

Climate Change, Water, and Cities: How Communities Can Adapt to Sea-Level Rise and Increased Flood Risk

**Association of Environmental Professionals
California State Conference Session, May 19, 2017**

Moderator:

**Alan Murphy
Perkins Coie LLP**

Panelists:

**Diane Oshima
Port of San Francisco**

**Brian Strong
City and County of San Francisco**

**Geoff Smick
WRA, Inc.**



ONESF

Building Our Future

onesanfrancisco.org

There's only one San Francisco. Let's take care of it.



Climate Change, Water and Cities

Association of Environmental Professionals

Brian Strong, Chief Resilience Officer, City and County of San Francisco

May 19, 2017

Resilience Planning in San Francisco

2



- ▣ Definition of resilience on the 100 RC model:
 - ▣ Consider disaster preparedness and recovery for both infrastructure and communities
 - ▣ Address systemic crises like economic downturns, poverty, and housing shortages
 - ▣ Incorporate slow-moving disasters such as climate change and sea level rise

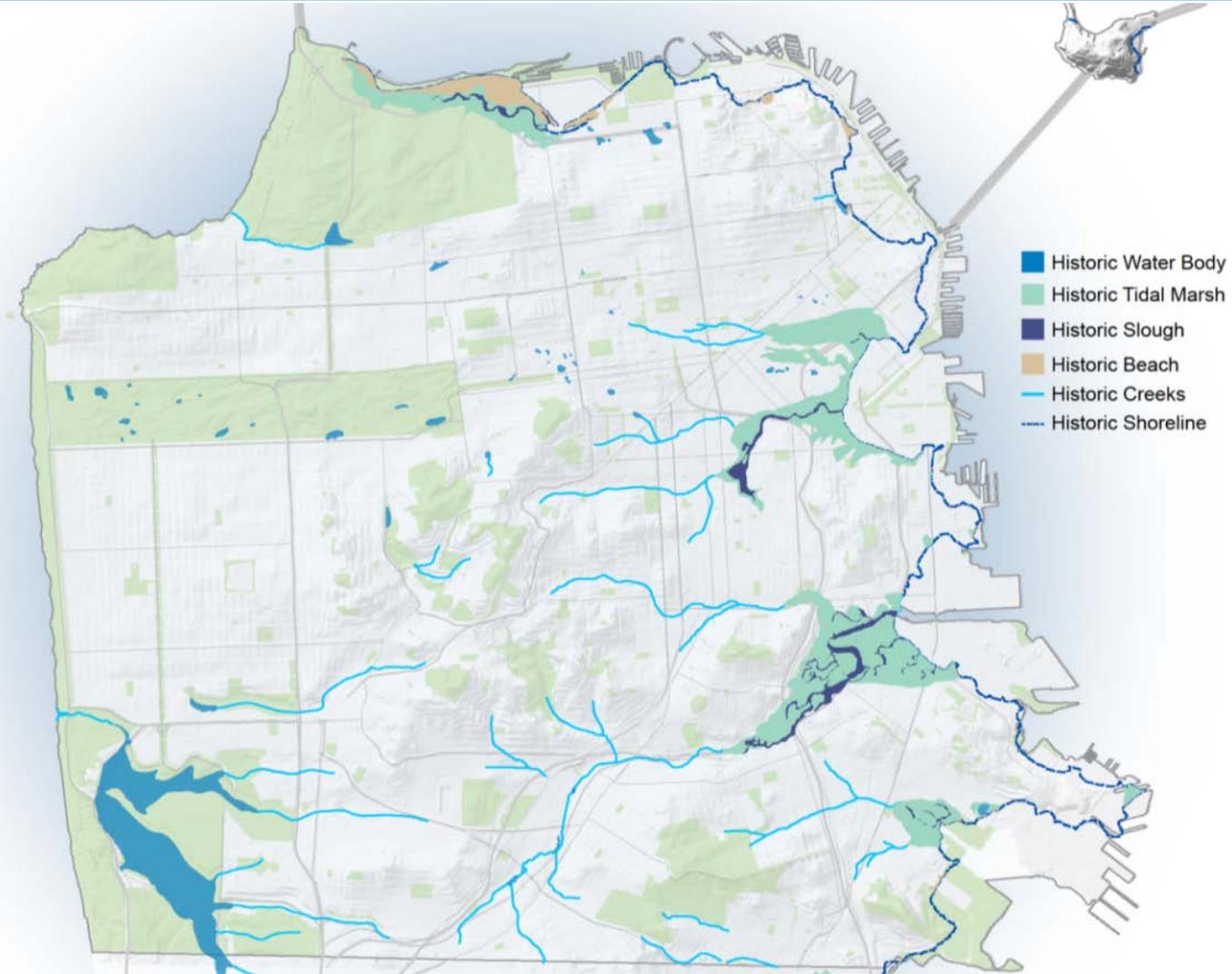
Critical Challenges to Resilience Planning

3

- ▣ Creating a sense of urgency
- ▣ Long-term planning and implementation in a political environment
- ▣ Focus on engineering and top-down isn't effective
 - ▣ Emphasis has been to engineer solutions with little thought about recovery
 - ▣ Need for greater community engagement
- ▣ Issues of equity, displacement, housing, demographics, and population growth
- ▣ Multiple challenges associated with water
 - ▣ Water and sewer systems are facing massive capital improvement needs
 - ▣ SLR is not your typical capital improvement projects
 - ▣ Sever storm frequency is also rising
- ▣ Lack of incentives to encourage the private sector to address resiliency
- ▣ Funding for mitigation and planning is non-existent

Natural Topography

4



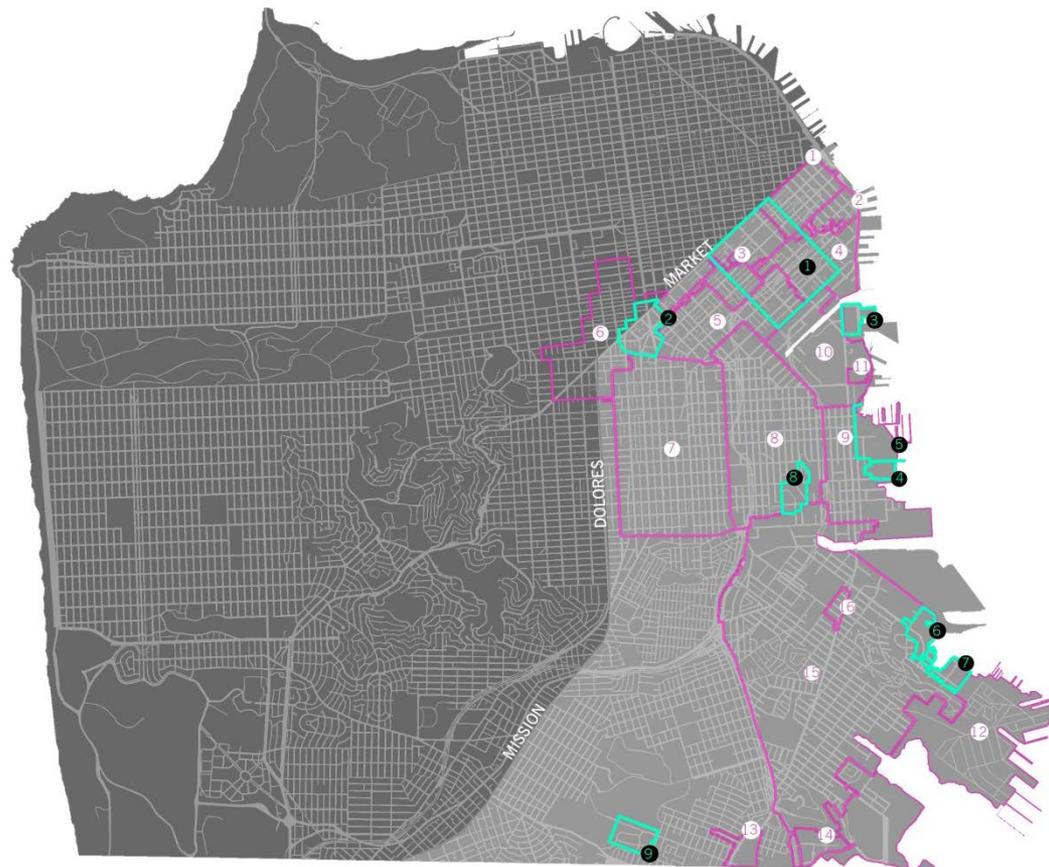
Changing Land Use and Growth

5

- Adopted and proposed Area Plans
- Growth

ADOPTED AREA PLANS PENDING AREA PLANS

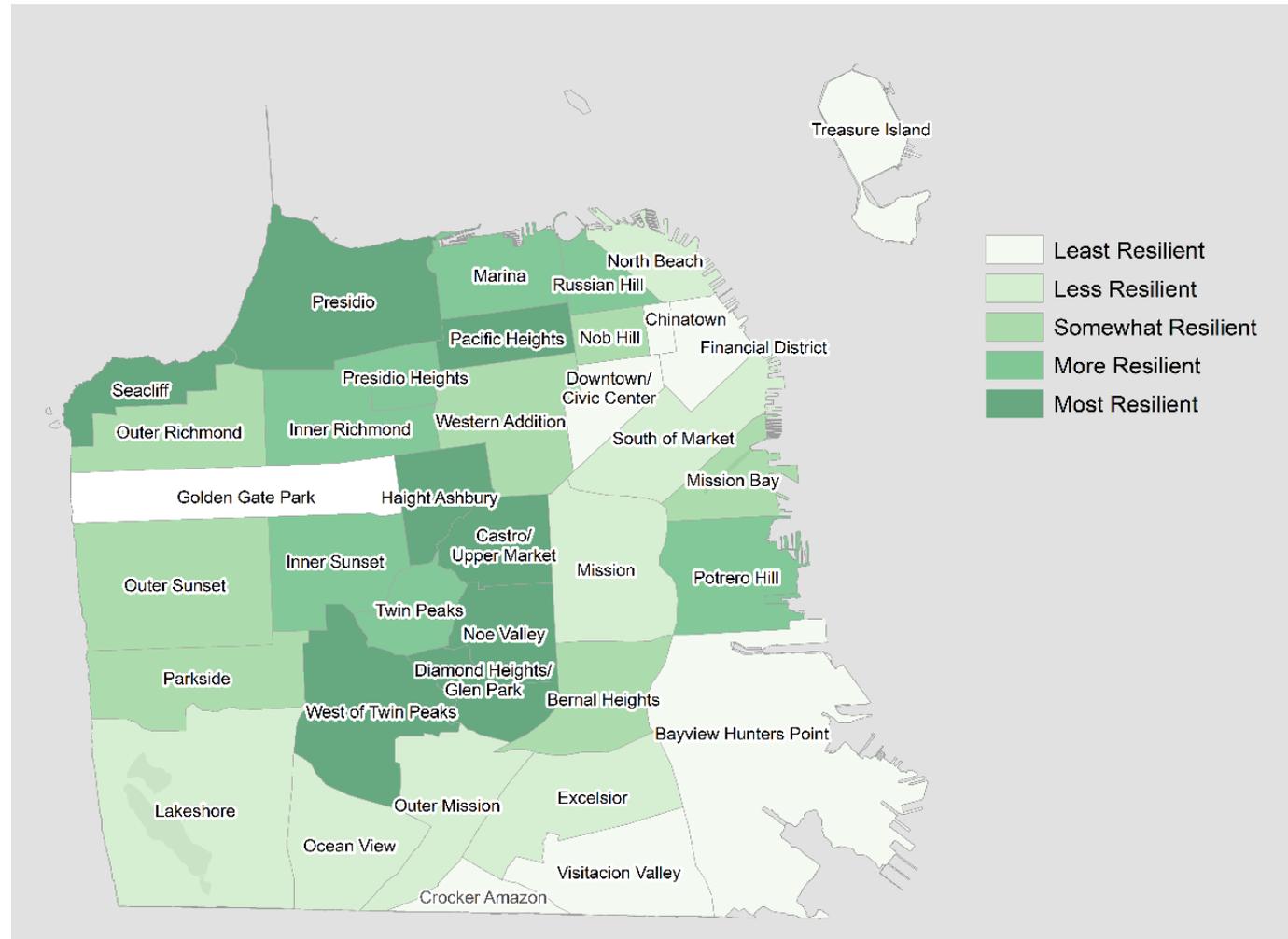
	UNITS		
EXISTING	95,417	266,762	362,179
GROWTH	91,027	53,756	144,783
TOTAL 2040	186,444	320,518	506,962
	POPULATION		
EXISTING	212,251	596,865	809,116
GROWTH	213,913	126,327	340,240
TOTAL 2040	426,164	723,192	1,149,356



Community Resilience

6

- Community Resilience – 2012
- 38 different indicators



Addressing the Resilience Deficit

7

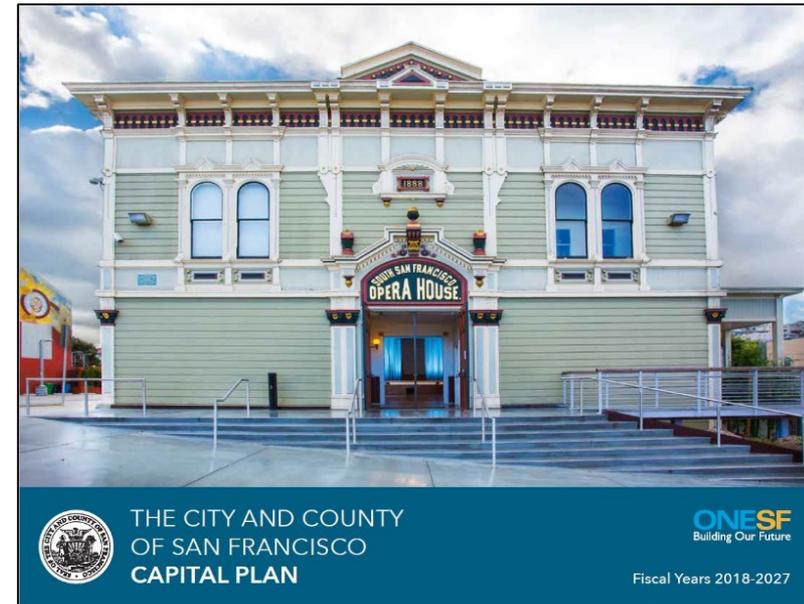
- Capital Plan
- Flooding
- Sea Level Rise Efforts
- Resilience By Design Competition
- Community Resilience



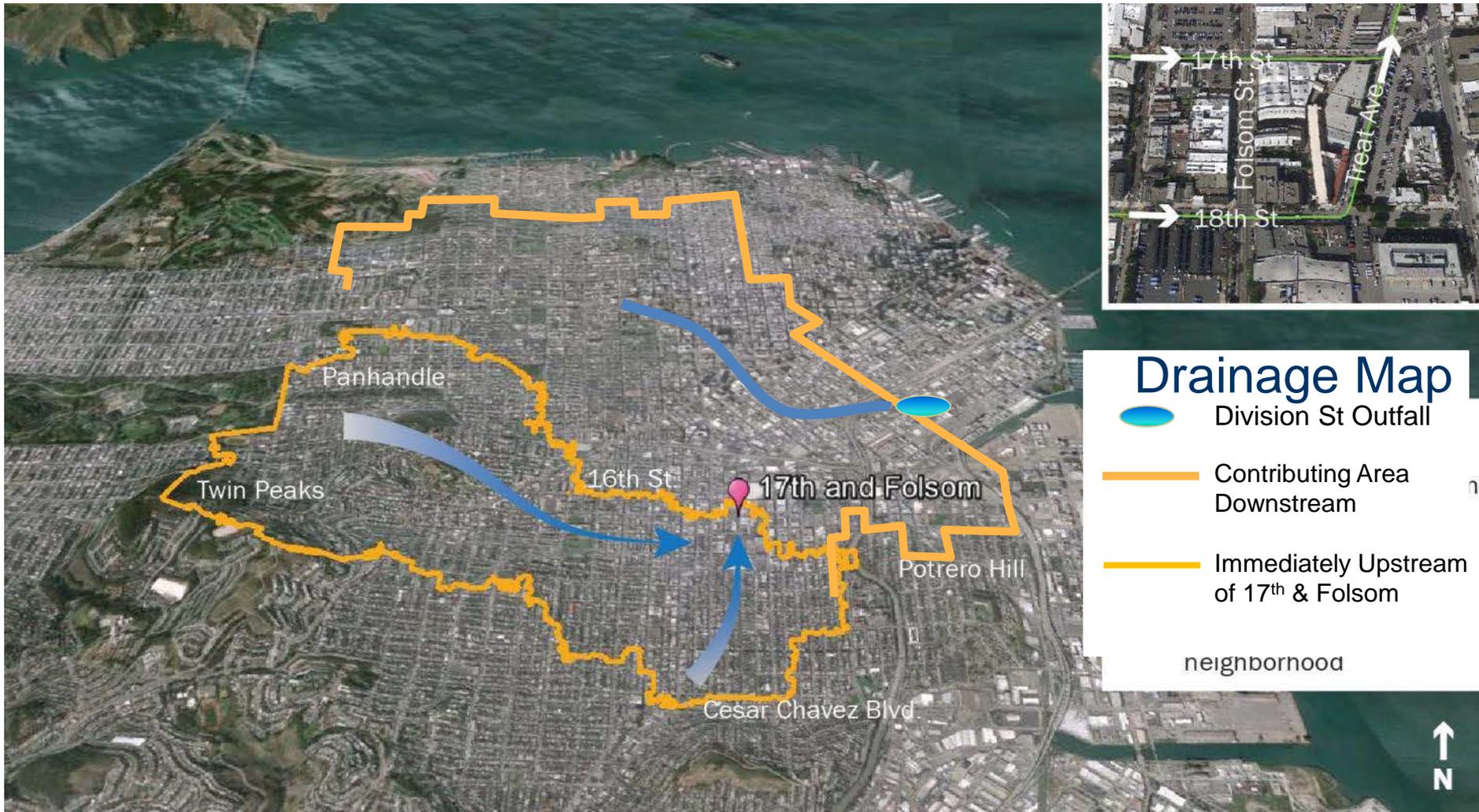
10-Year Capital Plan

8

- Constrained 10-year plan of finance
 - Created in 2006 to coordinate and prioritize infrastructure investments
 - Objective funding principles
 - Current plan proposes to spend \$35 billion through 2027
- Accomplishments
 - Over \$10 billion approved since 2006
 - \$3.5 billion GO bonds since 2008
- Ongoing Projects
 - Sea Wall / Sea Wall Fin. Wkg. Group
 - Sewer System Improvement Program
 - SFO Sea Wall and Improvements
 - Emergency Firefighting Water System
 - Transportation



SSIP Flood Resilience Study



Sea Level Rise Guidelines for Capital Planning

11

- Findings on best available science
- Incorporates exposure, sensitivity and adaptive capacity
- Trained over 100 project managers, easy-to-use checklist
- Paves way for private property

Year	Projections Likely levels of SLR	Ranges Unlikely but possible SLR
2030	6 in	12 in
2050	11 in	24 in
2100	36 in	66 in



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GUIDANCE FOR INCORPORATING SEA LEVEL RISE
INTO CAPITAL PLANNING IN SAN FRANCISCO:
ASSESSING VULNERABILITY AND RISK TO SUPPORT ADAPTATION

Prepared by the City and County of San Francisco
Sea Level Rise Committee for the San Francisco Capital Planning Committee

Adopted by the Capital Planning Committee
September 22, 2014

onesanfrancisco.org

Sea Level Rise Guidelines for Capital Planning

12

Sea Level Rise	Water Level above MHHW	Extreme Tide (Storm Surge) Levels						
		1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0"	0	12	19	23	27	32	36	41
+6"	6	18	25	29	33	38	42	47
+12"	12	24	31	35	39	44	48	53
+18"	18	30	37	41	45	50	54	59
+24"	24	36	43	47	51	56	60	65
+30"	30	42	49	53	57	62	66	71
+36"	36	48	55	59	63	68	72	77
+42"	42	54	61	65	69	74	78	83
+48"	48	60	67	71	75	80	84	89
+54"	54	66	73	77	81	86	90	95
+60"	60	72	79	83	87	92	96	101
+66"	66	78	85	89	93	98	102	107

SLR Action & Adaptation Plan

Cost of Inaction

YEAR 2100	PRIVATE PROPERTY	PUBLIC PROPERTY	TOTAL EXPOSURE
66" (SLR)	\$19 Billion	\$35 Billion	\$54 Billion
108" (SLR + storm surge)	\$38 Billion	\$37 Billion	\$75 Billion

Note: Dollar amounts indicate asset replacement cost only. Numbers are in today's dollars and reflect upper range, end-of-century projections without adaptation or action.

SLR Action & Adaptation Plan



SLR Action & Adaptation Plan

15

**Asset Inventory and
Exposure Analysis
(2017)**

**Vulnerability and
Risk Assessment
(2017-18)**

Adaptation Plan (2019)

- **Prioritized Projects**
- **Policies and Code**
- **Design Guidelines**
- **Funding Strategies**

Resilience by Design

16

- ▣ Regional
- ▣ Open competition
- ▣ 10 Multi-disciplinary teams
- ▣ Replicable and implementable
- ▣ Science-based
- ▣ Include community engagement and issues of equity

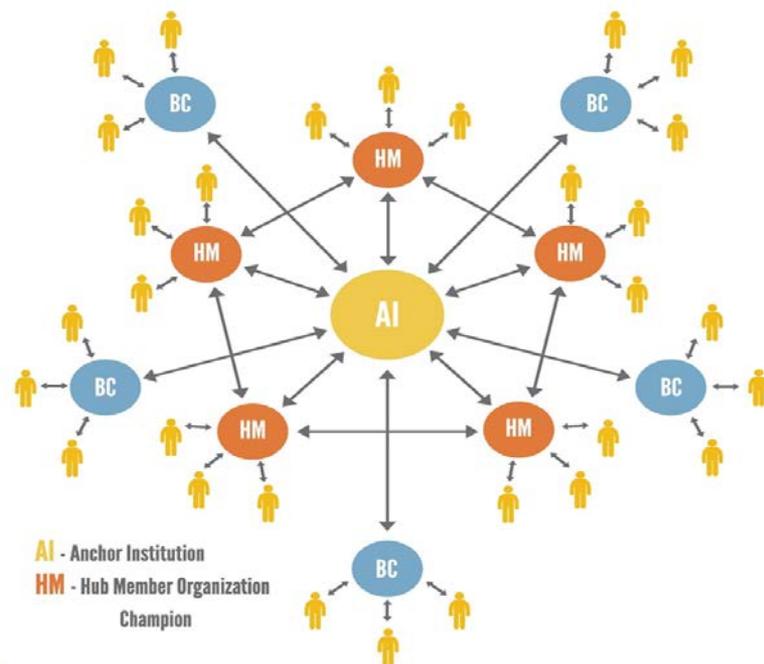


Neighborhood Empowerment Network (NEN)

17

- ❑ Disaster response cannot be driven by government alone
- ❑ Community-based partners expand government's reach
- ❑ NEN organizes local institutions to activate once disaster strikes
- ❑ Community leadership academy in development
- ❑ Nine hubs in southern portion of San Francisco

HUB Pre-Event

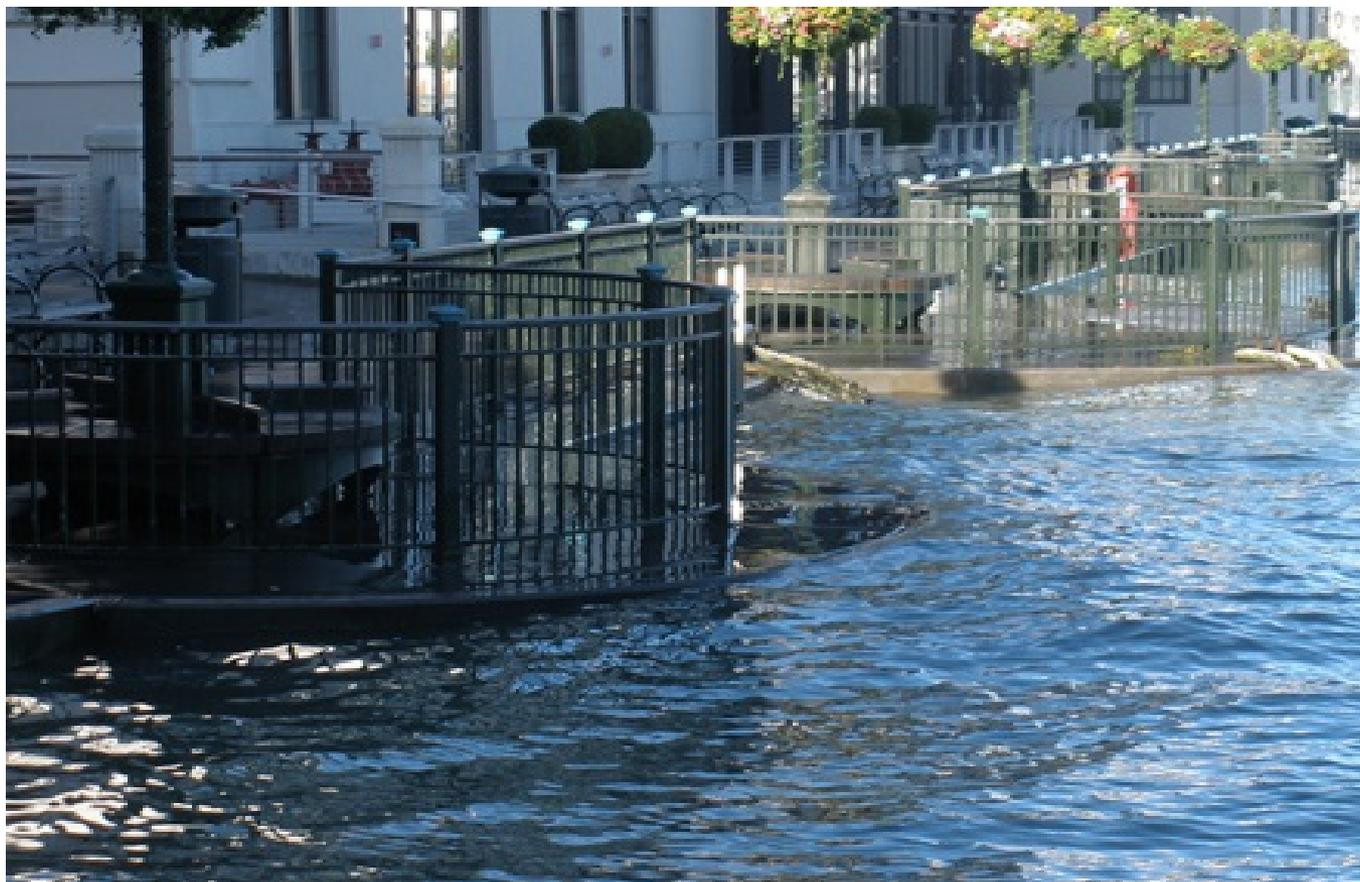


Questions & Comments

18

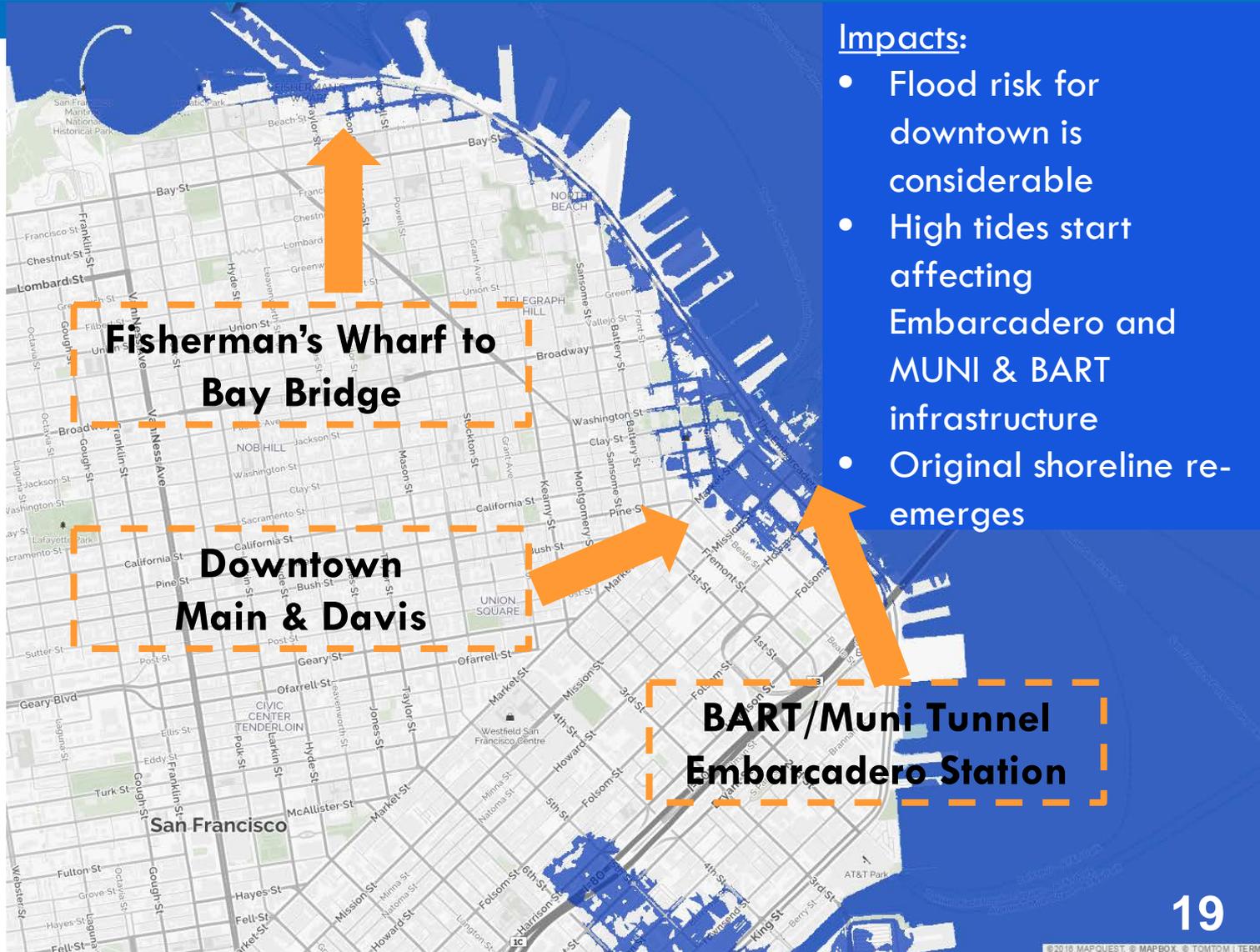
www.onesanfrancisco.org

Brian Strong, Director 554-5165



Projected sea level rise: mid-century

+18 inches | 2040 High Scenario | 2068 Likely Scenario

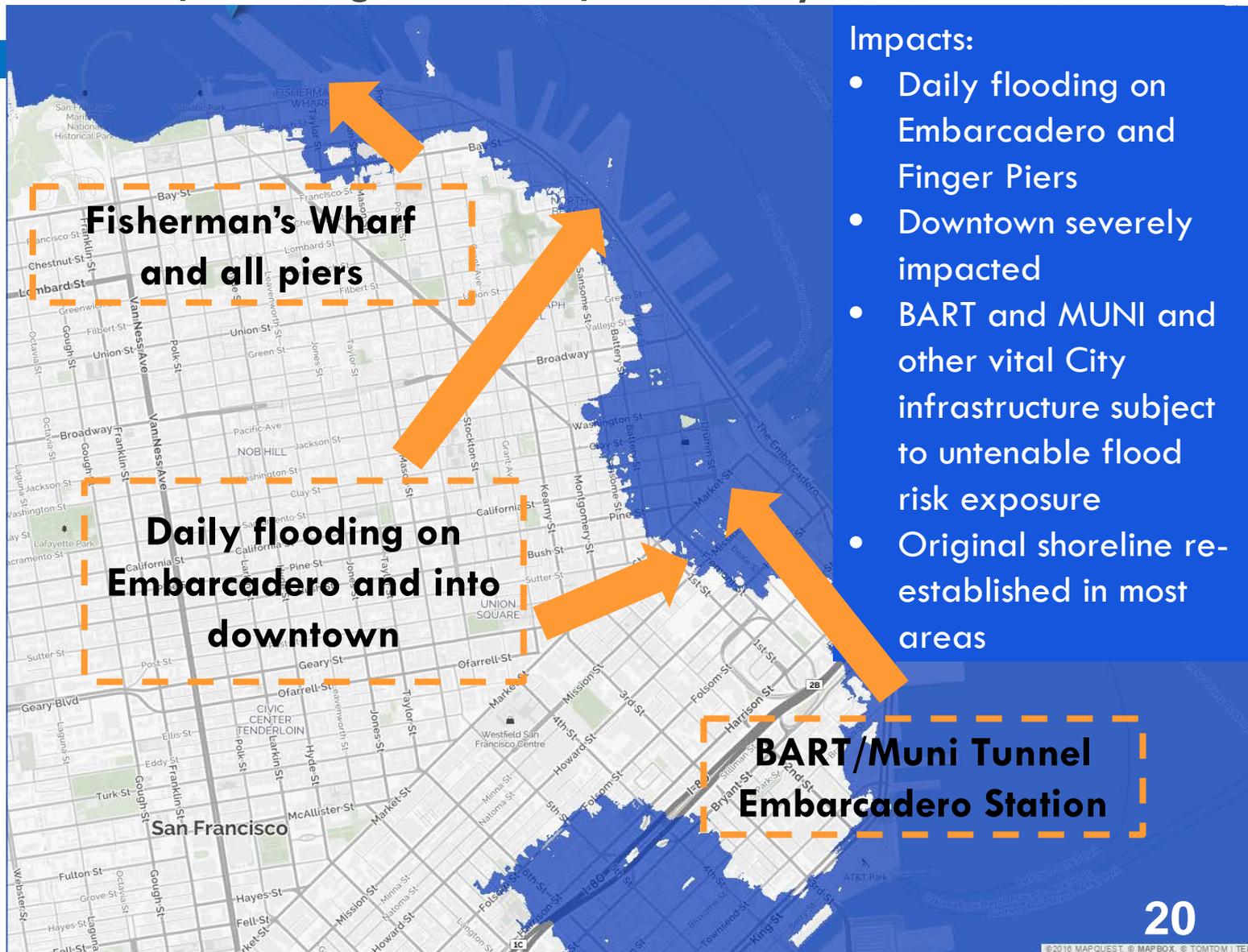


Impacts:

- Flood risk for downtown is considerable
- High tides start affecting Embarcadero and MUNI & BART infrastructure
- Original shoreline re-emerges

Projected sea level rise: end of century

+66 inches | 2100 High Scenario | 2160 Likely Scenario



SFWG Work Process

21

- ▣ 8 meetings between November 2016 and April 2017
- ▣ Work to date:
 - ▣ Research on 48 possible funding strategies
 - ▣ Establishment of 11 evaluation criteria
 - ▣ Analysis of 48 funding strategies based on the criteria
 - ▣ Drafting recommendations and report (in progress)
- ▣ \$350 million G.O. Bond Measure in the proposed Capital Plan

SFWG List of Funding Strategies

23

■ The SFWG analyzed 48 local, regional, state, and federal possible funding strategies:

- State Resilience G.O. Bond
- State Share of Property Tax Increment
- Incorporate into Pier Rehab Projects
- Geologic Hazard Abatement Districts (GHADs)
- Surcharge on Event Tickets
- Transit Pass Transfer Fee
- Increase Ferry Charges
- Cruise Ticket Surcharge
- Hazard Mitigation Grants
- National Foundation Grants
- Historic Tax Credits
- Federal Transportation Funding
- Army Corps of Engineers (USACE) – General Investigation
- USACE – CAP 103 Program
- DHS Office of Infrastructure Protection
- Commuter Transportation Tax
- Vehicle License Fee Increase
- Tax/Fee on Auto Sales
- Tax/Fee on Marina Uses
- Transit Impact Development Fee
- Increased Parking Revenues
- G.O. Bonds
- Assessment District
- CFD/Mello-Roos
- Port IFD
- IRFDs
- Sale/Lease Increment of Port Assets
- Insurance Value Capture/Resilience Bonds
- Sales Tax Increase
- Parcel Tax
- Real Estate Transfer Tax Increase
- Utility User Tax Surcharge
- Business License Tax Surcharge
- RM3- Bridge Tolls
- Cap & Trade Program Funding
- Regional Gas Tax
- Congestion Pricing
- Tax/Fee on Rental Cars
- Business Gross Receipts Tax Surcharge
- Hotel Assessment
- Infrastructure Trust Bank
- Green/Climate Bonds
- Environmental Impact Bonds
- Advertising
- Naming Rights
- Public Private Partnerships
- Philanthropy
- Pension Plan Investment

A woman with a backpack is walking on a wet pier with a metal railing. In the background, the Golden Gate Bridge spans across the water under a cloudy sky. The scene is reflected in a puddle on the pier.

Port of San Francisco

RESILIENCY
CHALLENGES
OPPORTUNITIES

AEP Conference ◦ May 19, 2017



Sea Level Rise & Flood Vulnerability

Sea Level in San Francisco

Increased 8 inches over last 100 yrs

Is predicted to increase

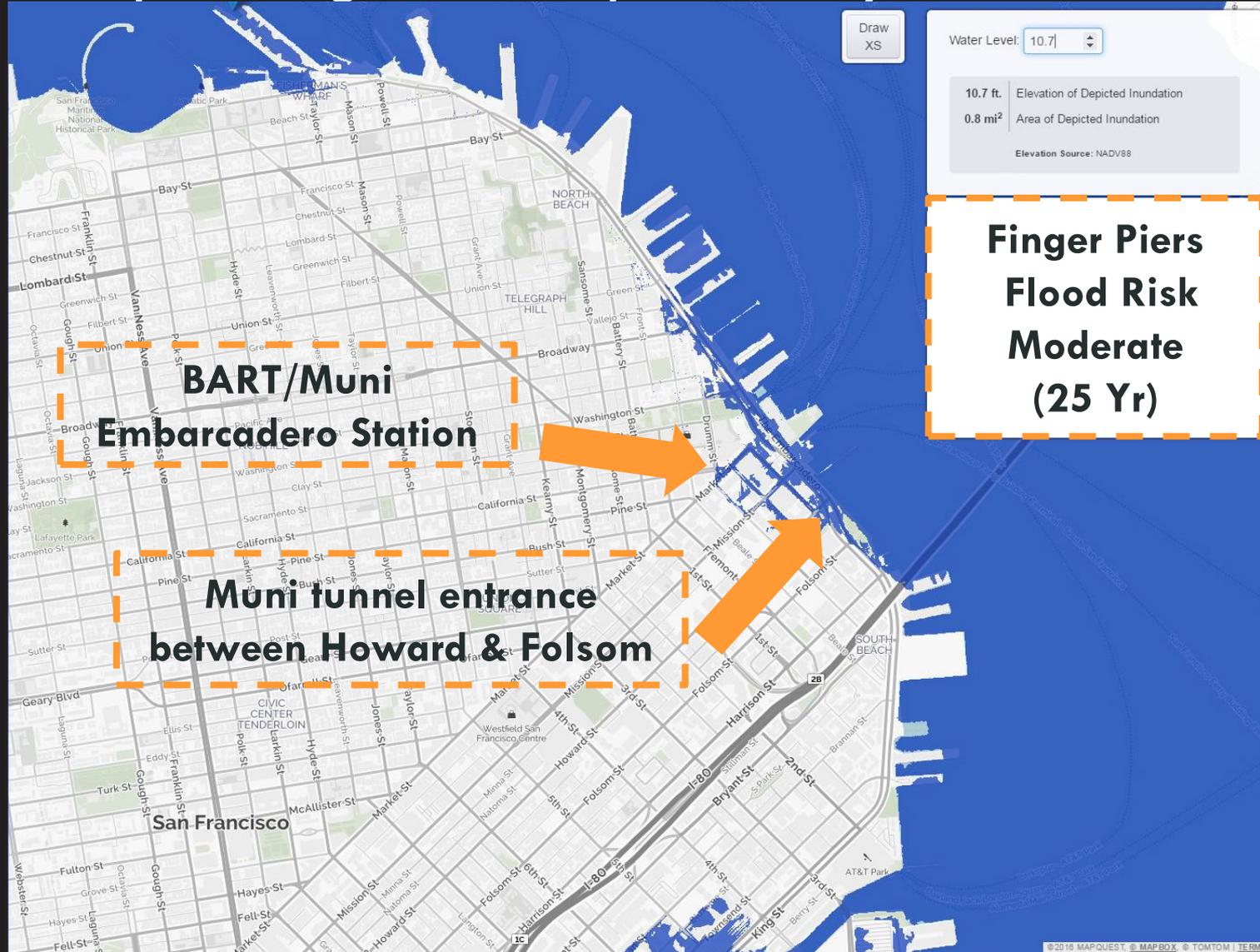
12-24 inches by 2050

36-66 inches by 2100

Sea Level Rise

100 Year Flood Vulnerability

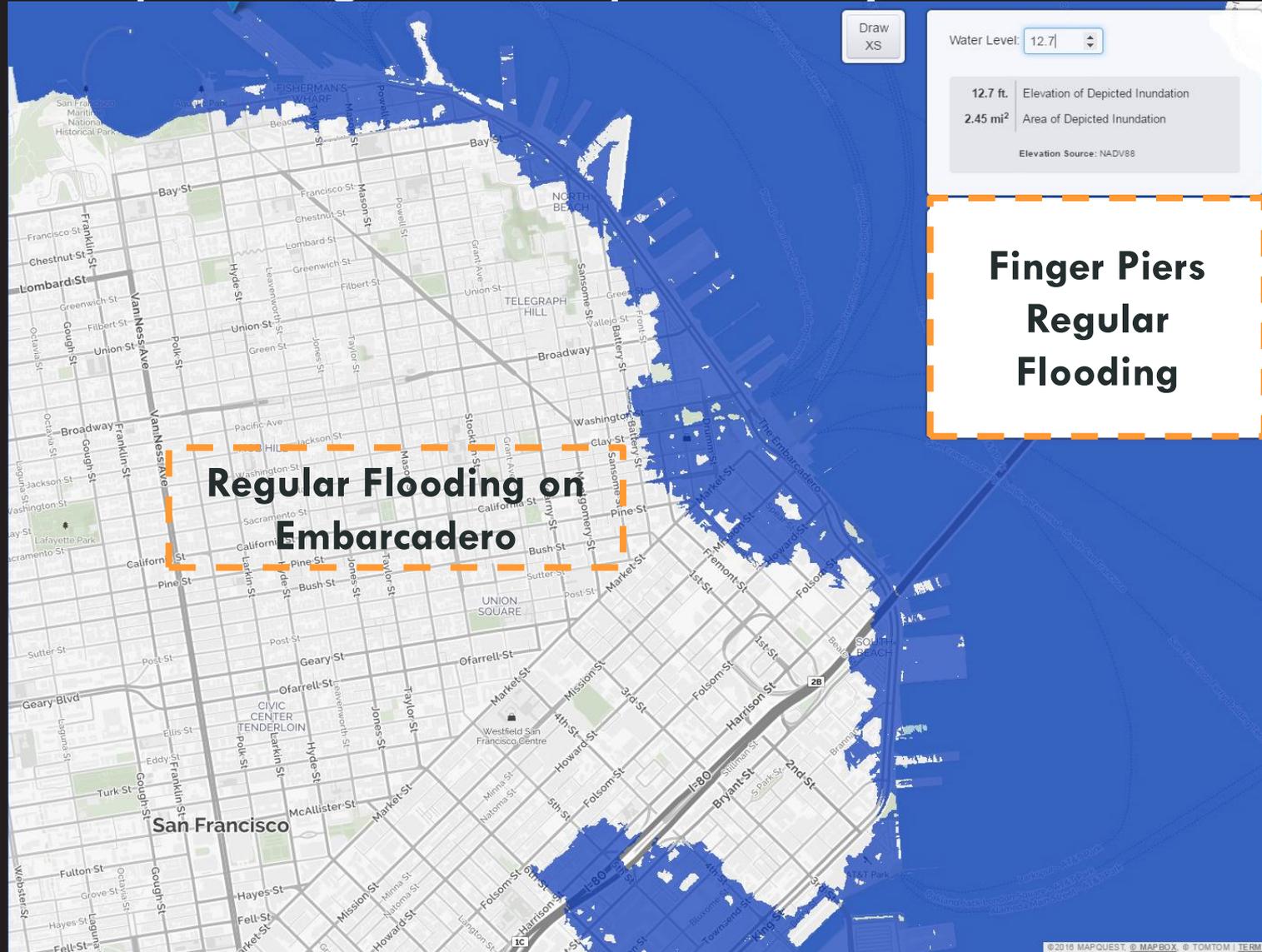
+12 inches | 2030 High Scenario | 2050 Likely Scenario



Sea Level Rise

100 Year Flood Vulnerability

+36 inches | 2067 High Scenario | 2100 Likely Scenario

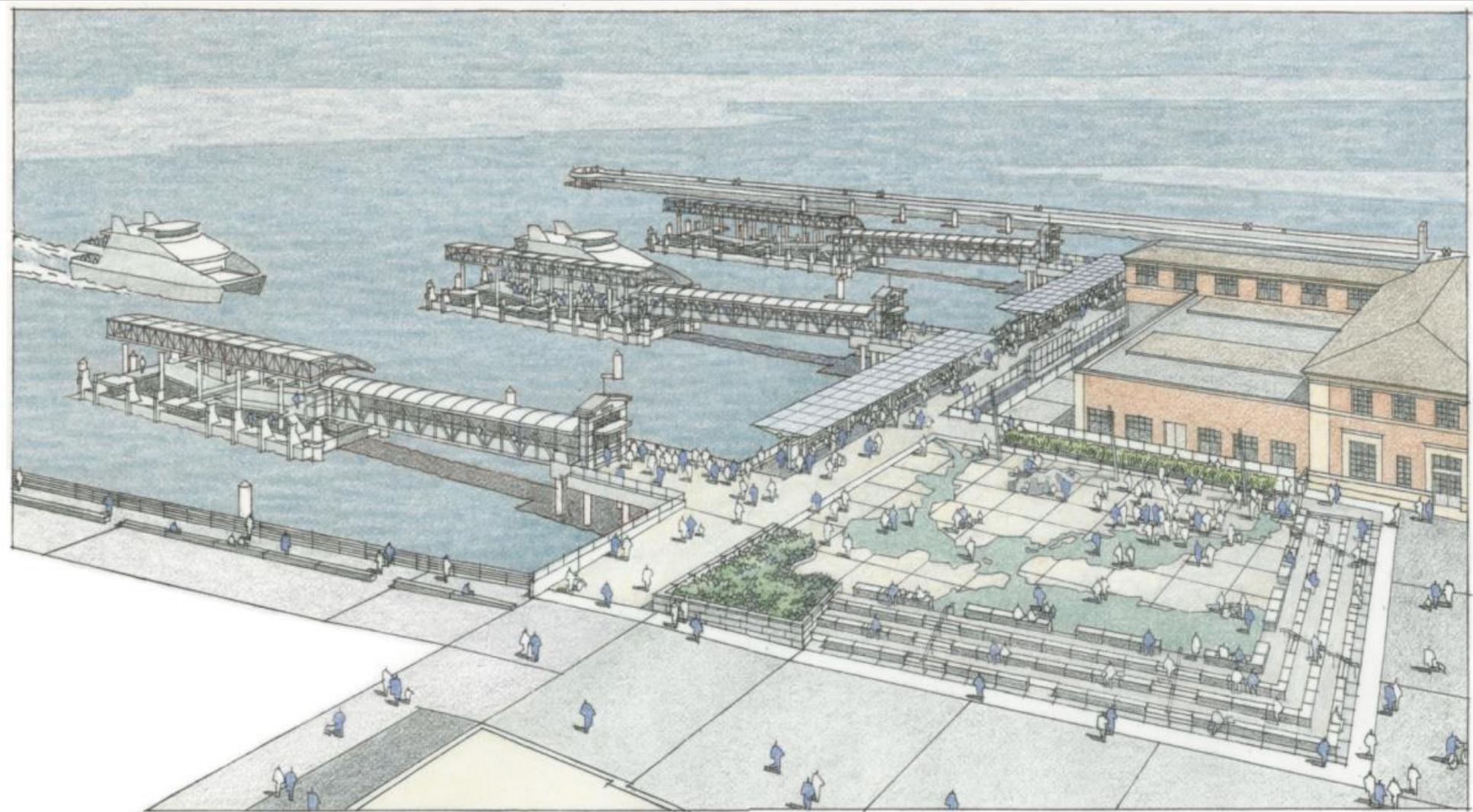


Sea Level Rise & Flood Vulnerability

Pier 14 in King Tides Today



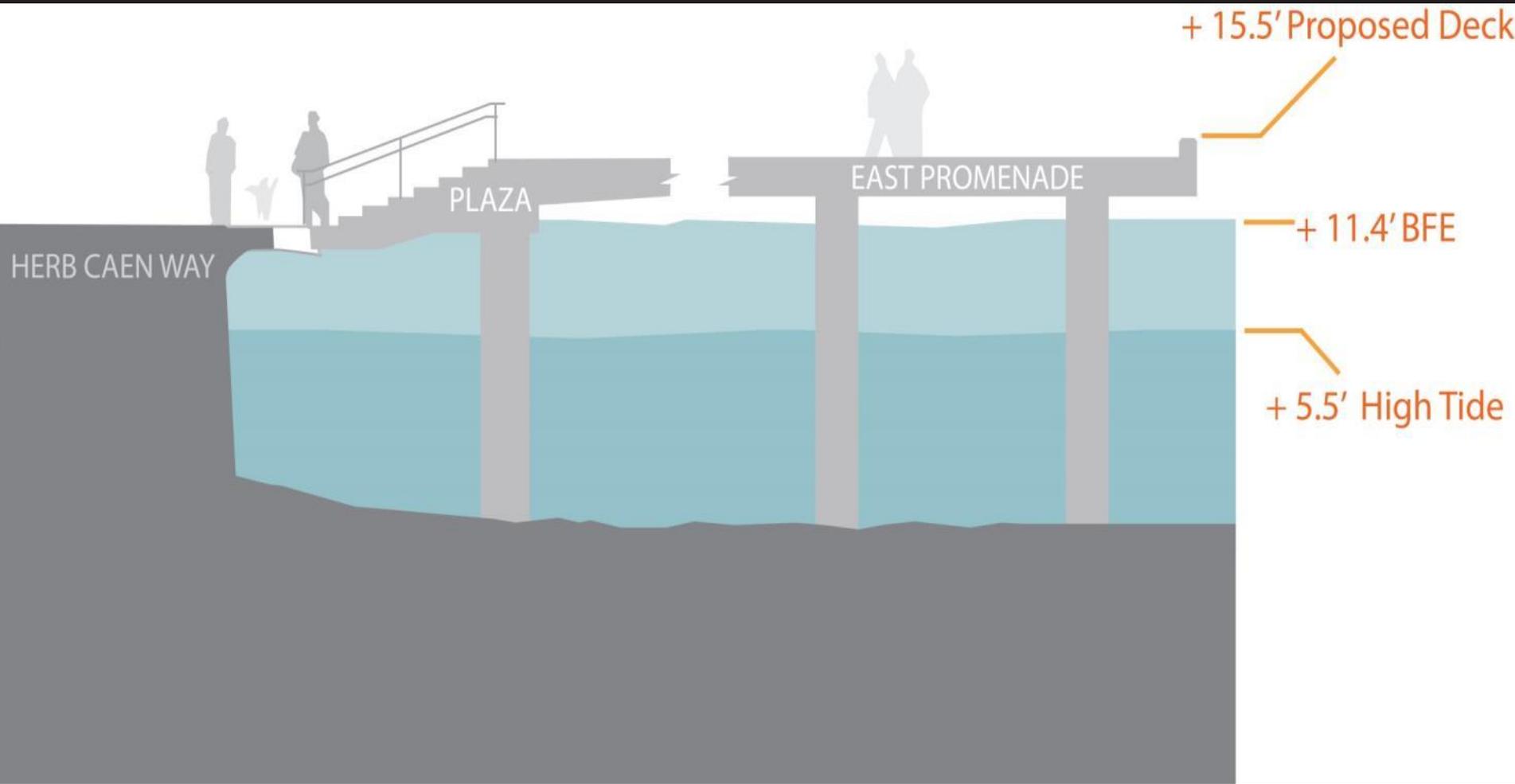
Downtown Ferry Terminal Expansion Project



San Francisco Ferry Terminal Expansion Project

Prepared for the Water Emergency Transportation Authority and the Port of San Francisco by ROMA Design Group and Simpson Gumpertz & Heger

Raising the Deck: Downtown Ferry Terminal Expansion Project



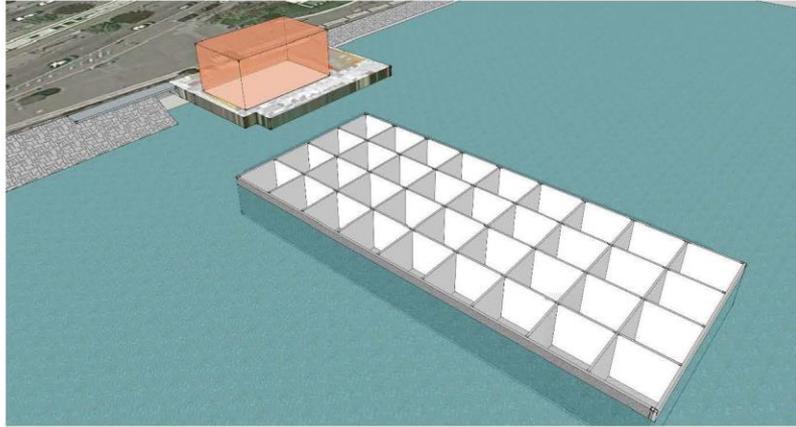
Pier 22 ½ Fireboat Station Expansion Project





photo credit

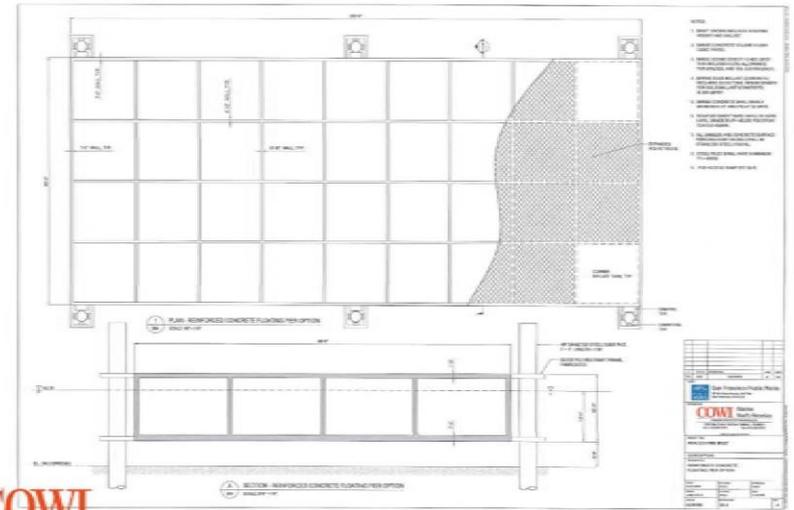
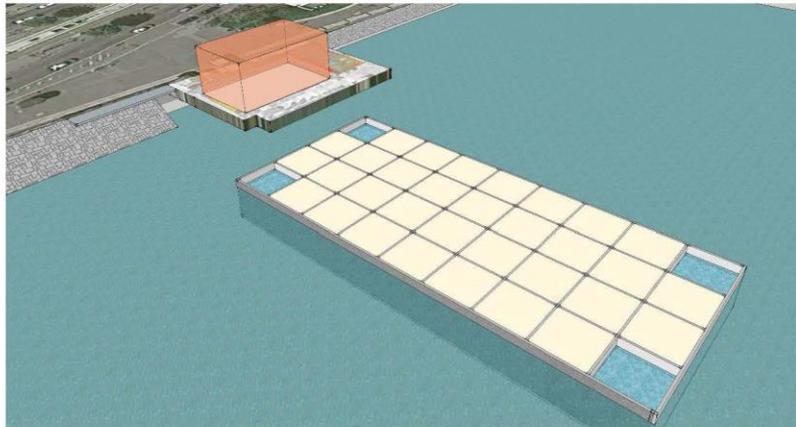
Concrete Barge



Concrete Barge with Guide Piles and Ramp



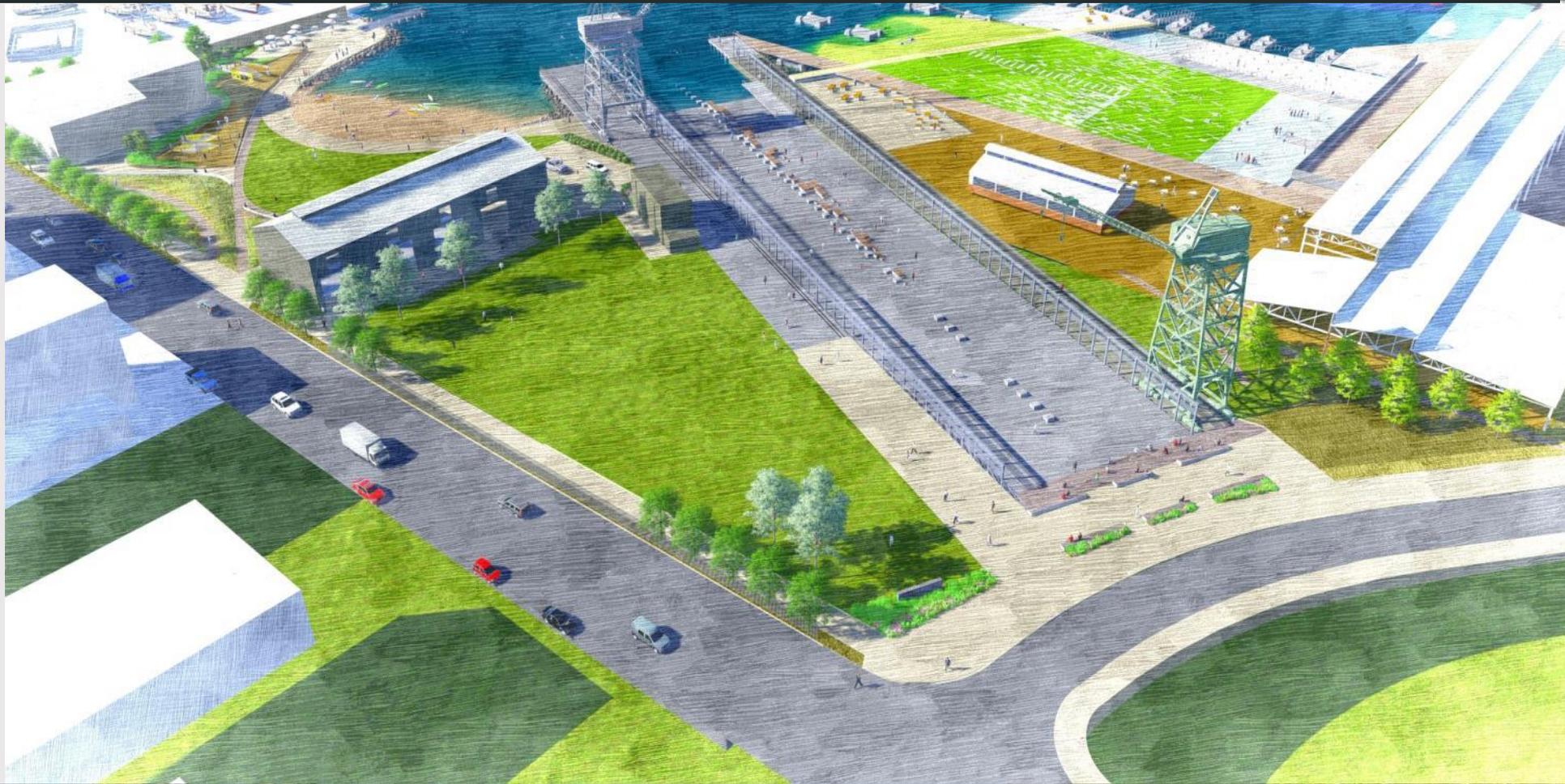
Concrete Barge Deck Slab w/Buoyancy Tanks



Soft Shore Edge to the South



Crane Cove Park: Managed Retreat



history



water



play

Earthquake Vulnerability

72% Probability of Major
Earthquake by 2044

Embarcadero Seawall Resiliency Project

3 Miles long • 500+ acres • Built over 40 years



1850's Shoreline

Mission
Creek

Fisherman's
Wharf

1878 - 1906

1906 - 1916

The Embarcadero Historic District



Bryan Ailo
Photography

Photo: Michael Macor

City Form & Identity

Bulkhead Buildings

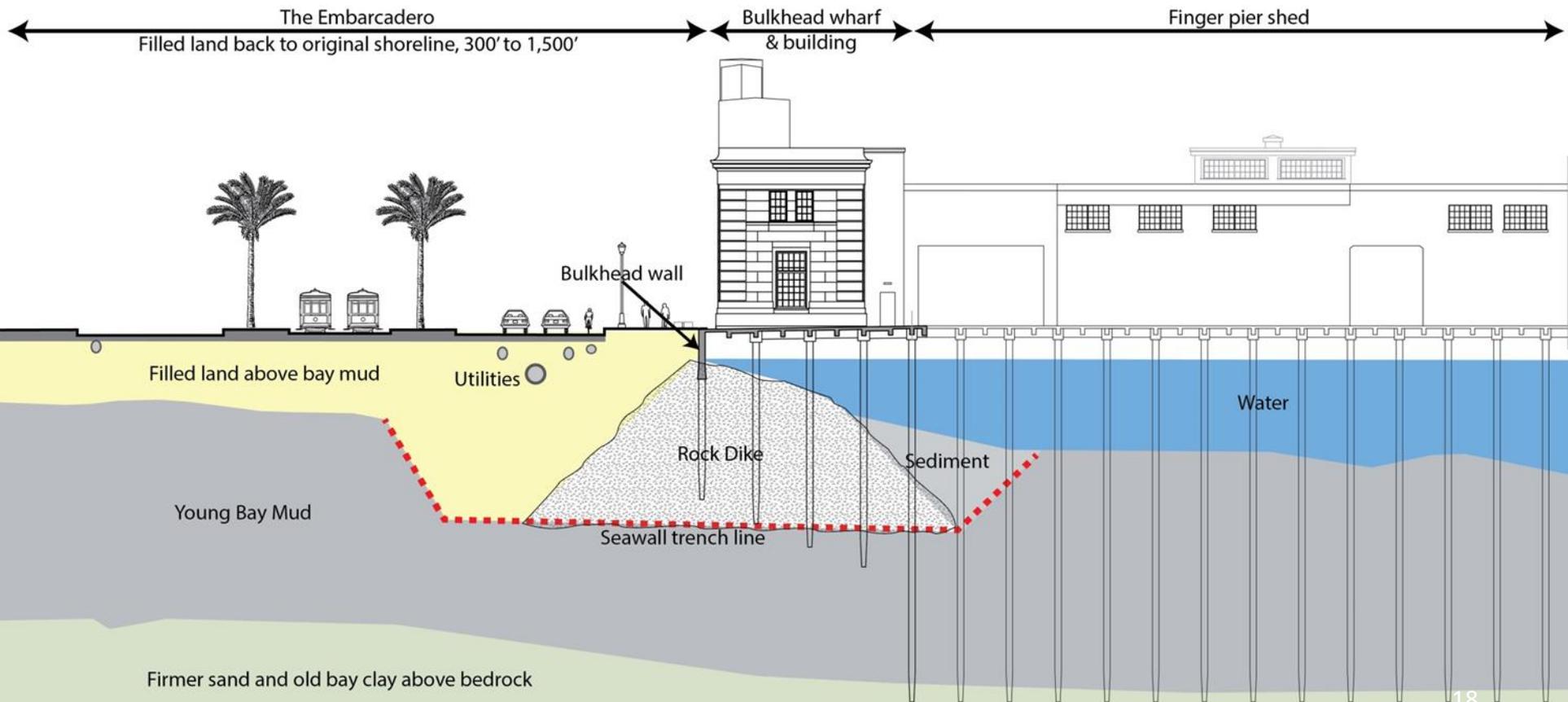


City Form & Identity

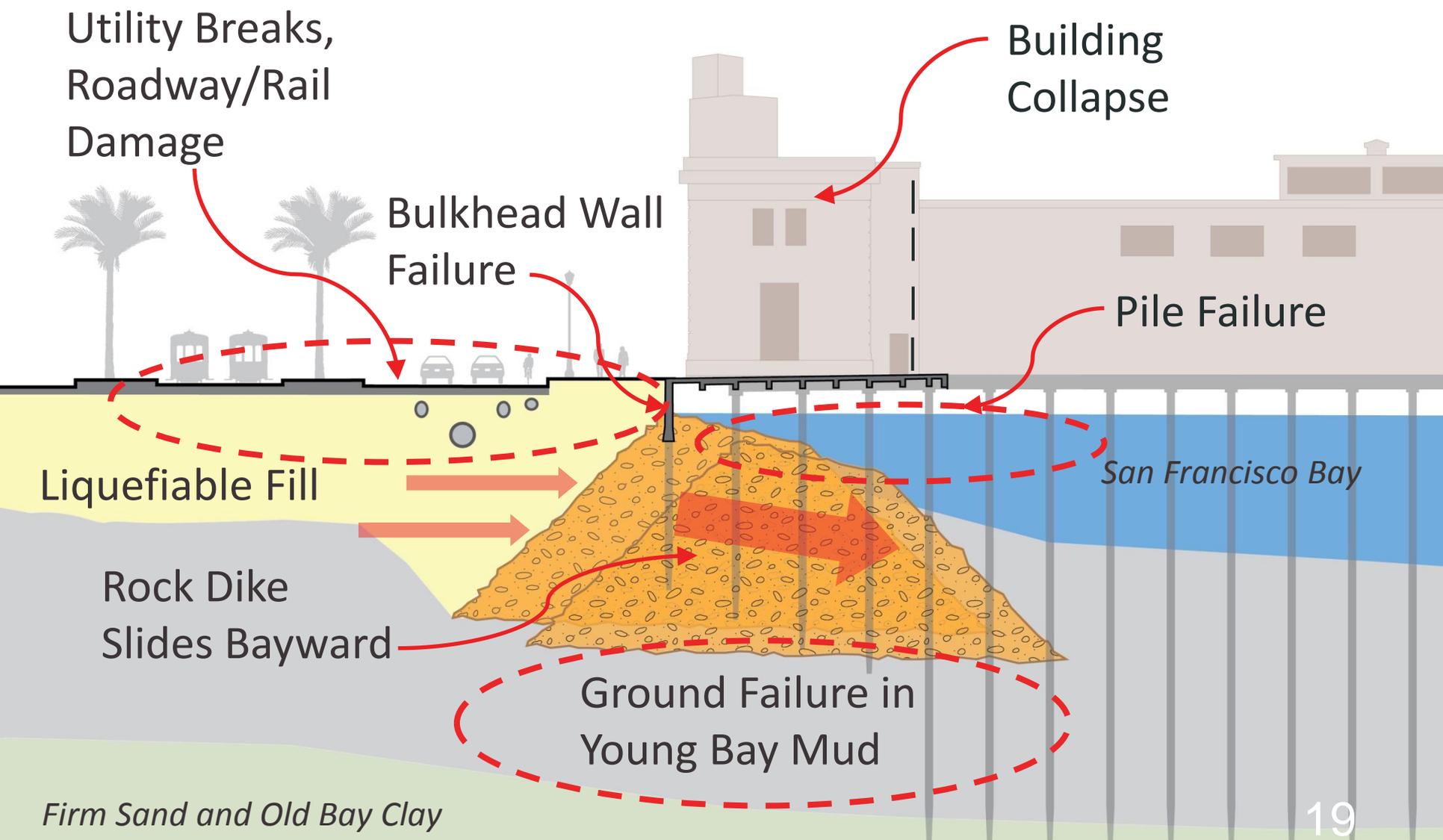
Finger Piers



Typical Construction

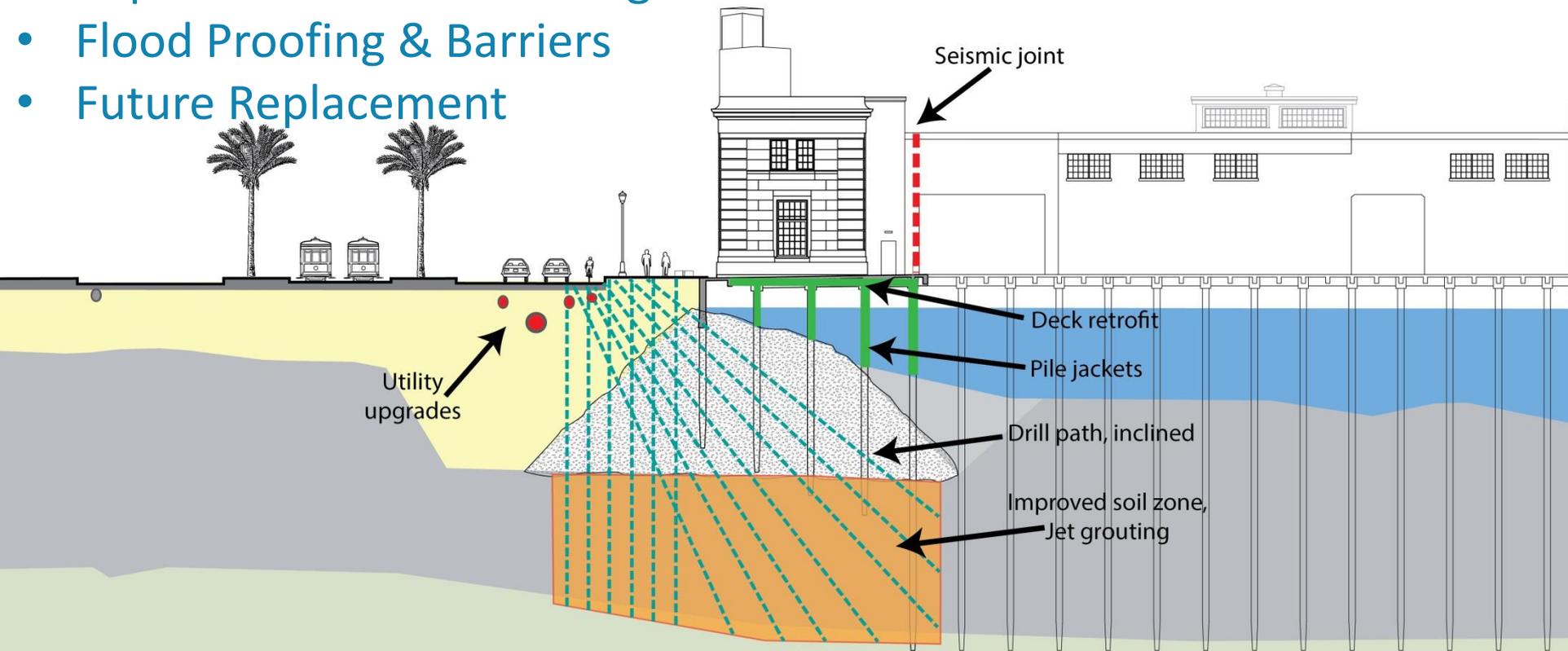


Liquefaction, Lateral Spreading & Settlement



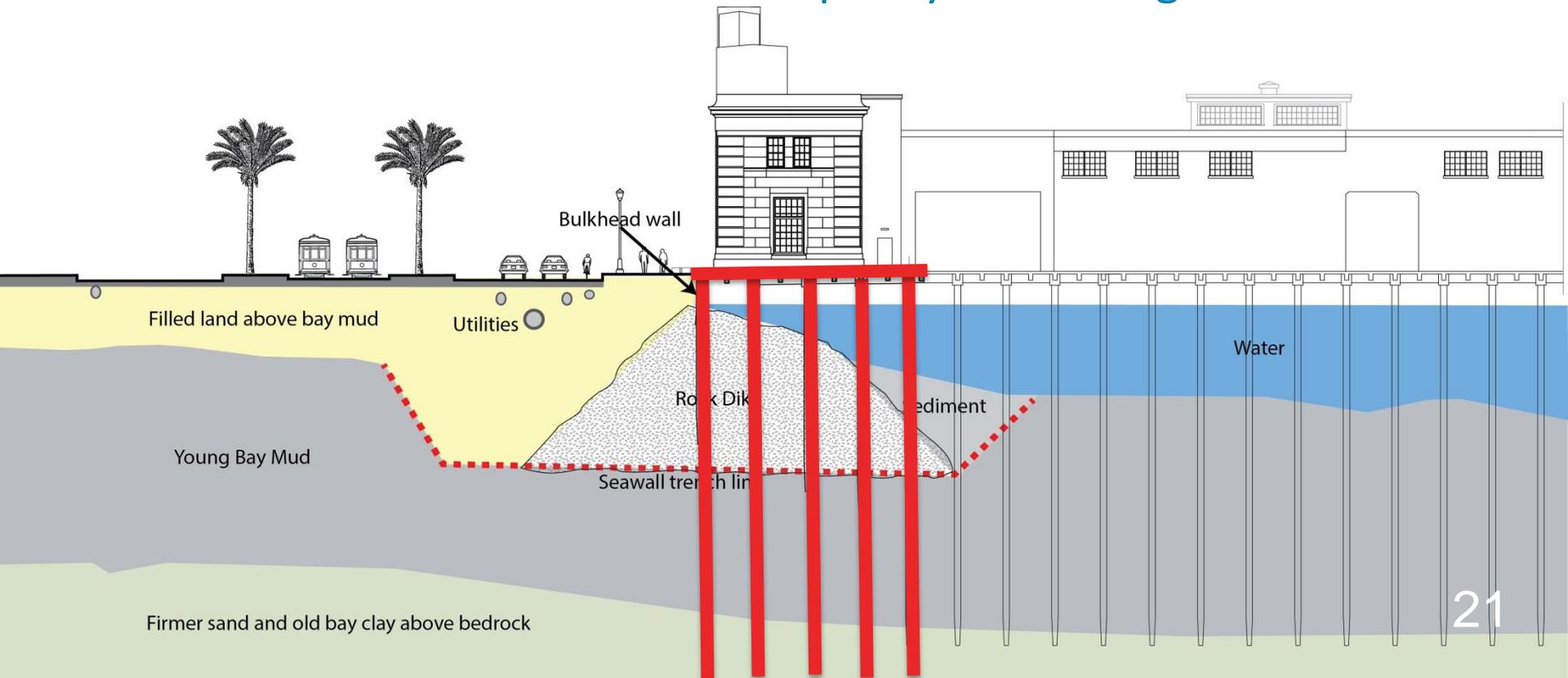
Option: Ground Improvement Under Seawall

- Ground Improvement Under Rock Dike
- Repair and Retrofit Existing Bulkhead Wharf & Wall
- Flood Proofing & Barriers
- Future Replacement



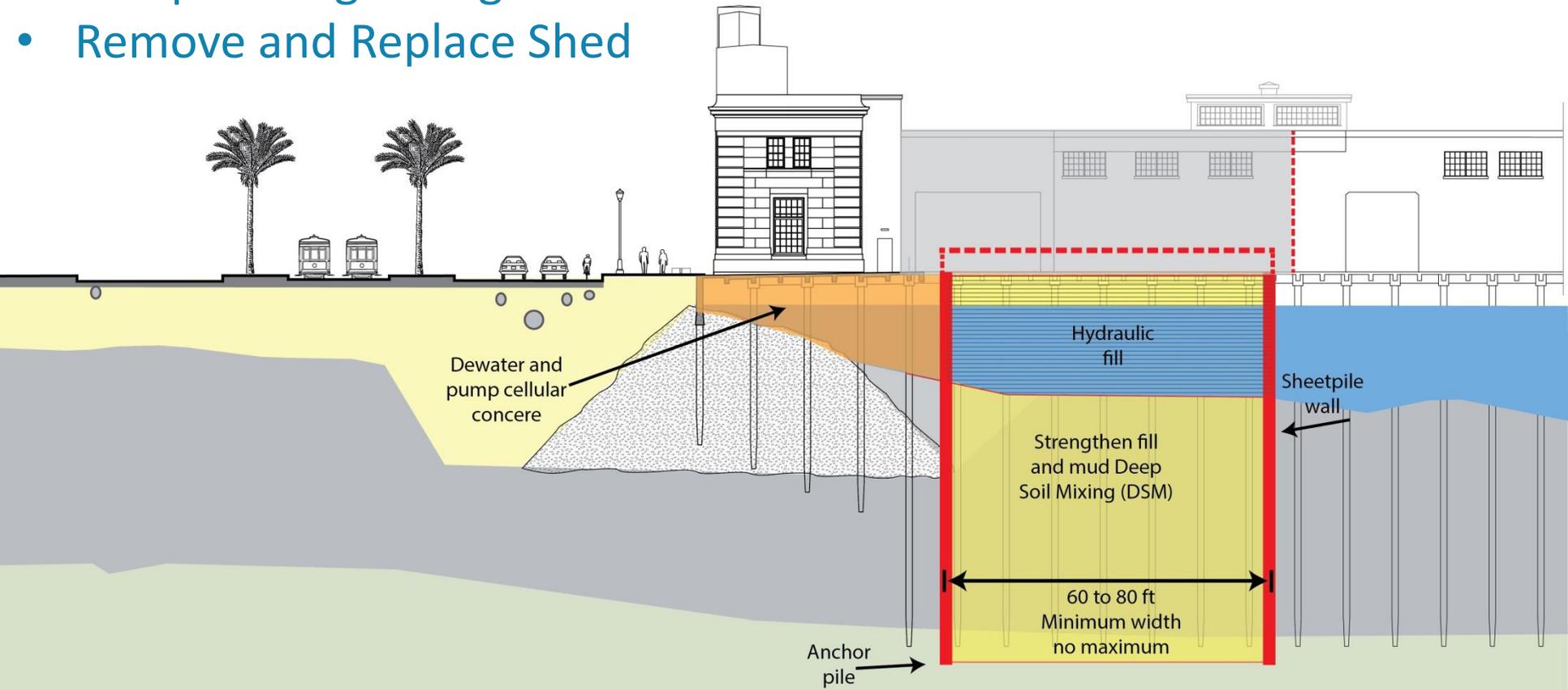
Option: Bulkhead Wharf Replacement

- Temporarily Relocate Bulkhead Buildings
- Demolish existing Bulkhead Wharf & Wall
- Construct new Bulkhead Wharf & Wall, Stabilize Rock Dike
 - Set New Elevation & Build in Capacity for Raising in Future



Option: New Bayward Seawall

- New Bayward Seawall, Construct from Waterside, New Elevation
- Pumpable Lightweight Fill Under Bulkhead Wharf
- Remove and Replace Shed



Waterfront Planning Public Process



Thank You

DESIGNING FOR RESILIENCE

FORM

HISTORIC PRESERVATION

- EXPLORE ACCEPTABLE CHANGES TO HIST. DISTRICT
- BE FLEXIBLE W/ APPROACHES
- PERRY BLDG TO FISH WH. BY PRIORITY
- RETAIN BULKHEADS & PIERS
- UPPER PUBLIC INFO ABOUT RESOURCES
- APPROACHES DON'T

VIEWS

URBAN FORM

- BE FLEXIBLE & ADAPTABLE
- GOOD ALLEYS IN THE CITY

VALUES WILL BE UNIQUE TO THE PORT'S GEOGRAPHY
"GRACEFUL RETREAT"

RESILIENCE

- PROBES TO ACHIEVE MULTIPLE BENEFITS
- FIX THE EASIEST FIRST
- PLAN FOR THE LONG TERM
- INTEGRATE DESIGN W/ LOCAL NEIGHBORHOOD
- PORT'S ROLE IN PROTECTING CITY
- CRITICAL LINKAGES FOR DISASTER PREPAREDNESS

TRANSPORTATION

- SHOULD EMPS CONTINUE IN CURRENT CAPACITY
- MAINTAIN EASE OF N/S MOVEMENT
- SUPPORT ALT MODES OF TRAVEL
- BETTER BIKE ALLEYS
- ALWAYS MULTI-PRONG APPROACH

LAND USE

- ACTIVATE THE HISTORIC DISTRICT
- DIVERSE USBS

ECOLOGY

- ENHANCE THROUGH BEST PRACTICES
- HOW COULD LIV. SHORELINE BE ADAPTED TO NORTH
- LIVING SHORELINE BETTER IN SOUTH W.
- HARD EDGE CAN BE DIVERSE & DESIRABLE
- OYSTERS
- ALWAYS LOOK FOR HABITAT ENHANCEMENT

VALUES FOR THE FUNCTION

WATERFRONT

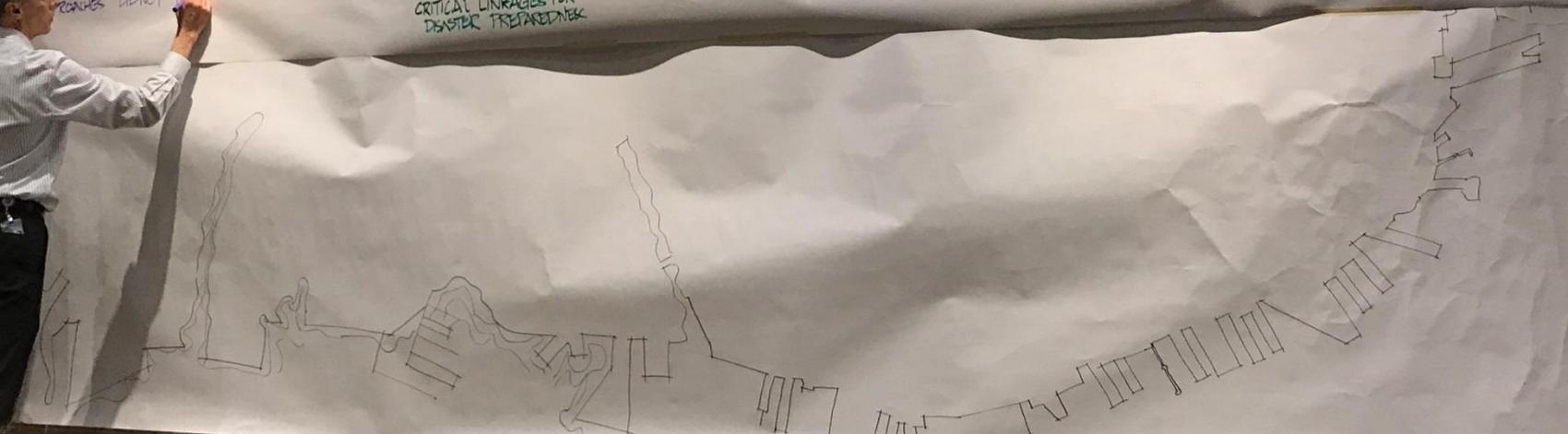
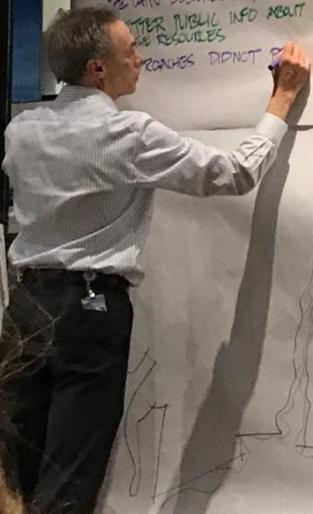
WHAT ELSE?

DIVERSITY OF PORT BUSINESSES

\$ MATTERS

NEW OPPORTUNITIES FOR RECREATION & MARITIME

CONSIDER BAY FILL AS AN ECONOMIC RESOURCE TO CITY





Climate Change, Water, and Cities: How Communities Can Adapt to Sea-Level Rise and Increased Flood Risk

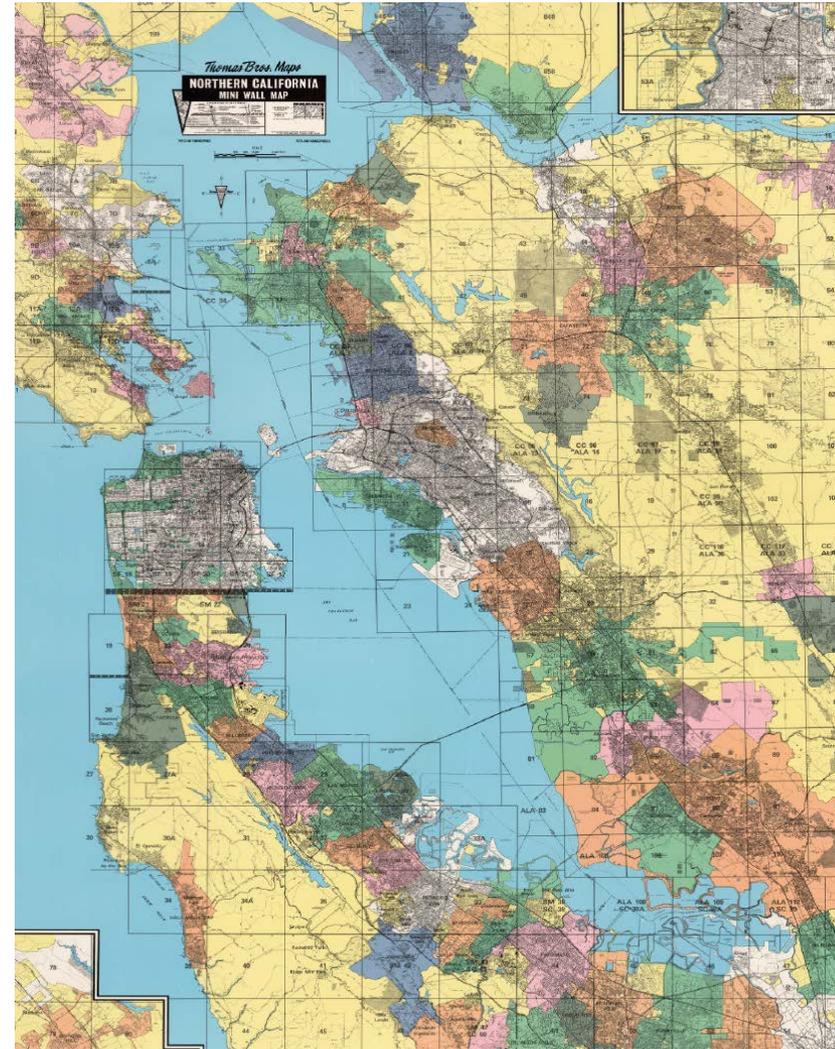
Geoff Smick – WRA, Inc.



Regulatory Primer

- FEDERAL
 - Corps of Engineers
- STATE
 - Bay Conservation and Development Commission (BCDC)
 - Regional Water Quality Control Board
- LOCAL
 - City/County Regulations

Sea Level Rise – Regulatory Primer



Climate Change, Water, and Cities: How Communities Can Adapt to Sea-Level Rise and Increased Flood Risk

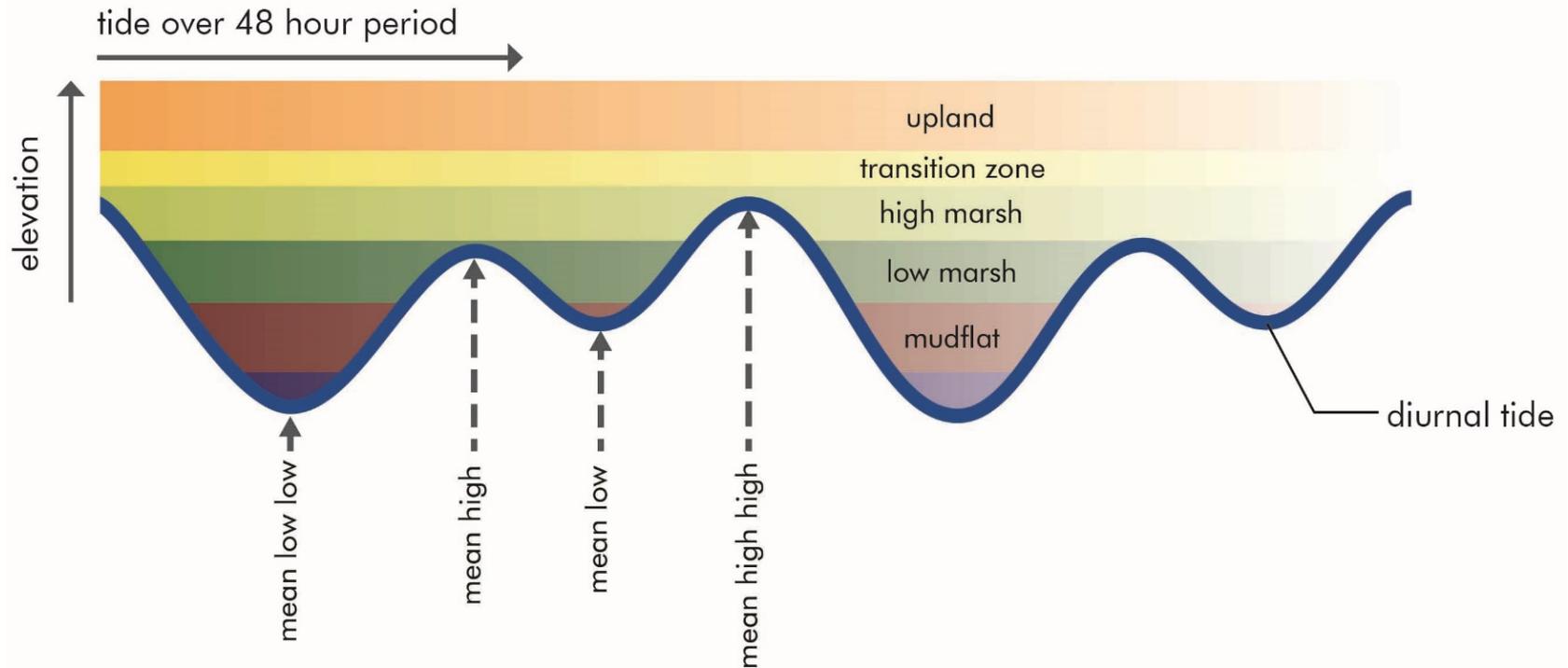
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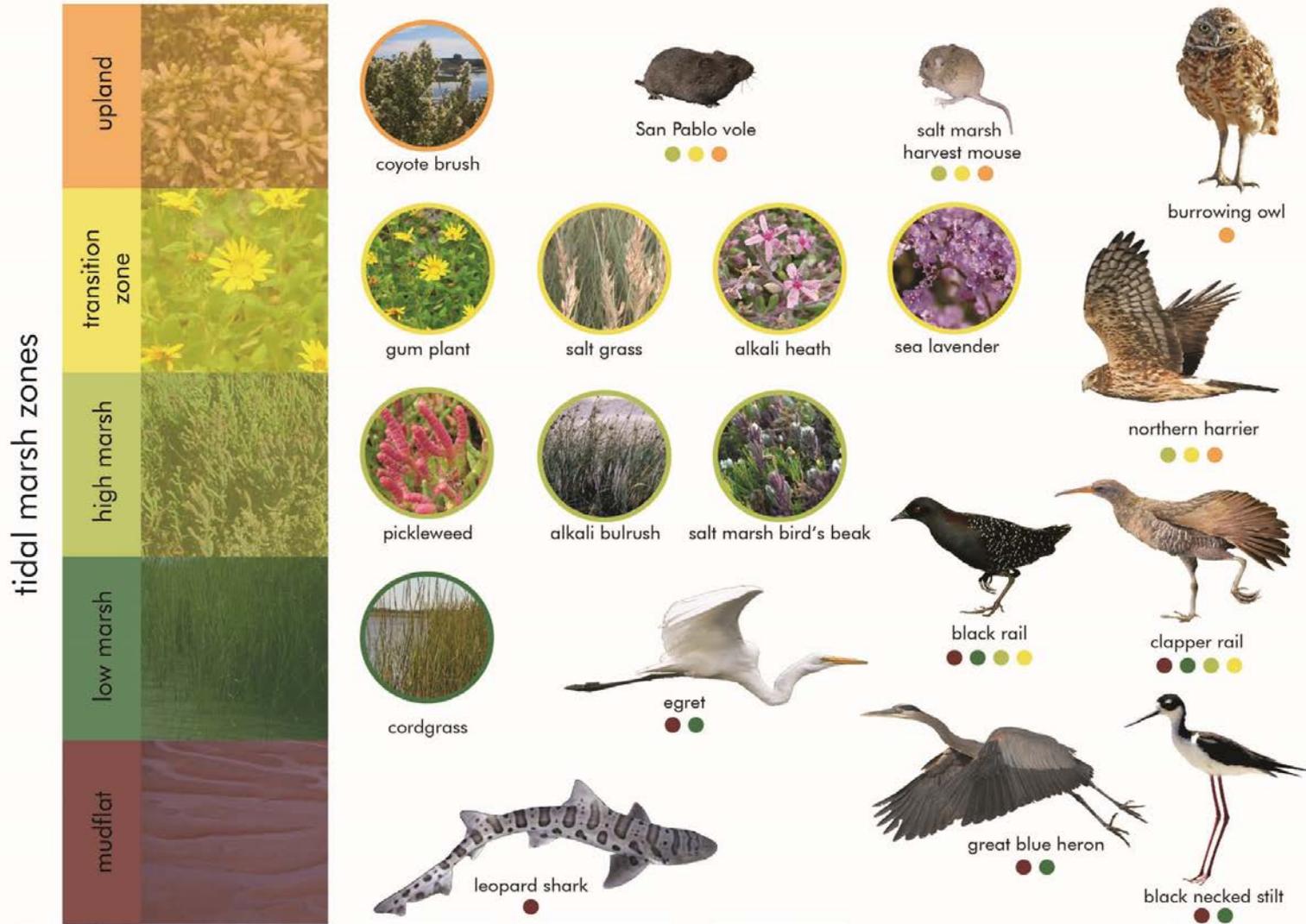
Tidal Marsh Ecology 101

Tidal Inundation & Correlation with Habitat

Marsh zones are correlated to the frequency of tidal inundation.



Tidal Marsh Ecology 101



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Tidal Marsh Ecology 101

Zone	Indicator Plant Species	Average Low (Ft.)	Average High (Ft.)	Elevation Range (Ft.)
Low Marsh	Cordgrass	2.37	4.78	2.41
High Marsh	Pickleweed	4.78	6.83	2.05
Transition	Grindelia	6.55	8.16	1.61
Upland	Coyote Brush	7.62	N/A	N/A

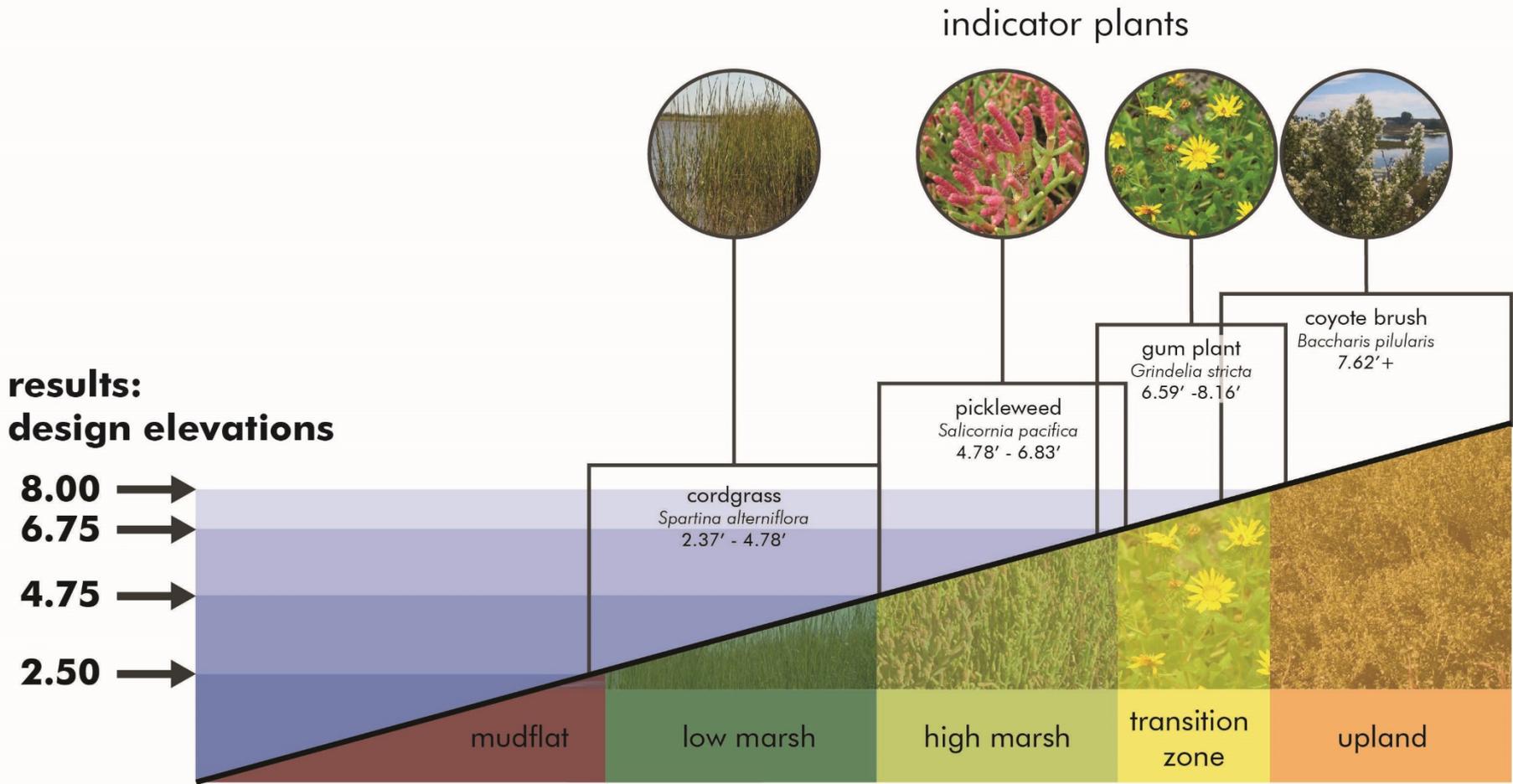


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Tidal Marsh Ecology 101



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Resiliency Strategies – Natural or Engineered?



Climate Change, Water, and Cities: How Communities Can Adapt to Sea-Level Rise and Increased Flood Risk

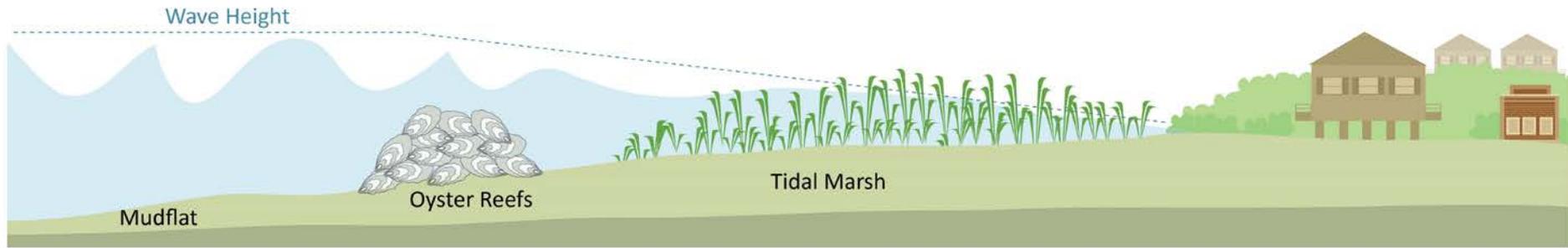
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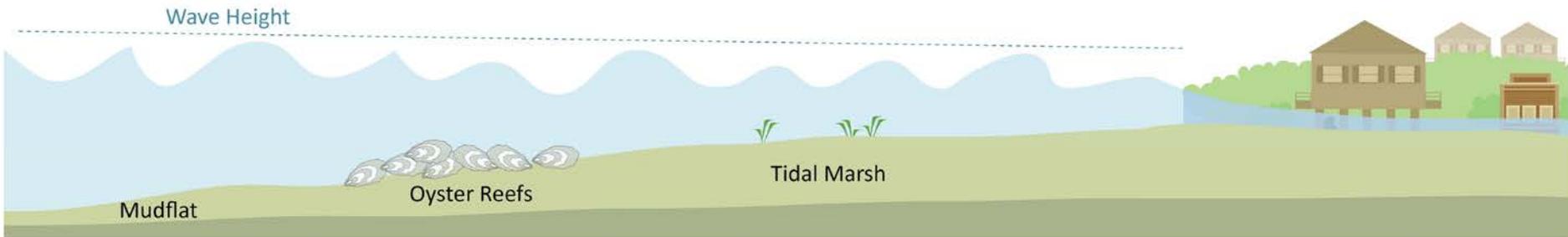
Resiliency Strategies – Natural or Engineered?

Living Shorelines

Waves decreased with healthy coastal habitats.



Waves with degraded coastal habitats.



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Geoff Smick – WRA, Inc.



Case Study: Dotson Family (Breuner) Marsh



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Dotson Marsh – Historic Marsh Filling

1958



1965

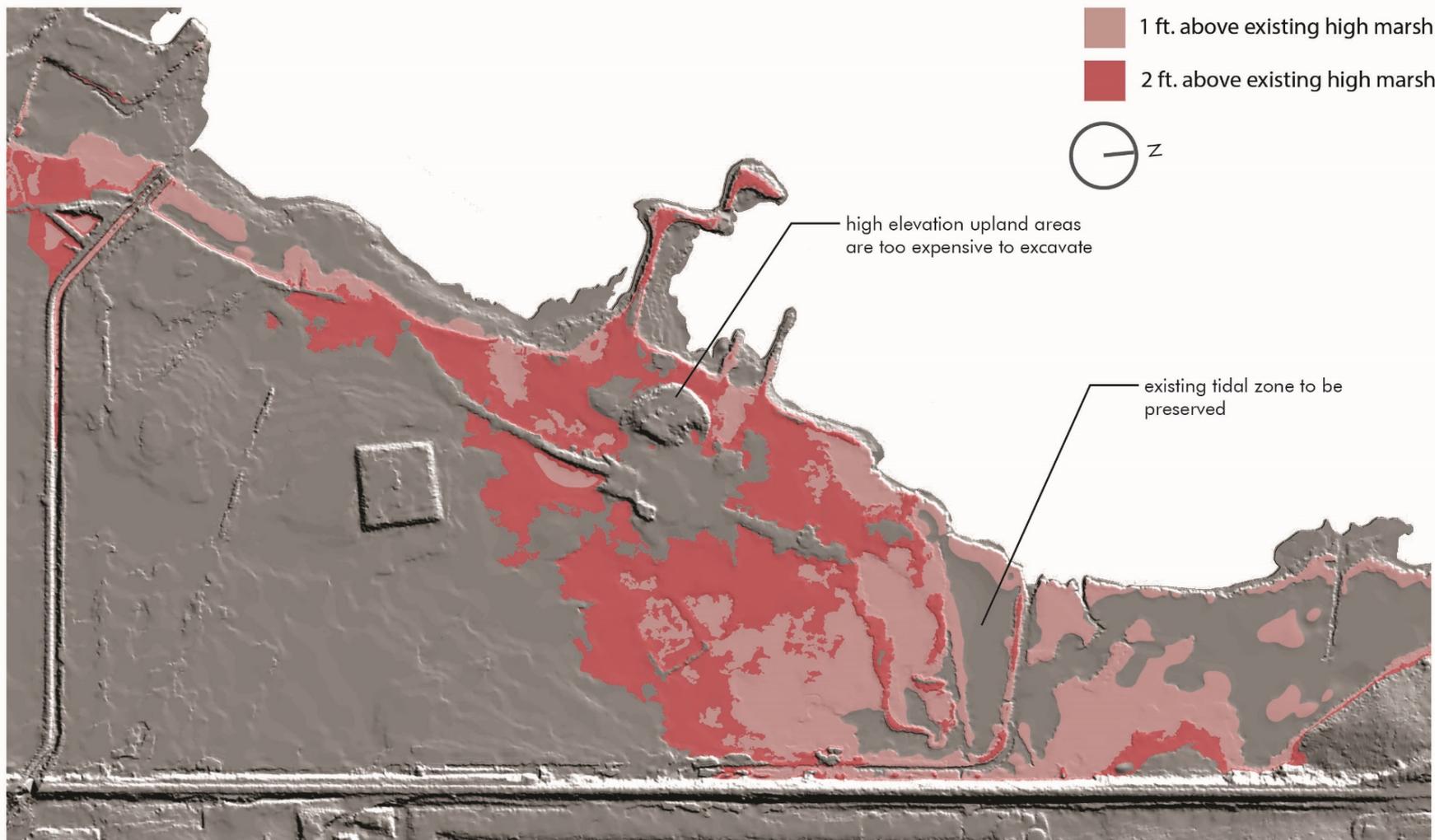


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Depth to Tidal (High) Marsh Elevation



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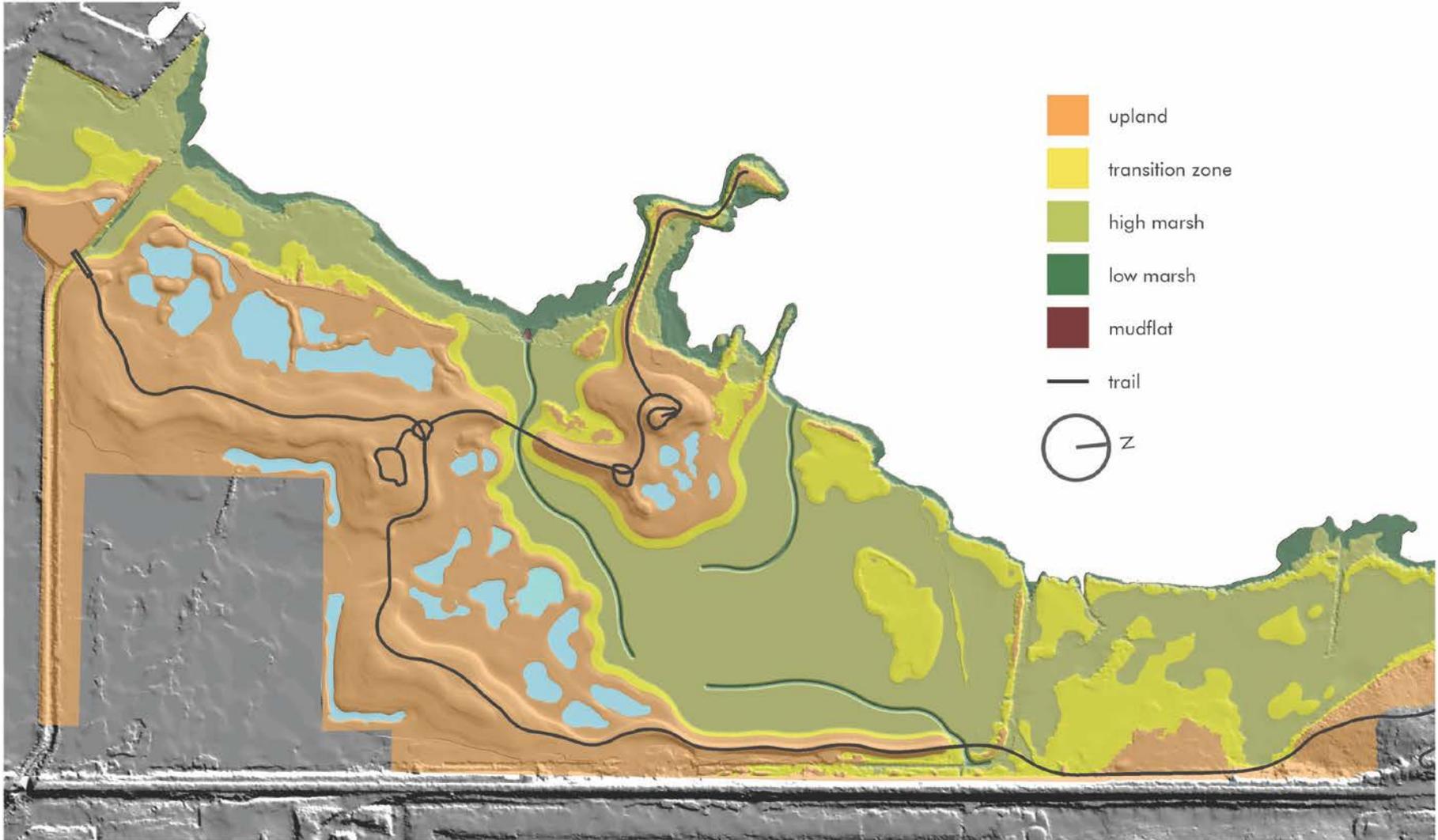
Grading Plan



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Grading Plan 3D Hillshade



Climate Change, Water, and Cities: How Communities Can Adapt to Sea-Level Rise and Increased Flood Risk

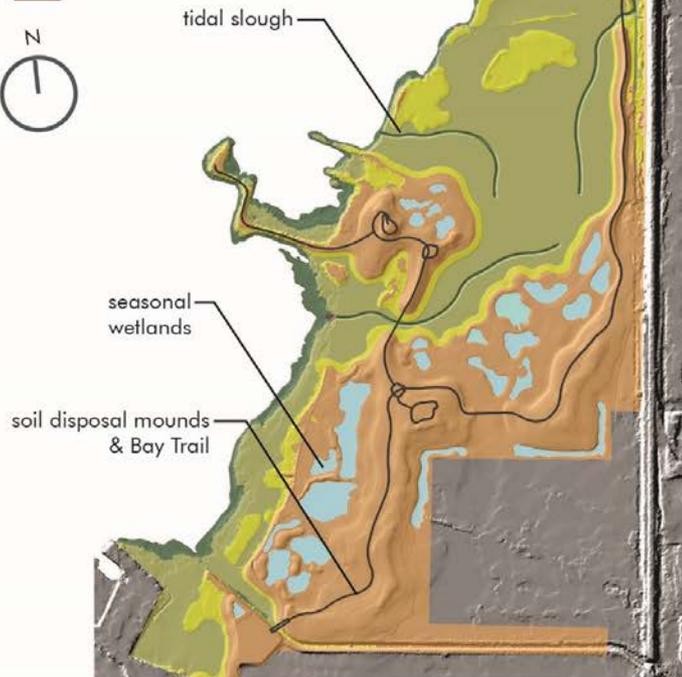
Geoff Smick – WRA, Inc.



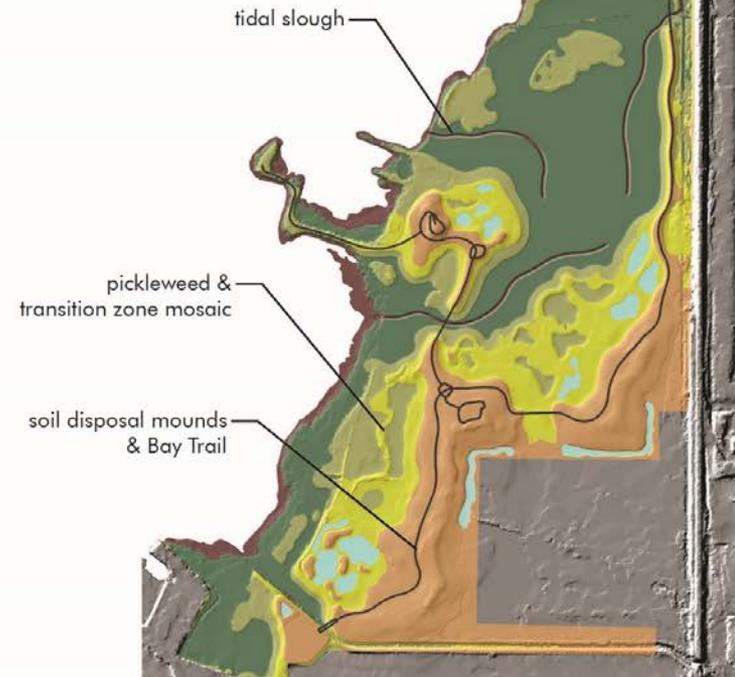
Grading Plan 3D Hillshade + SLR

proposed restoration
plan: sea level 2014

- upland
- transition zone
- high marsh
- low marsh
- mudflat



proposed restoration
plan: sea level rise 2080

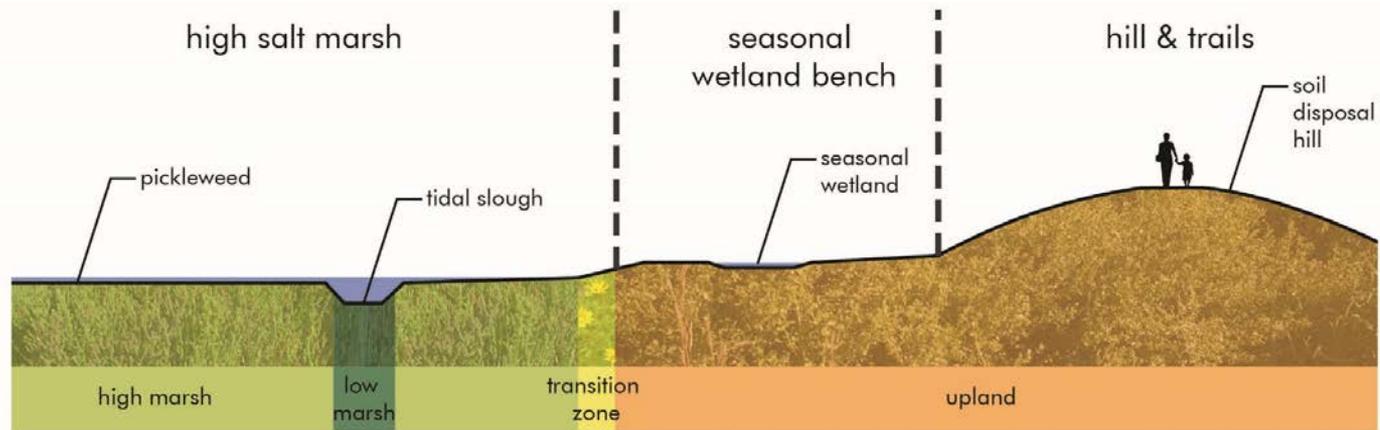


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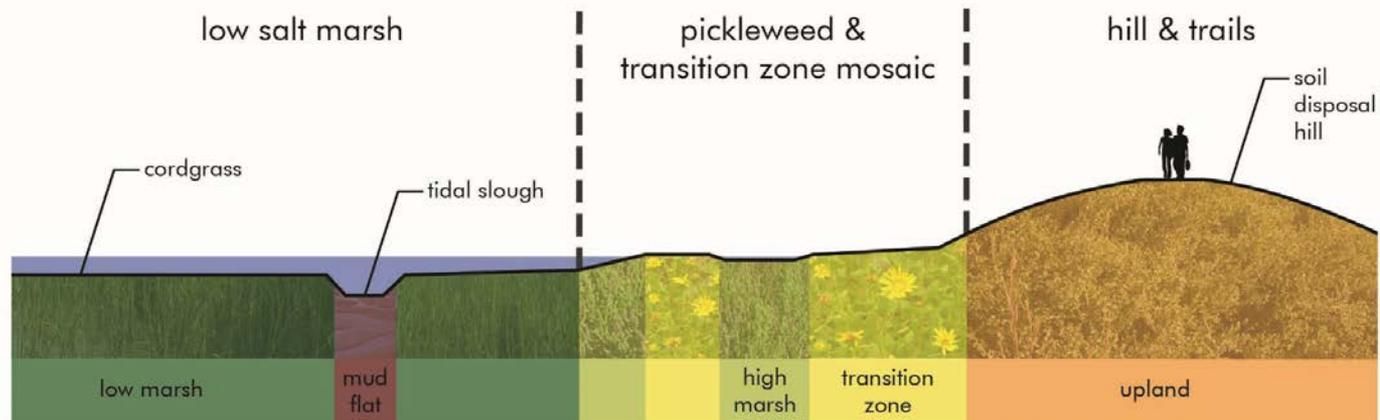
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Grading Plan Cross Section w Sea Level Rise



sea level 2014



projected sea level rise 2080

vertically exaggerated, not to scale

Restoration Construction - 2014

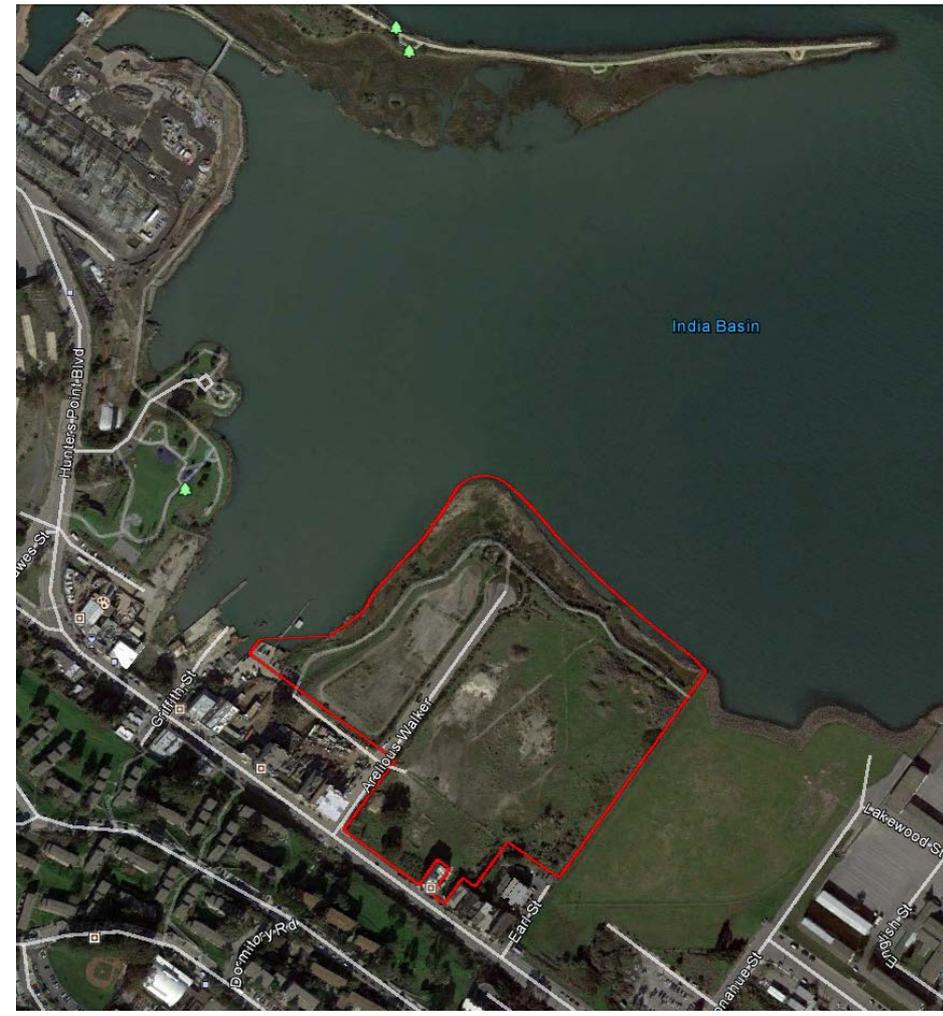


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Case Study: India Basin



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Existing Conditions



bionic **BUILD:** | SOM | BIONIC | GEHL STUDIO | SHERWOOD

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Project Rendering



bionic **BUILD:** | SOM | BIONIC | GEHL STUDIO | SHERWOOD

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India Basin: Beach 2017



bionic

Climate Change, Water, and Cities: How Communities Can Adapt to Sea-Level Rise and Increased Flood Risk

Geoff Smick – WRA, Inc.



India Basin: Beach 2050



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India Basin: Beach 2100



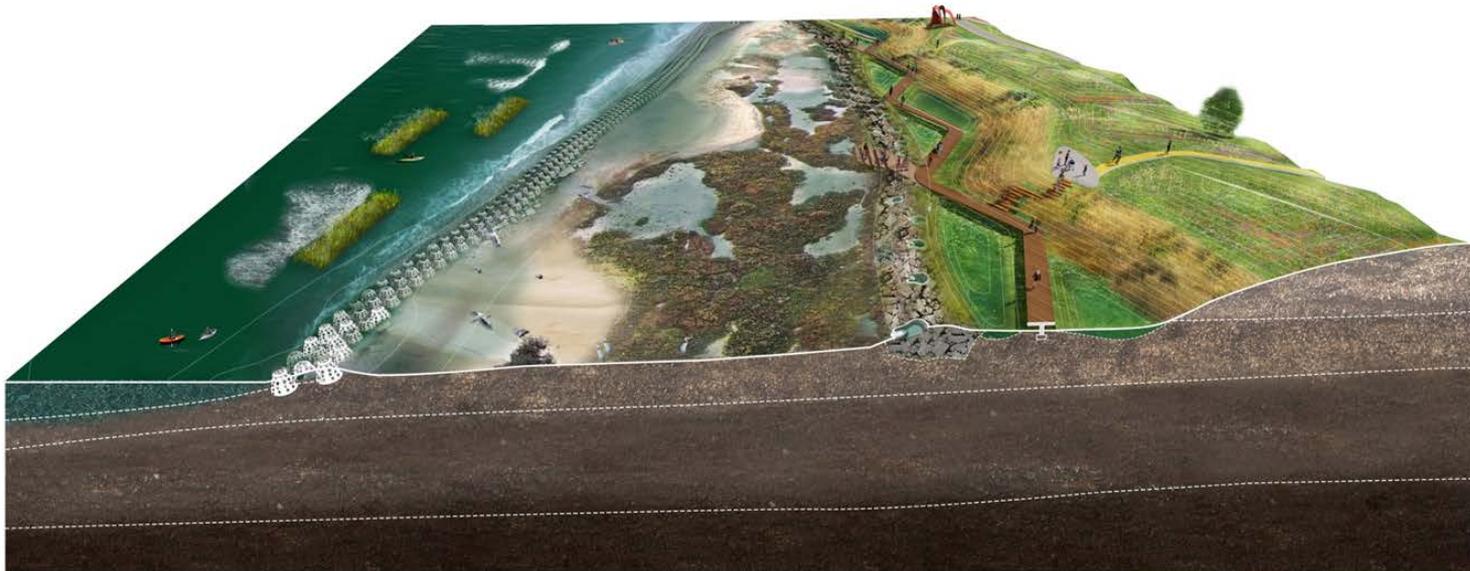
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India Basin: Tidal Marsh 2017



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India Basin: Tidal Marsh 2050

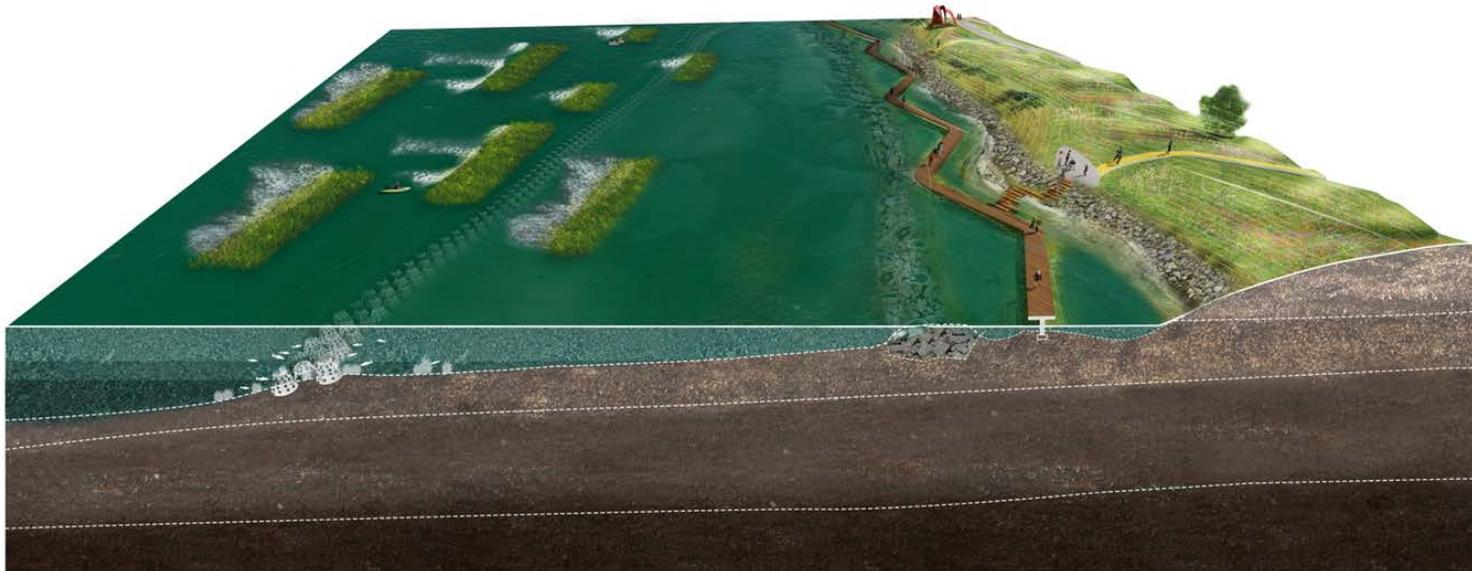


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India Basin: Cove 2017



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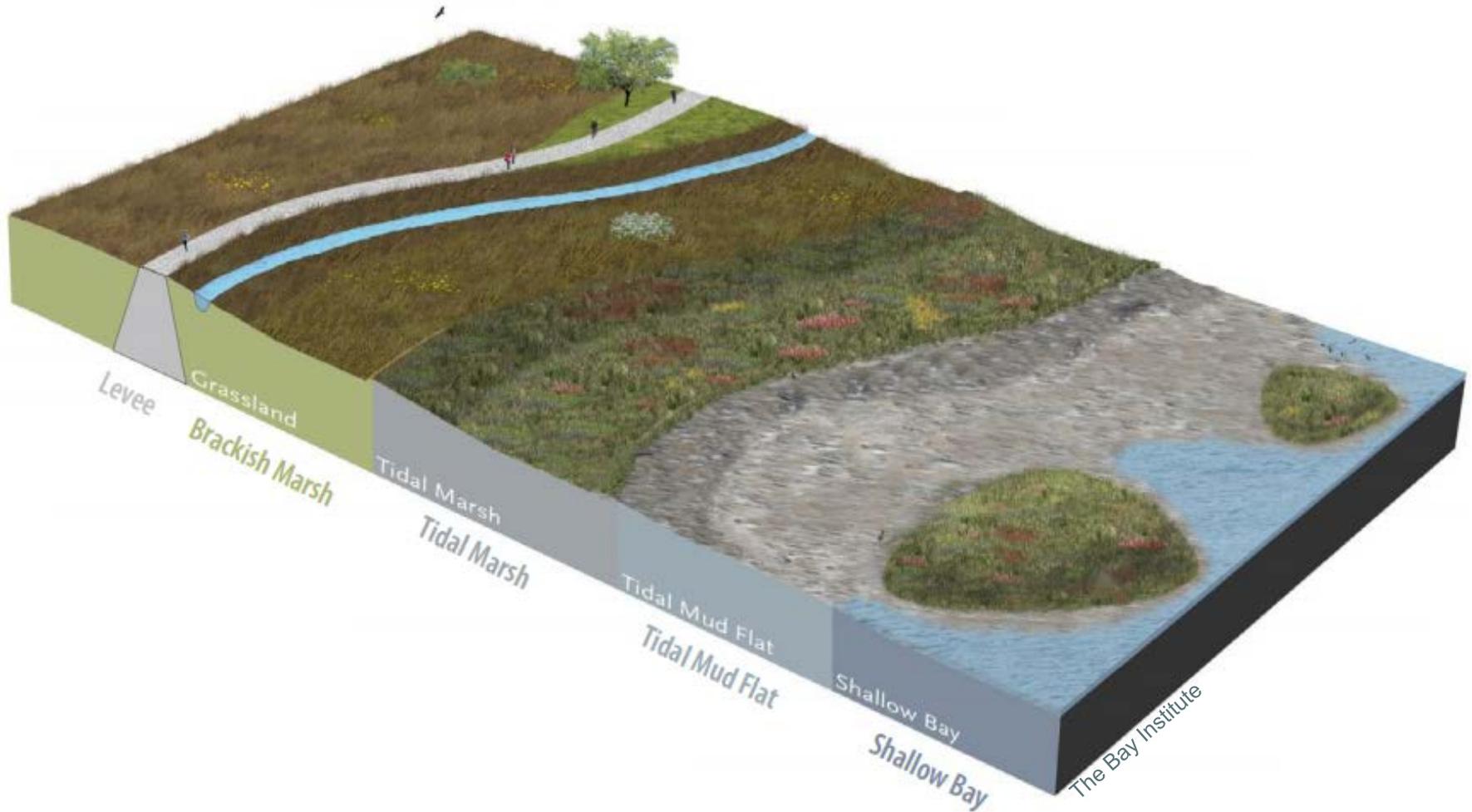
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Long Term Solutions

- Change in state and federal regulatory policy
- Regional framework for harmonizing local jurisdictions
- Some real out-of-the-box thinking

Horizontal Levee



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Modernized Seawalls



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Engineering Marvels



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LEAP



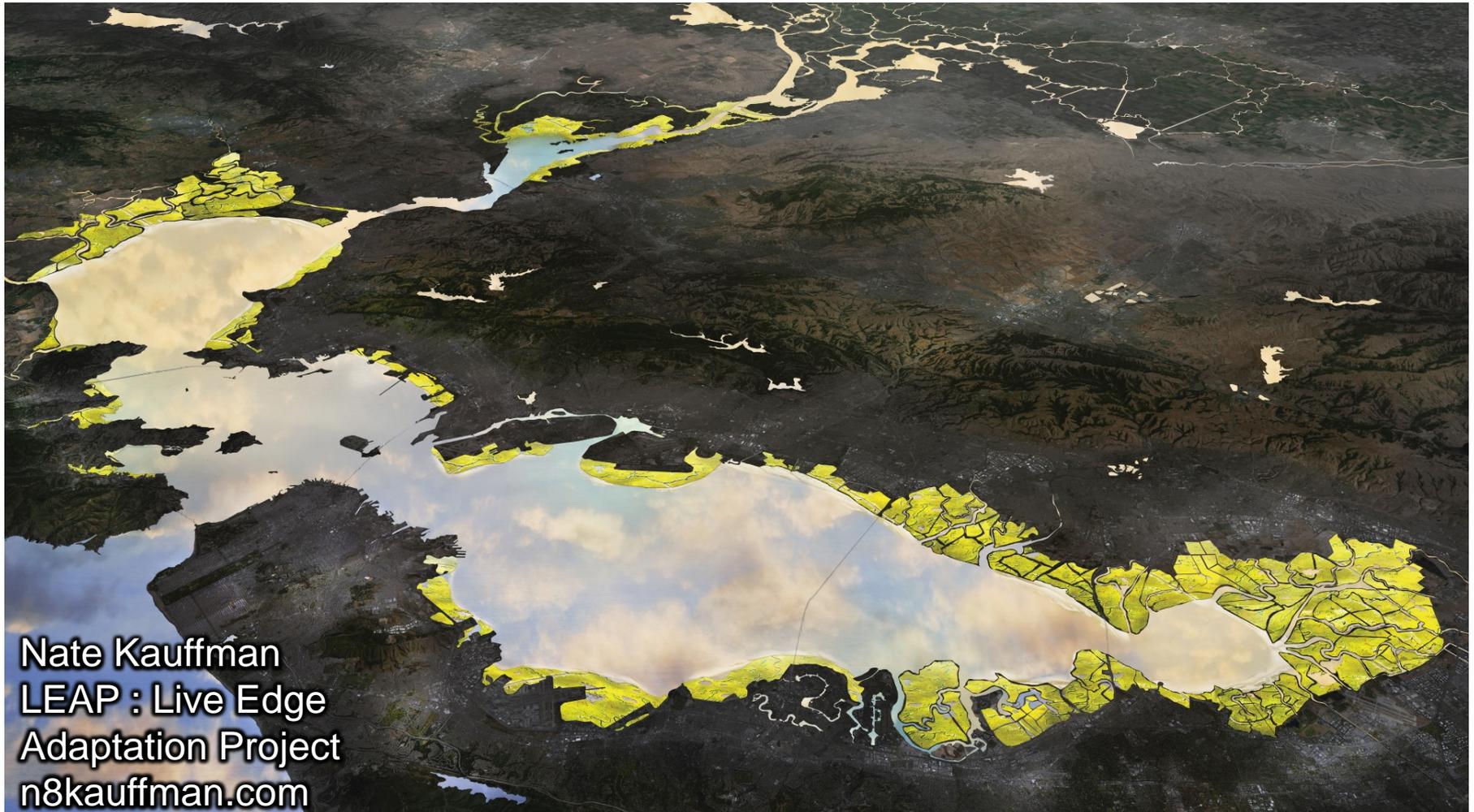
Nate Kauffman
LEAP : Live Edge Adaptation Project
n8kauffman.com

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King Tide - January 2017



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San Francisco Bay Conservation and Development Commission (BCDC)

- BCDC has planning and regulatory authority over tidal areas of the Bay and over the 100-foot shoreline band.
 - Maximum feasible public access
 - Minimum necessary placement of fill
- In 2011, BCDC amended the San Francisco Bay Plan to account for expected impacts of climate change on Bay

Policies for a Rising Bay Project

- *Stated goal:* “Collaboratively evaluate BCDC’s fill policies in light of sea level rise and develop guidance for the Commission, staff and project proponents to promote shoreline resilience”
- Concerns were raised that BCDC laws and policies might impede resilience and adaptation efforts, especially natural shoreline protection approaches
- Final report issued in November 2016
- Ongoing implementation process

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**Association of Environmental Professionals
California State Conference Session, May 19, 2017**

Moderator:

**Alan Murphy
Perkins Coie LLP**

Panelists:

**Diane Oshima
Port of San Francisco**

**Brian Strong
City and County of San Francisco**

**Geoff Smick
WRA, Inc.**