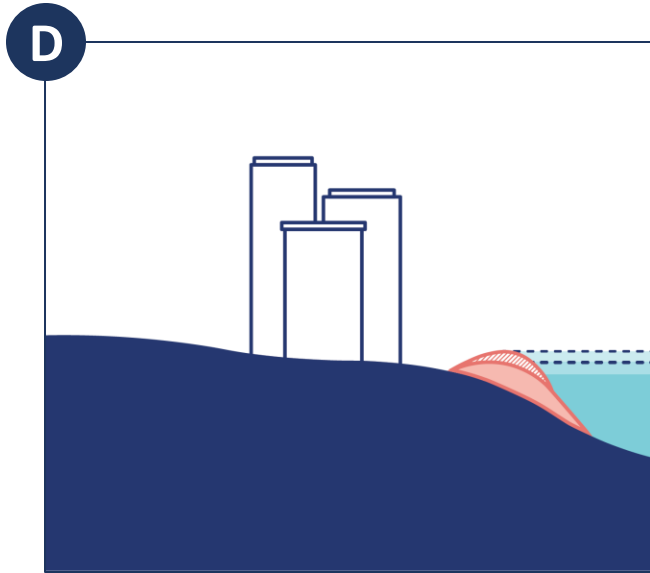
- Coastal Flood Defense
- ▨ Inland Adaptation Zone

Raise the bay shoreline and use deployable flood defense structures to protect against 1.5 feet of sea level rise from the Bay Bridge to Pier 7, and near Pier 45. Deployable structures will maintain maritime access and uses at some locations.

No long-term actions are included. The flood defense measures would not be adaptable to higher rates of sea level rise; so future actions to adapt to a higher rate of sea level rise would need to go through the planning and approval process if needed.

Although the floodwalls would consider seismic risks, consistent with state and local building codes, the seismic risks associated with the aging Embarcadero Seawall and other shoreline infrastructure would not be comprehensively addressed.

STRATEGY D – LOWER SEA LEVEL RISE – ADAPTABLE



Adapts the shoreline to withstand 1.5' of sea level rise by 2040, with the possibility of building higher by 2090

STRATEGY D – LOWER SEA LEVEL RISE – ADAPTABLE

Embarcadero Strategy D (2040)

Legend

- Coastal Flood Defense
- ▨ Inland Adaptation Zone
- ▨ Coastal Adaptation Zone

Raise bay shoreline to defend against up to 3.5 feet of sea level rise at the lowest-lying locations, including from the Bay Bridge to Pier 7, and near Pier 45. Deployable structures will maintain maritime access and uses at some locations. Design the flood risk reduction actions to be adaptable to a higher rate of sea level rise in the future.



STRATEGY D – LOWER SEA LEVEL RISE – ADAPTABLE

Embarcadero Strategy D (2090)

Legend

- Coastal Flood Defense
- ▨ Inland Adaptation Zone
- ▨ Coastal Adaptation Zone

In the long term, 2090 and beyond, implementation of Strategy D in the Embarcadero, would include additional shoreline protections to protect the remaining shoreline area against up to 3.5 feet of sea level rise.



STRATEGY D – LOWER SEA LEVEL RISE – ADAPTABLE

Embarcadero Strategy D (2090)

Legend

- Coastal Flood Defense
- ▨ Inland Adaptation Zone
- ▨ Coastal Adaptation Zone

In the long term, 2090 and beyond, implementation of Strategy D in the Embarcadero, would include additional shoreline protections to protect the remaining shoreline area against up to 3.5 feet of sea level rise.

This strategy addresses some earthquake risks in the areas with actions closer to 2090.

USACE SAN FRANCISCO WATERFRONT COASTAL FLOOD STUDY

Focused on Strategies E, F, and G

What if...
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STRATEGY B

What if...
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sea level rise?

STRATEGY C

STRATEGY D

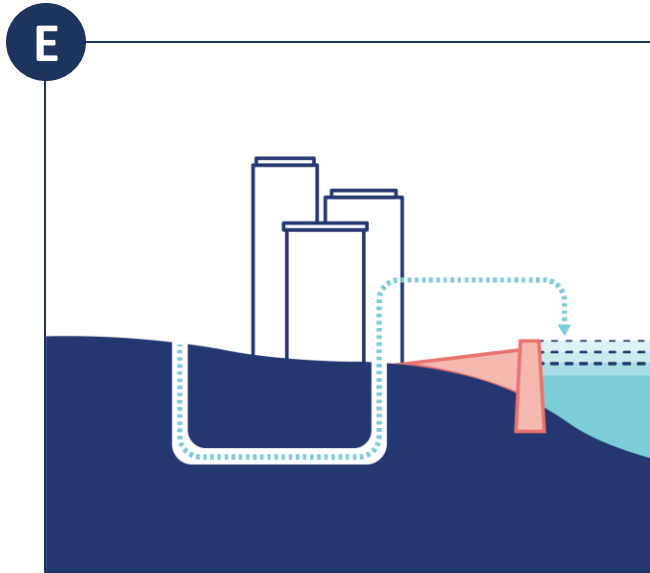
What if...
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STRATEGY E

STRATEGY F

STRATEGY G

STRATEGY E – HIGHER SEA LEVEL RISE – HOLD THE LINE



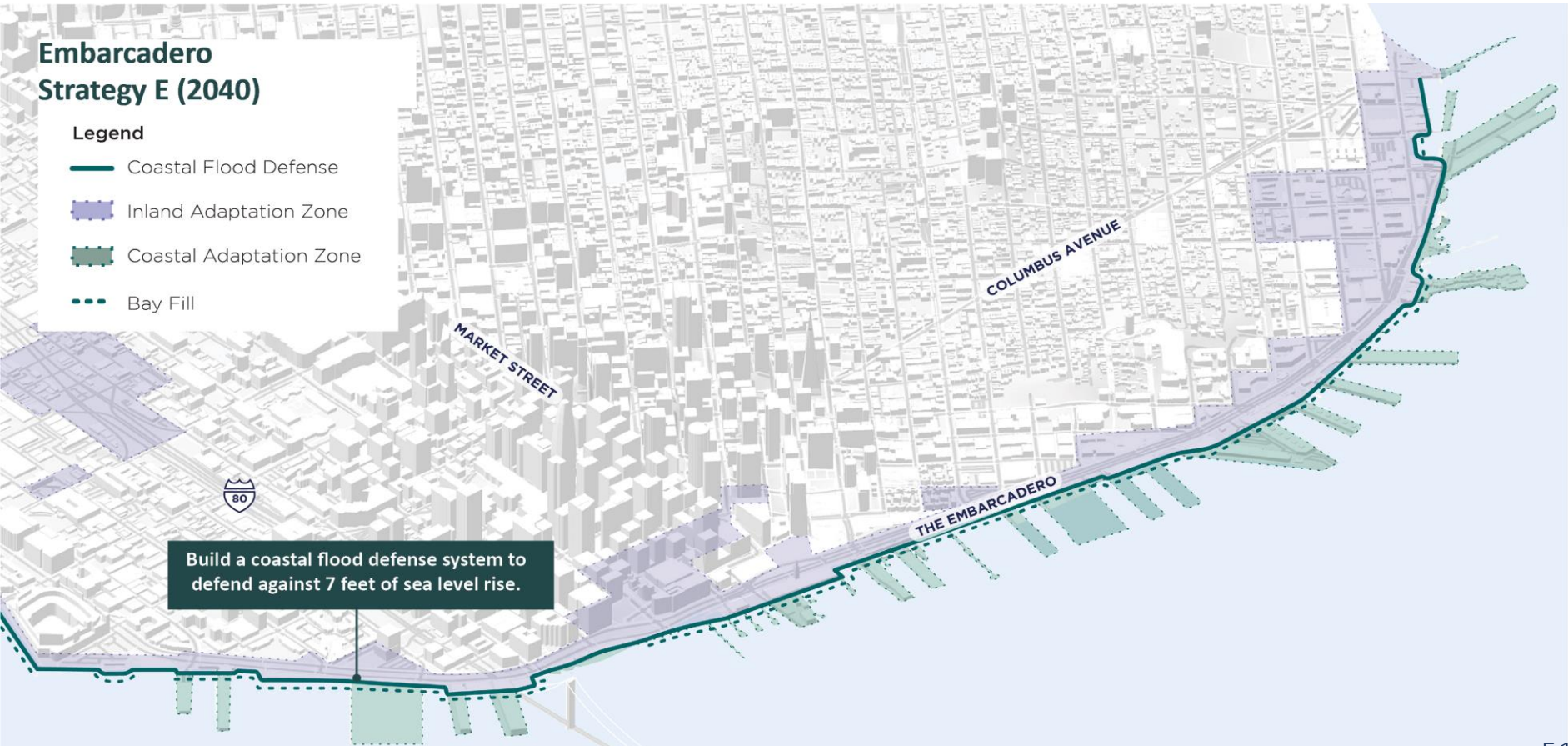
Preserves a waterfront that looks and functions much as it does today by adapting the shoreline

STRATEGY E – HIGHER SEA LEVEL RISE – HOLD THE LINE

Embarcadero Strategy E (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- - - Bay Fill



Build a coastal flood defense system to defend against 7 feet of sea level rise.

NOTE: ALL DRAWINGS FOR FEASIBILITY STUDY ONLY. NOT A PROPOSED DESIGN.

STRATEGY E – HIGHER SEA LEVEL RISE – HOLD THE LINE

Embarcadero Strategy E (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- Bay Fill



STRATEGY E – HIGHER SEA LEVEL RISE – HOLD THE LINE

Embarcadero Strategy E (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- Bay Fill

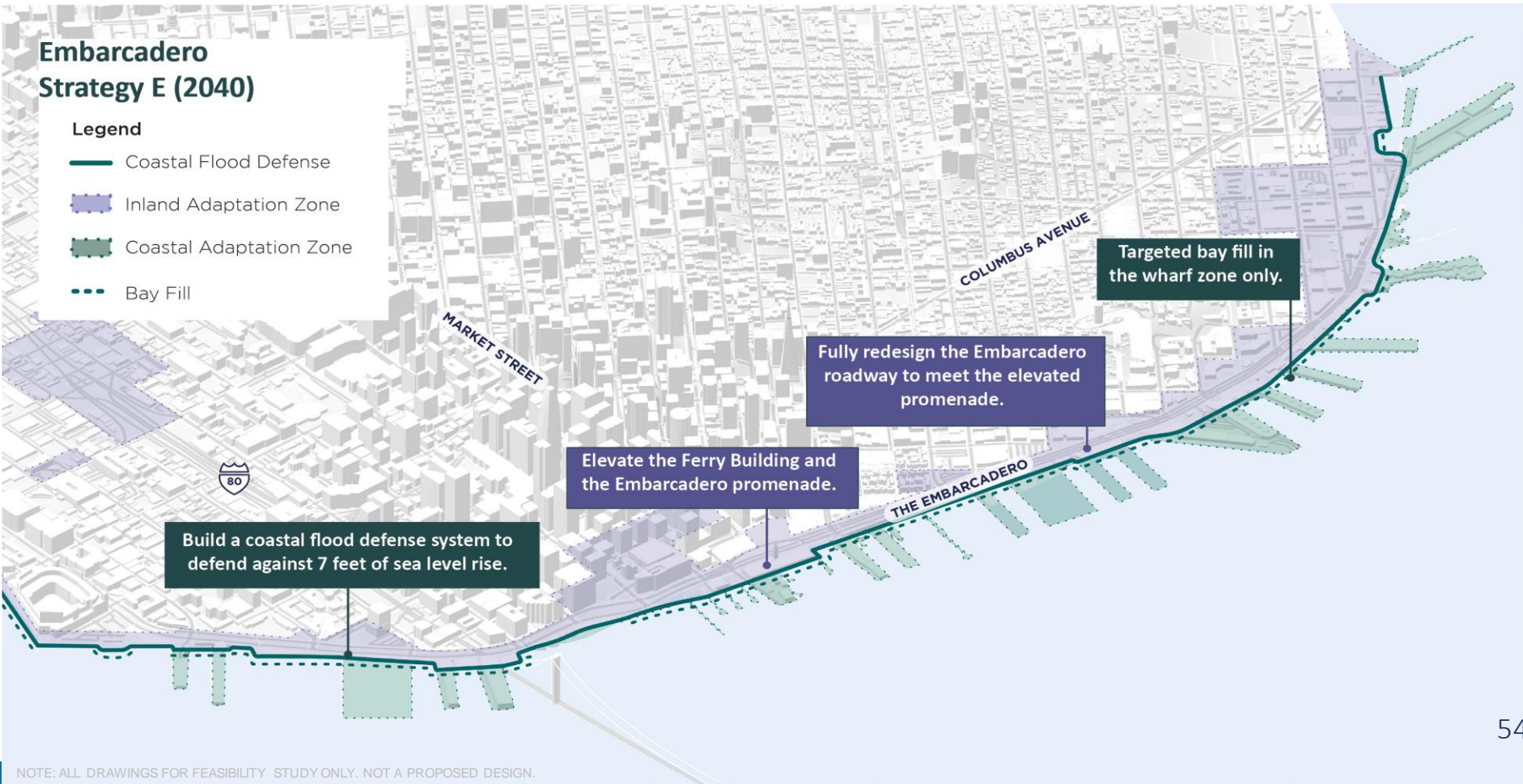


STRATEGY E – HIGHER SEA LEVEL RISE – HOLD THE LINE

Embarcadero Strategy E (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- Bay Fill



STRATEGY E – HIGHER SEA LEVEL RISE – HOLD THE LINE

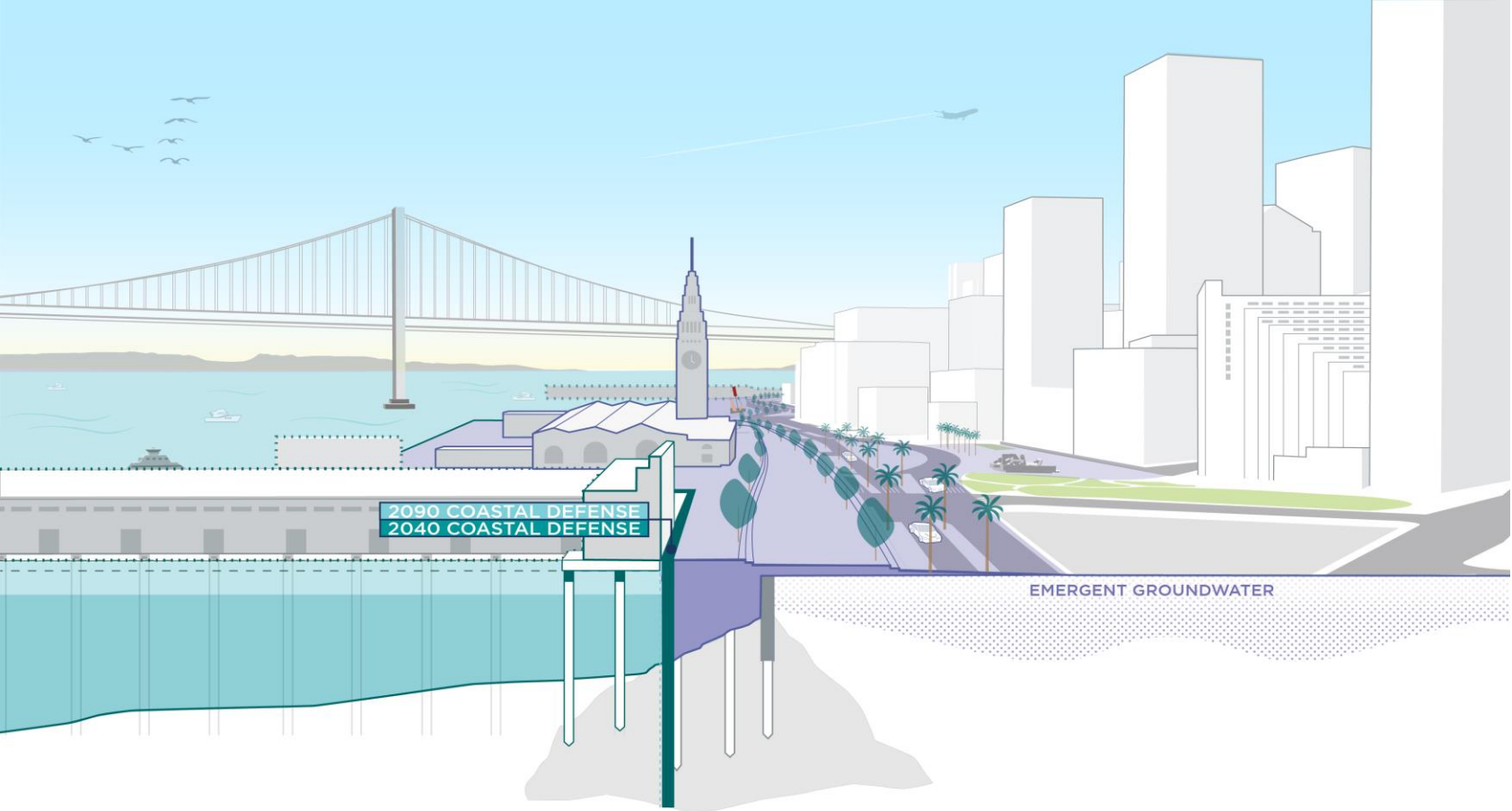
Embarcadero Strategy E (2040)

Legend

- Coastal Flood Defense
- ▨ Inland Adaptation Zone
- ▨ Coastal Adaptation Zone
- - - Bay Fill

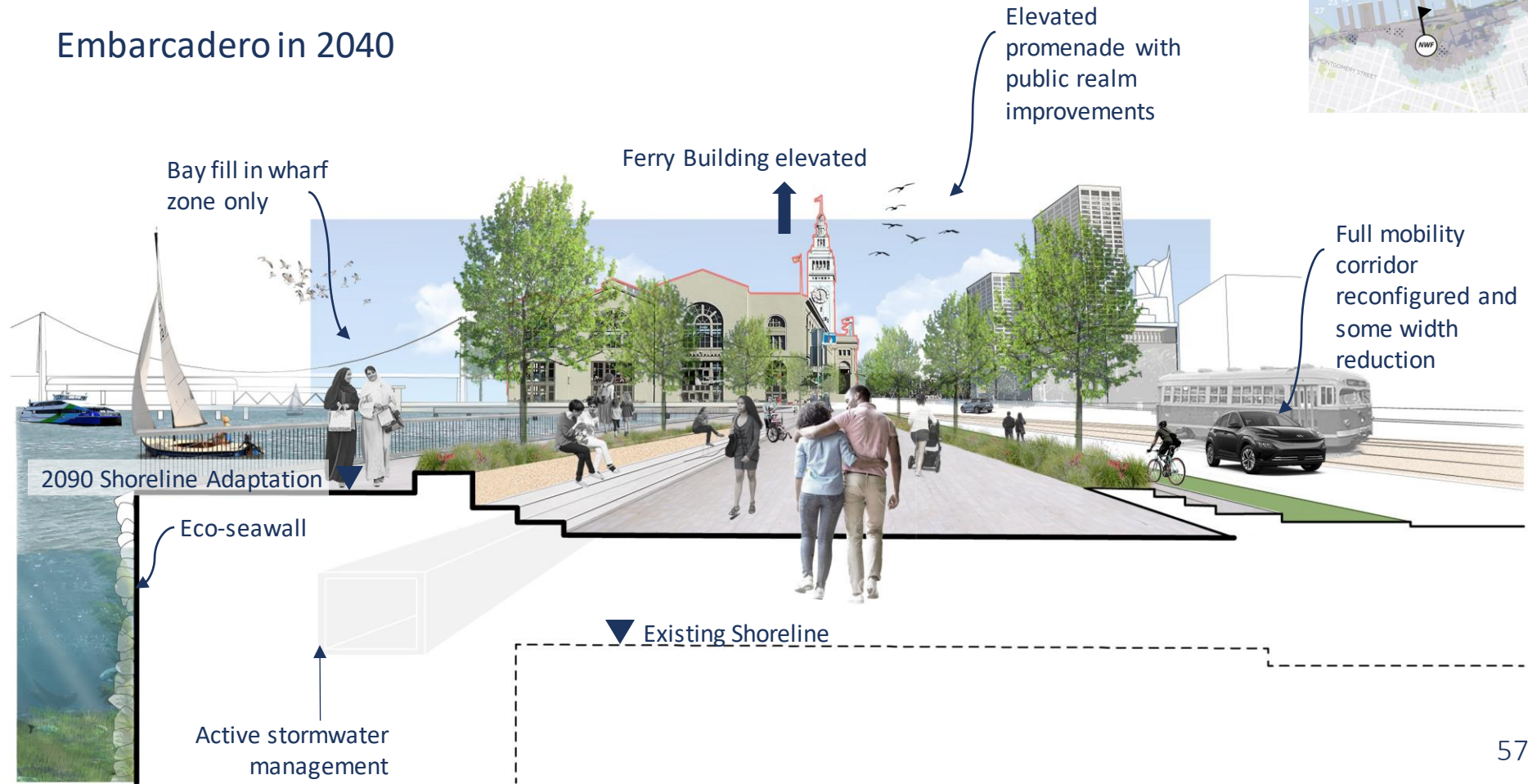


STRATEGY E – HIGHER SEA LEVEL RISE – HOLD THE LINE

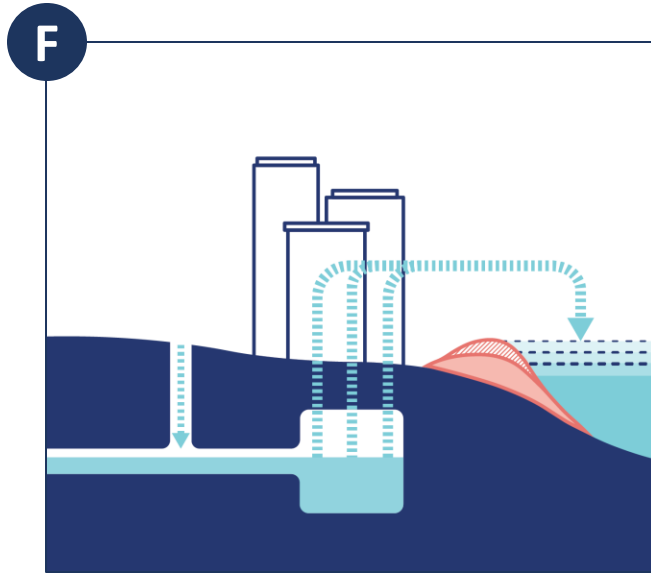


STRATEGY E – HIGHER SEA LEVEL RISE – HOLD THE LINE

Embarcadero in 2040



STRATEGY F – HIGHER SEA LEVEL RISE – MANAGE THE WATER



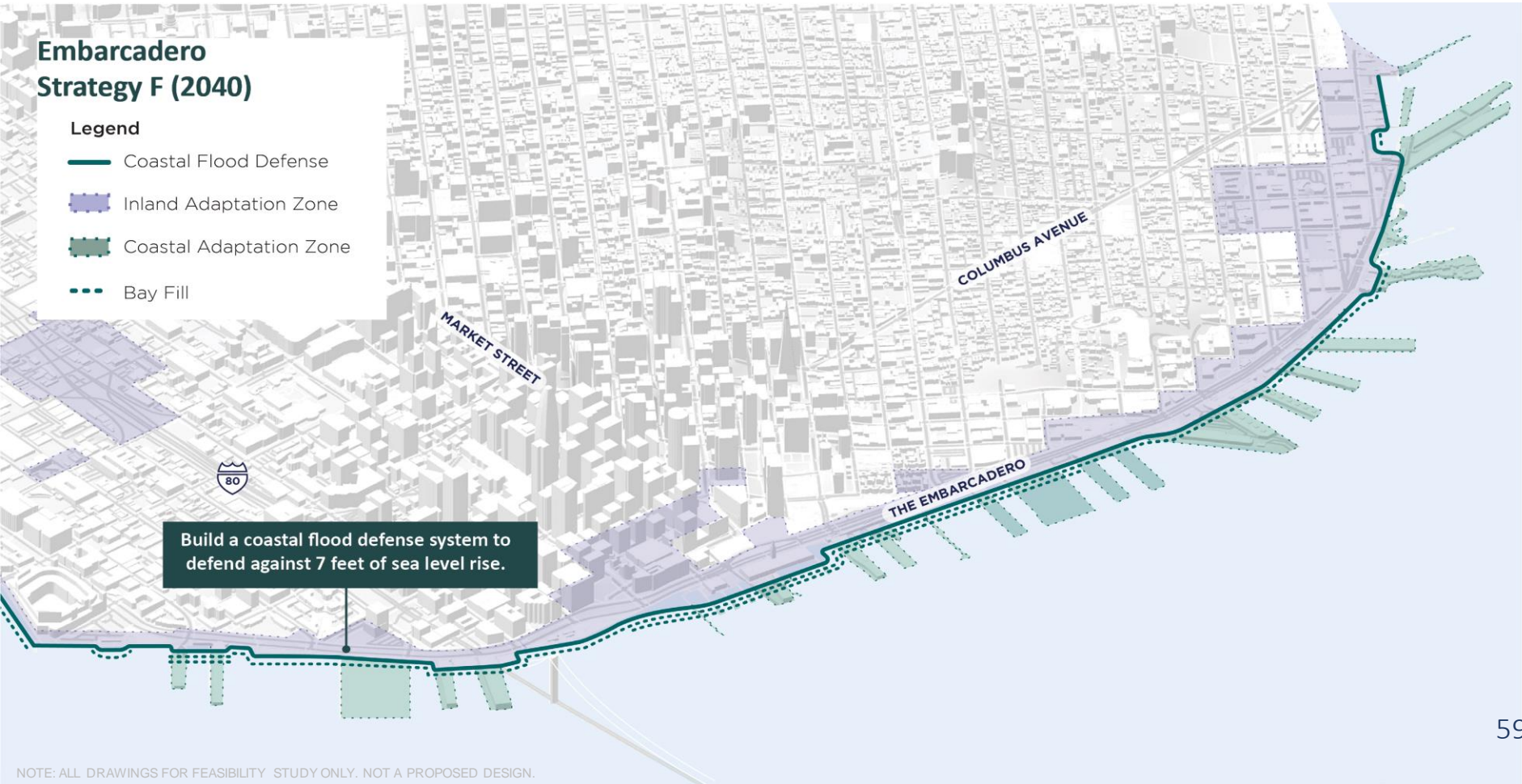
Creates an active system for managing flooding by heavily relying on machinery

STRATEGY F – HIGHER SEA LEVEL RISE – MANAGE THE WATER

Embarcadero Strategy F (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- Bay Fill



Build a coastal flood defense system to defend against 7 feet of sea level rise.

STRATEGY F – HIGHER SEA LEVEL RISE – MANAGE THE WATER

Embarcadero Strategy F (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- Bay Fill



Maintain the Ferry Building at its existing location and elevation, as the shoreline would be elevated bayward of the Ferry Building.

Build a coastal flood defense system to defend against 7 feet of sea level rise.

STRATEGY F – HIGHER SEA LEVEL RISE – MANAGE THE WATER

Embarcadero Strategy F (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- Bay Fill



Build a coastal flood defense system to defend against 7 feet of sea level rise.

Maintain the Ferry Building at its existing location and elevation, as the shoreline would be elevated bayward of the Ferry Building.

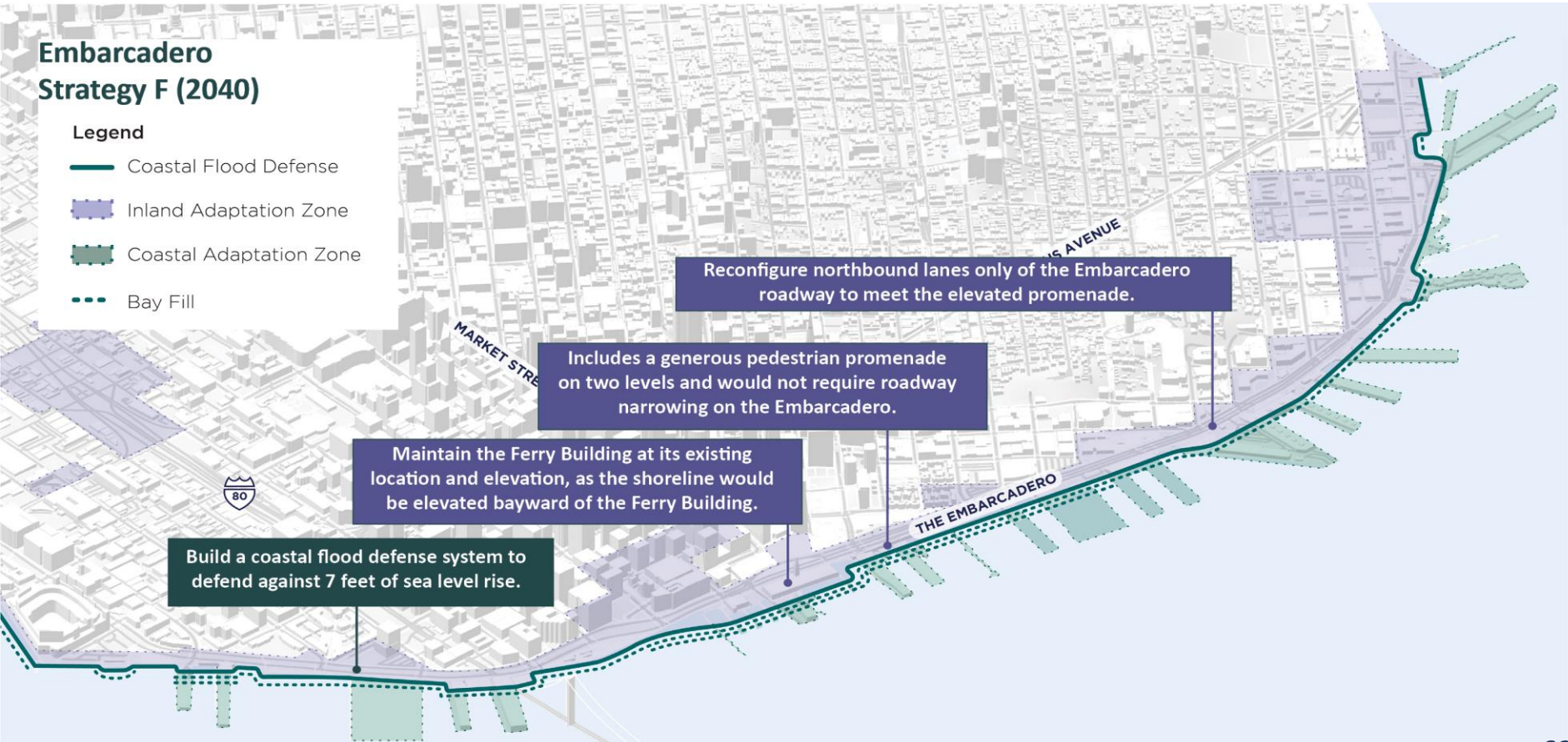
Includes a generous pedestrian promenade on two levels and would not require roadway narrowing on the Embarcadero.

STRATEGY F – HIGHER SEA LEVEL RISE – MANAGE THE WATER

Embarcadero Strategy F (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- Bay Fill



Reconfigure northbound lanes only of the Embarcadero roadway to meet the elevated promenade.

Includes a generous pedestrian promenade on two levels and would not require roadway narrowing on the Embarcadero.

Maintain the Ferry Building at its existing location and elevation, as the shoreline would be elevated bayward of the Ferry Building.

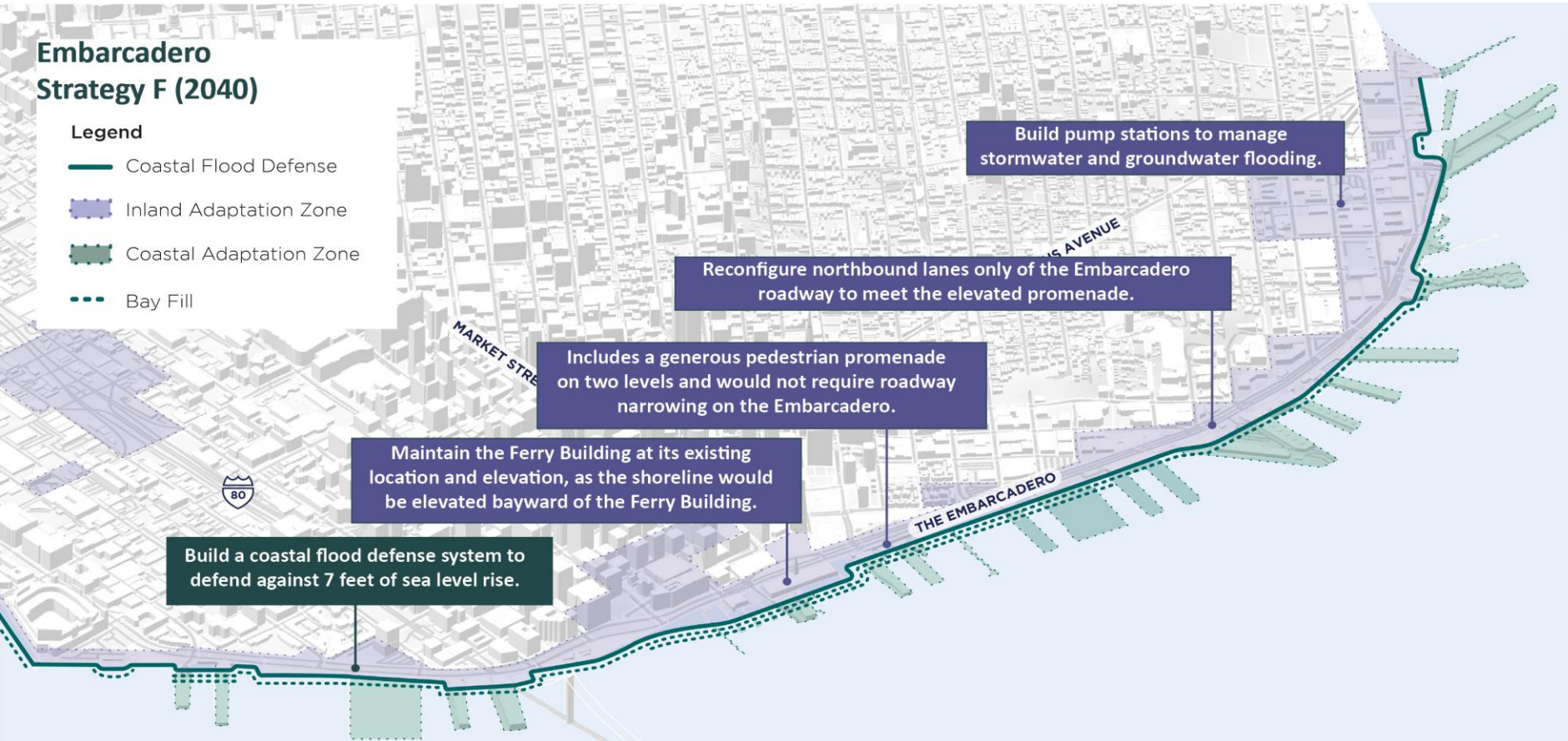
Build a coastal flood defense system to defend against 7 feet of sea level rise.

STRATEGY F – HIGHER SEA LEVEL RISE – MANAGE THE WATER

Embarcadero Strategy F (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone
- Bay Fill

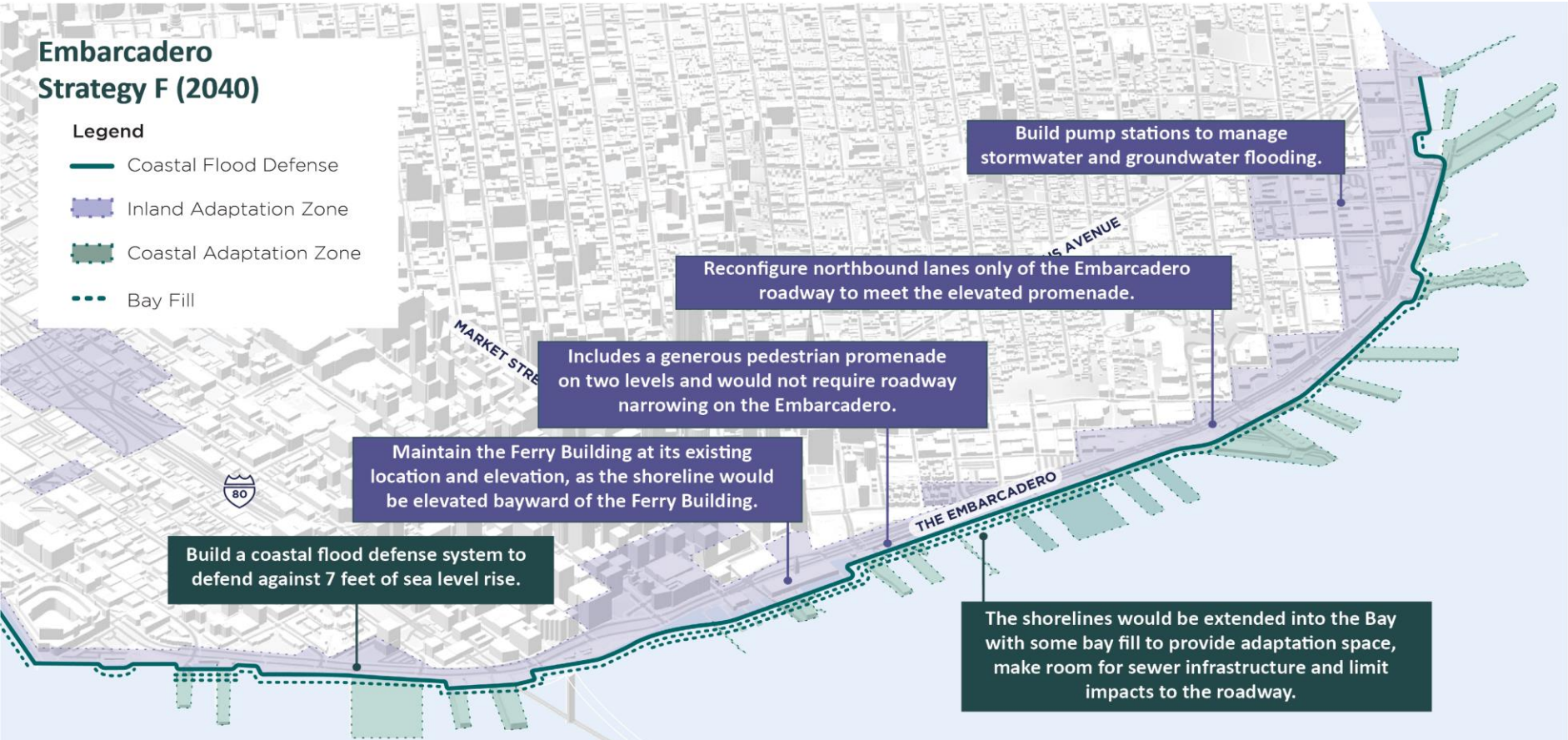


STRATEGY F – HIGHER SEA LEVEL RISE – MANAGE THE WATER

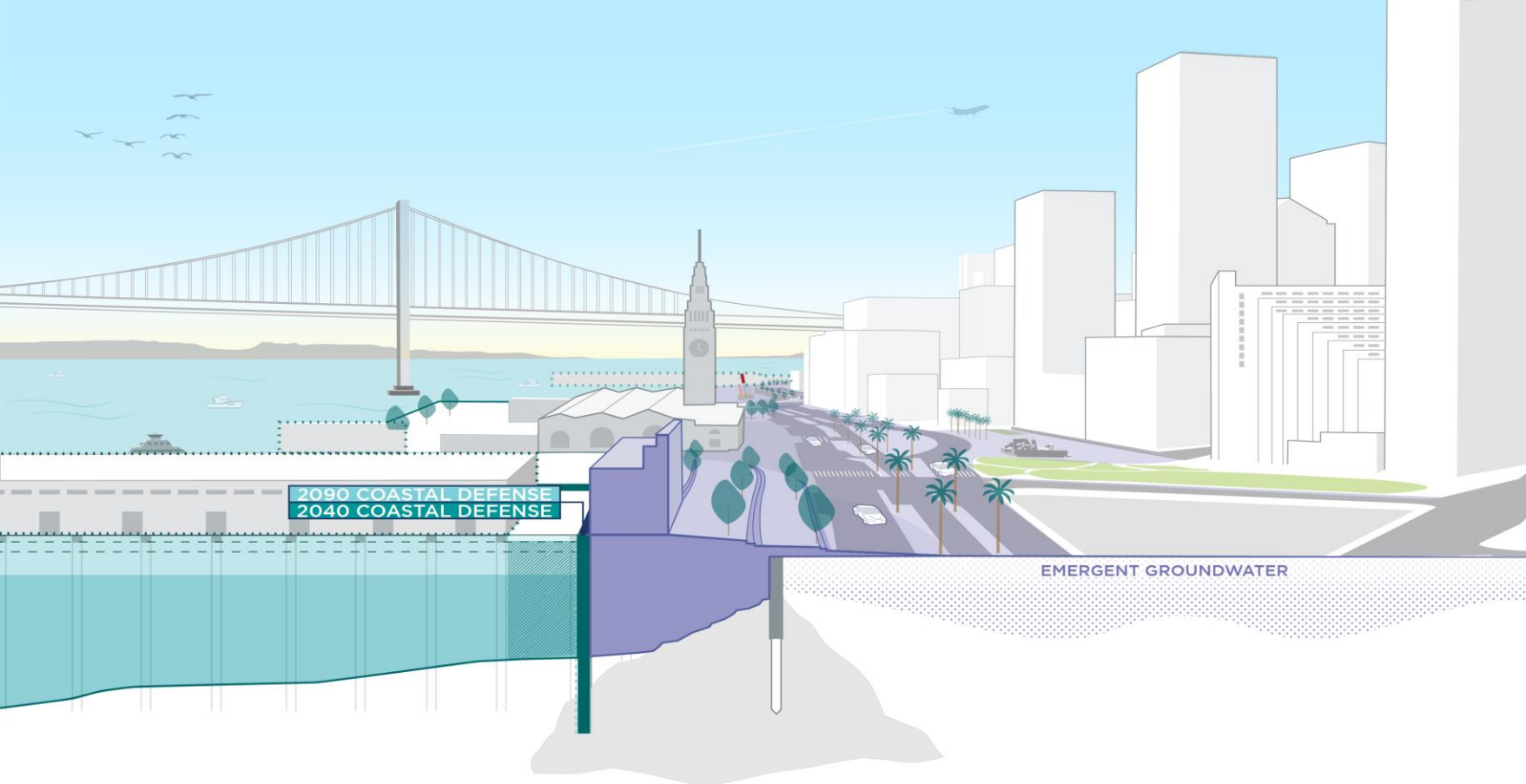
Embarcadero Strategy F (2040)

Legend

- Coastal Flood Defense
- ▨ Inland Adaptation Zone
- ▨ Coastal Adaptation Zone
- - - Bay Fill

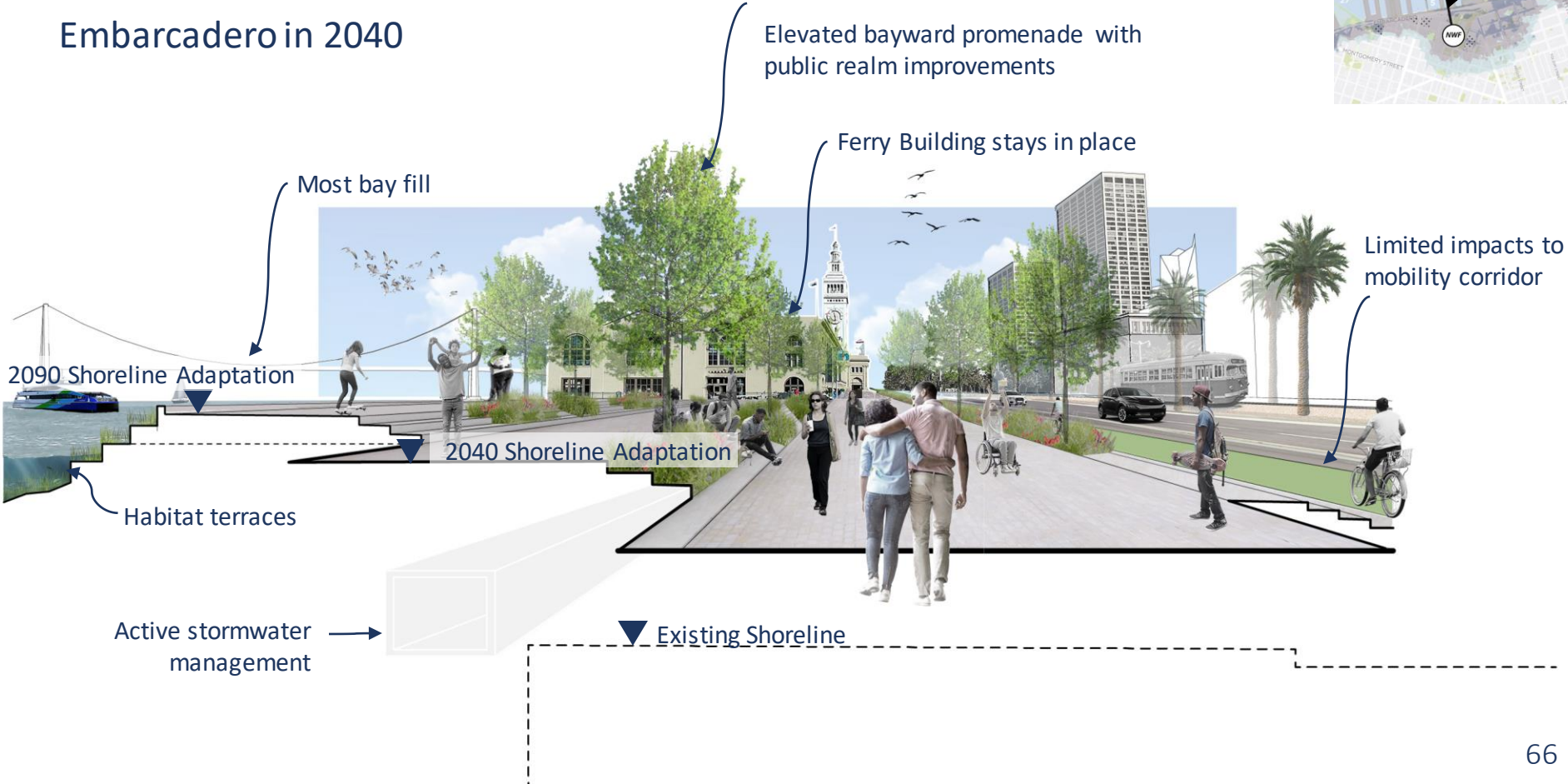


STRATEGY F – HIGHER SEA LEVEL RISE – MANAGE THE WATER



STRATEGY F – HIGHER SEA LEVEL RISE – MANAGE THE WATER

Embarcadero in 2040



Most bay fill

Elevated bayward promenade with public realm improvements

Ferry Building stays in place

Limited impacts to mobility corridor

2090 Shoreline Adaptation

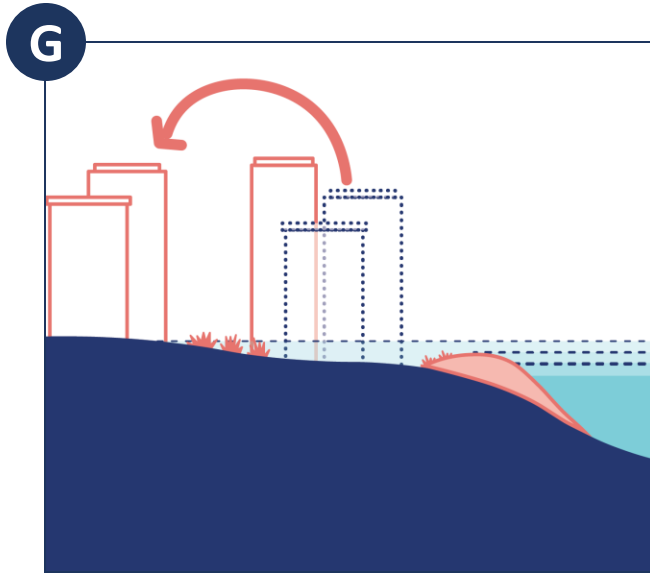
2040 Shoreline Adaptation

Habitat terraces

Active stormwater management

Existing Shoreline

STRATEGY G – HIGHER SEA LEVEL RISE – ALIGN WITH WATERSHEDS



Advances shoreline adaptation while working with natural inland flooding patterns to floodproof some buildings and infrastructure and move others away from the highest risk areas

STRATEGY G – HIGHER SEA LEVEL RISE – ALIGN WITH WATERSHEDS

Embarcadero Strategy G (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone



STRATEGY G – HIGHER SEA LEVEL RISE – ALIGN WITH WATERSHEDS

Embarcadero Strategy G (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone



Raise the Ferry Building at its existing location.

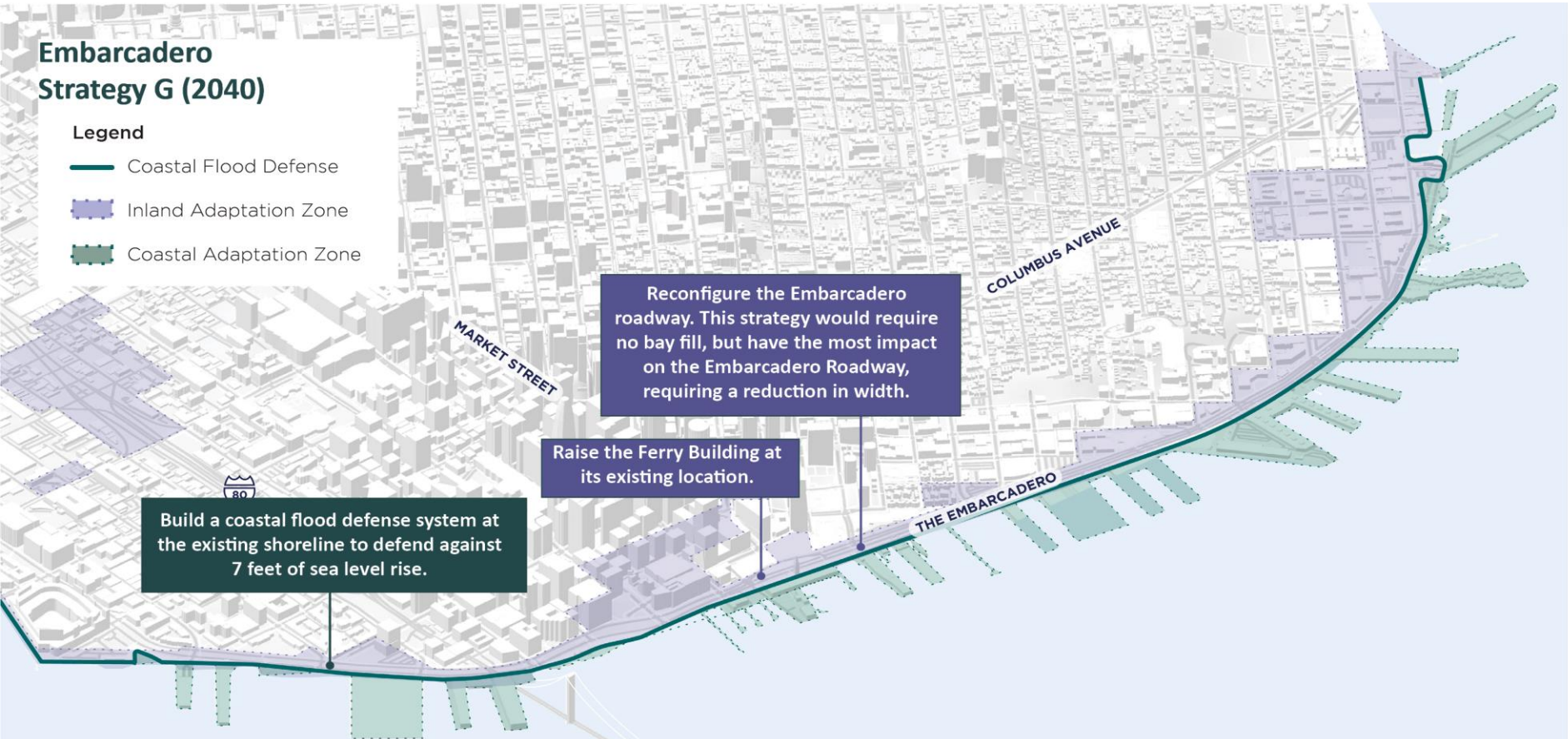
Build a coastal flood defense system at the existing shoreline to defend against 7 feet of sea level rise.

STRATEGY G – HIGHER SEA LEVEL RISE – ALIGN WITH WATERSHEDS

Embarcadero Strategy G (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone



Reconfigure the Embarcadero roadway. This strategy would require no bay fill, but have the most impact on the Embarcadero Roadway, requiring a reduction in width.

Raise the Ferry Building at its existing location.

Build a coastal flood defense system at the existing shoreline to defend against 7 feet of sea level rise.

STRATEGY G – HIGHER SEA LEVEL RISE – ALIGN WITH WATERSHEDS

Embarcadero Strategy G (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone

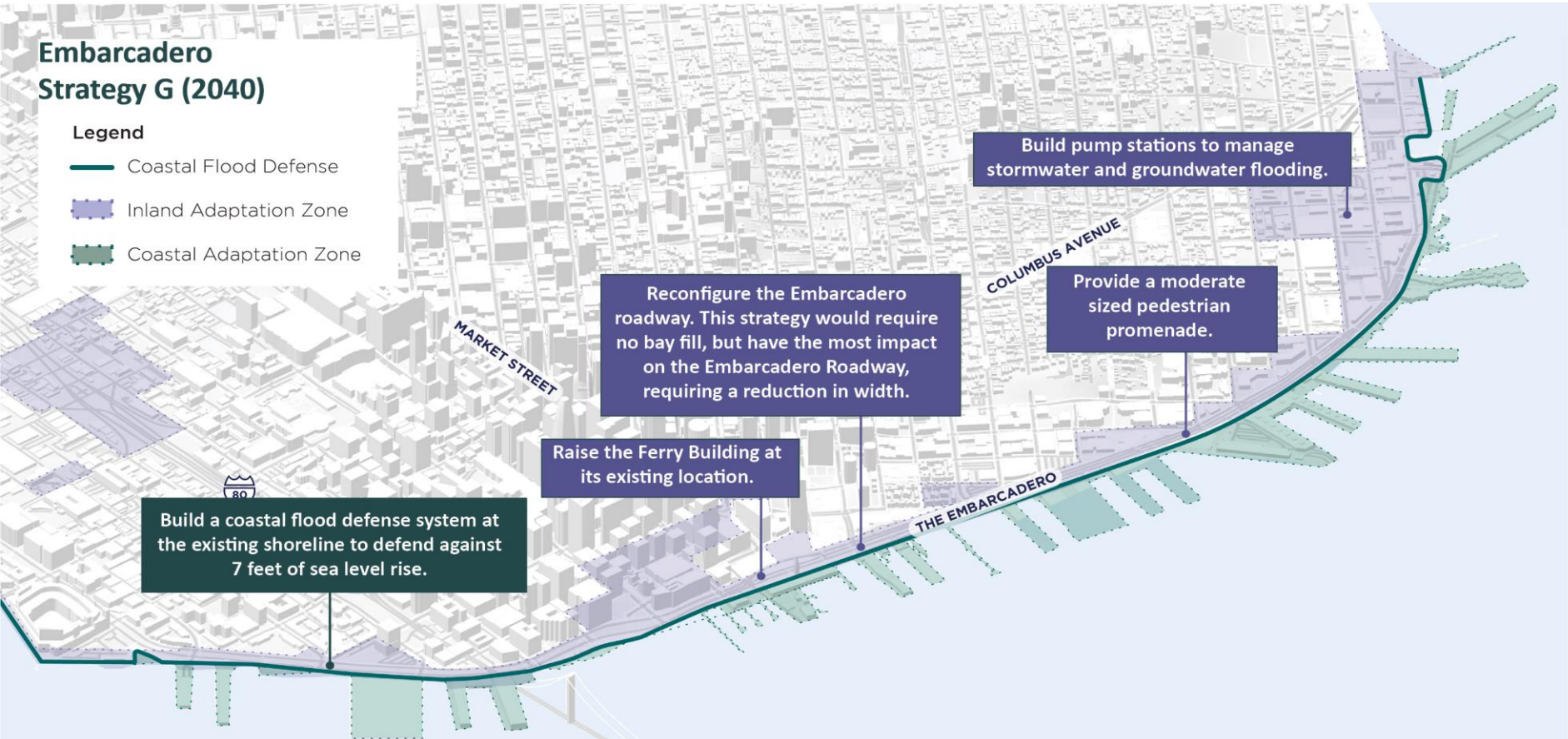


STRATEGY G – HIGHER SEA LEVEL RISE – ALIGN WITH WATERSHEDS

Embarcadero Strategy G (2040)

Legend

- Coastal Flood Defense
- Inland Adaptation Zone
- Coastal Adaptation Zone



Build pump stations to manage stormwater and groundwater flooding.

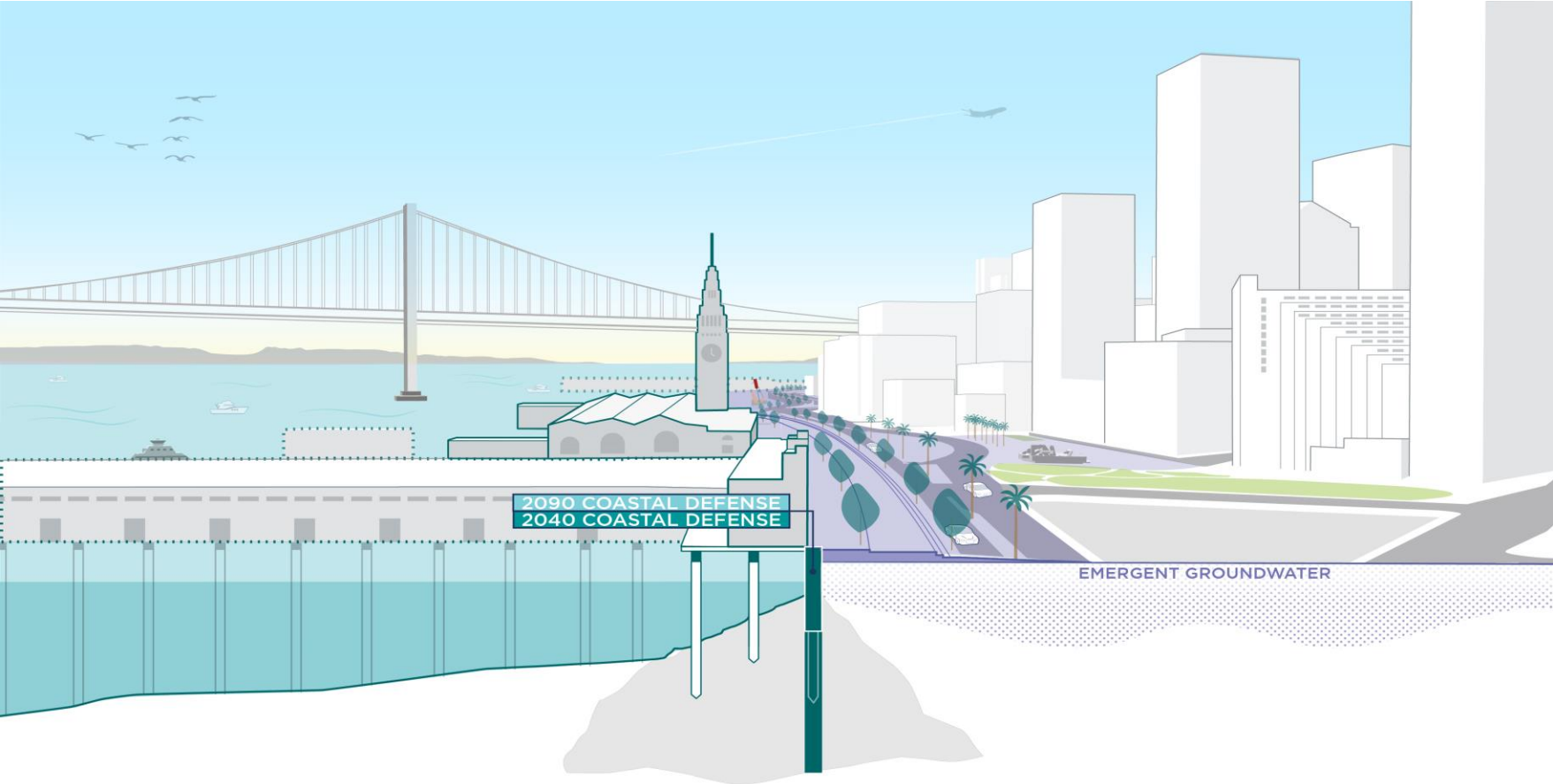
Reconfigure the Embarcadero roadway. This strategy would require no bay fill, but have the most impact on the Embarcadero Roadway, requiring a reduction in width.

Provide a moderate sized pedestrian promenade.

Raise the Ferry Building at its existing location.

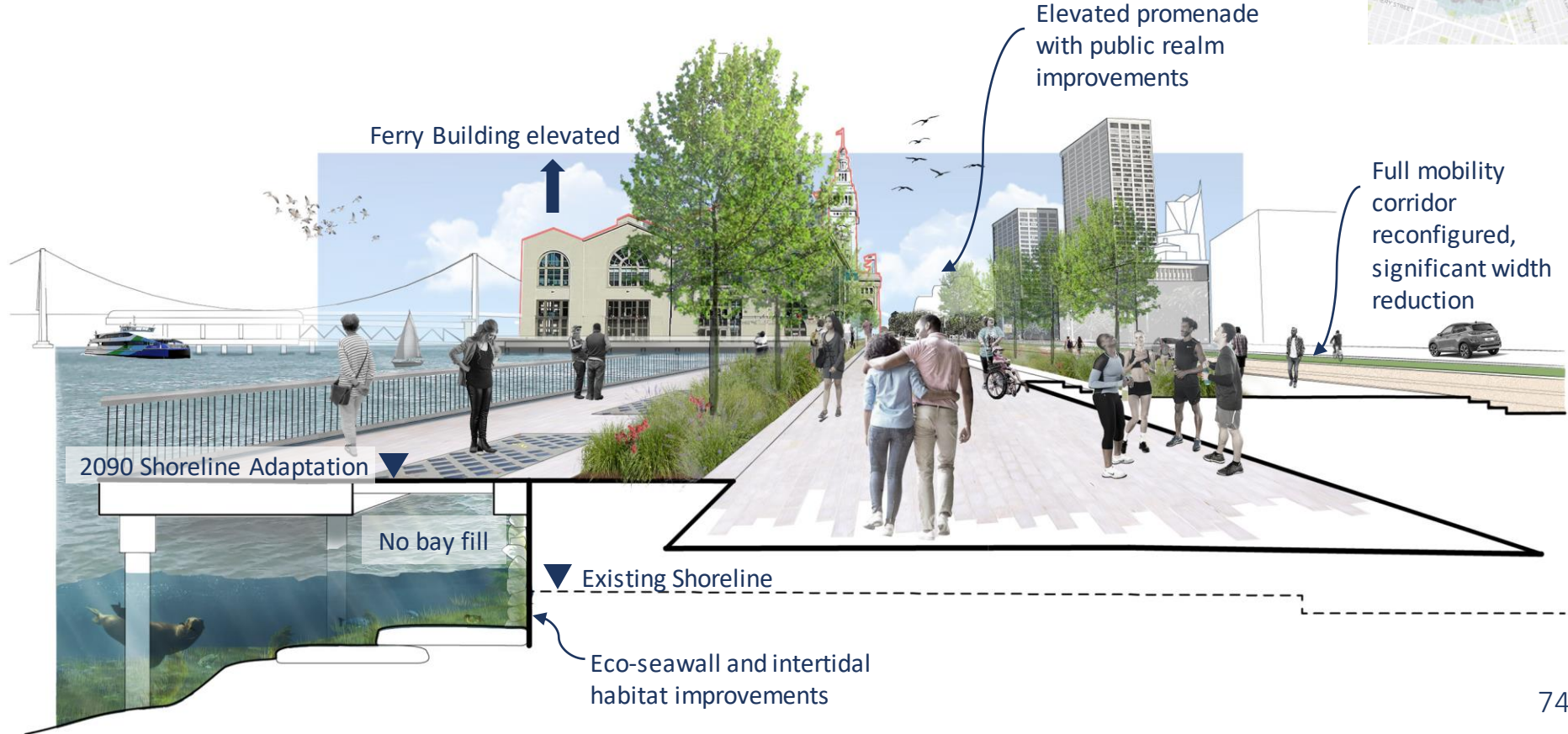
Build a coastal flood defense system at the existing shoreline to defend against 7 feet of sea level rise.

STRATEGY G – HIGHER SEA LEVEL RISE – ALIGN WITH WATERSHEDS



STRATEGY G – HIGHER SEA LEVEL RISE – ALIGN WITH WATERSHEDS

Embarcadero in 2040



Ferry Building elevated

Elevated promenade with public realm improvements

Full mobility corridor reconfigured, significant width reduction

2090 Shoreline Adaptation

No bay fill

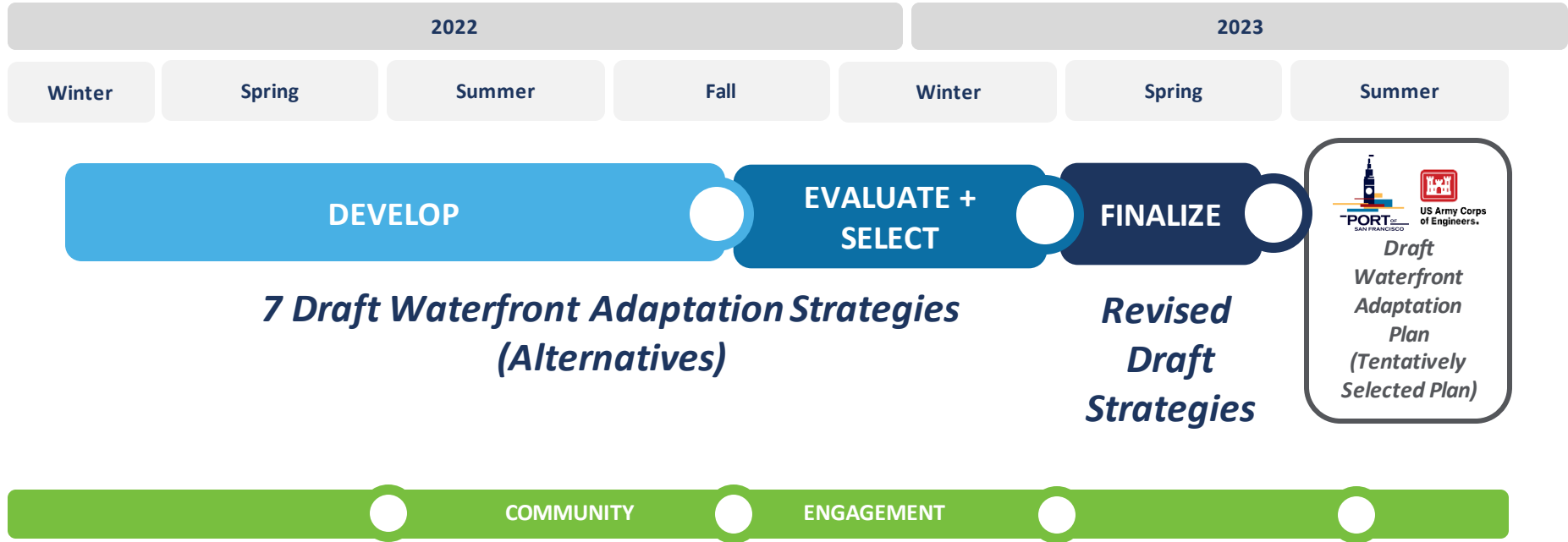
Existing Shoreline

Eco-seawall and intertidal habitat improvements

Next Steps



DRAFT WATERFRONT ADAPTATION STRATEGIES DEVELOPMENT SCHEDULE



COMMUNITY ENGAGEMENT PLAN

OCT

NOV

DEC

JAN

Materials Live on sfport.com/wrp

Other Commission Meetings

Community Workshops /
Meetings

In Person Outreach via Walking Tours
and Waterfront Community Mixer

Digital Engagement via StoryMaps

Presentations to CACs, southern waterfront CBOs, etc.

Focus Groups



WHAT WE'VE HEARD SO FAR



- Summer Survey of over 1000 respondents
- Openness to exploring many kinds of adaptation approaches (including more transformative options)
- Desire to preserve and expand connections between the city and the waterfront
- Curiosity about feasibility, cost, and disruption impacts

A photograph of two children riding bicycles on a dirt path. The child in the foreground is wearing a red and white jersey and a yellow helmet. The child in the background is wearing a dark jersey with the number 30 and a dark helmet. In the background, a large ship is visible in a harbor under a clear blue sky.

Thank You

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