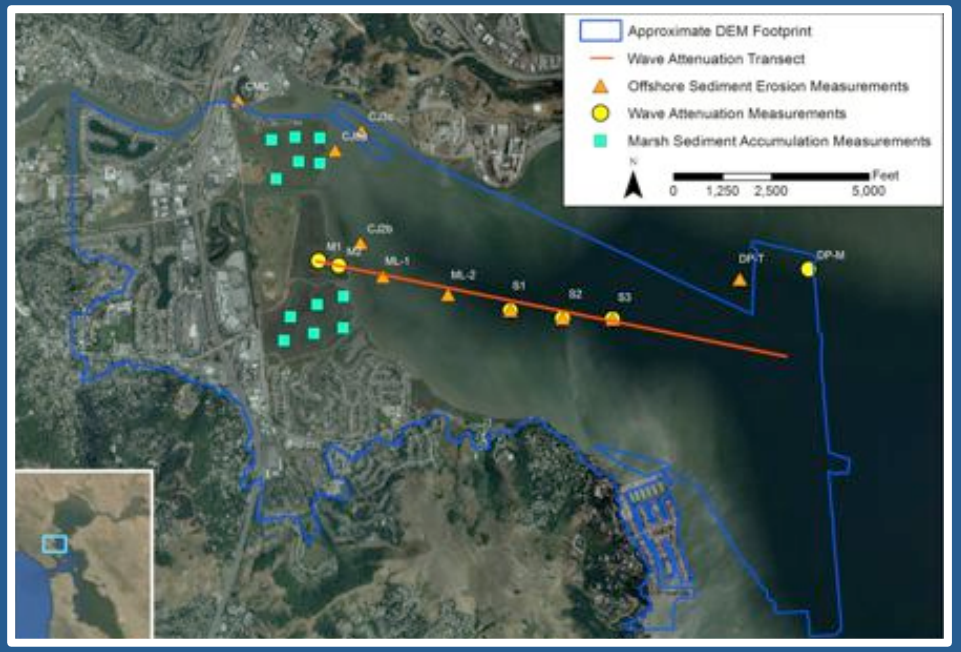
Building resilience: Sea level rise adaptation through research and collaborative planning

Corte Madera Marsh

Hayward Shoreline

July 30, 2014 SPUR

Local efforts designed to inform the region



Corte Madera Marsh Sea Level Rise Adaptation

- Research on marsh wave attenuation benefits and vulnerability
- Development of phased adaptation strategy

Adapting to Rising Tides Hayward Resilience Study

- Collaborative planning process
- Multi-sector vulnerability assessment and adaptation responses

Current and future flooding scenarios

2012 King Tide, Miller Ave. Southern Marin; photograph courtesy of Roger Leventhal

<u>Permanent inundation</u>
36” Sea level rise + MHHW
(most likely 2100)

<u>Temporary flooding</u>
12” Sea level rise + 5-yr extreme tide
(most likely 2050)

<u>Current flooding</u>
0” Sea level rise + 50-yr extreme tide
(today!)

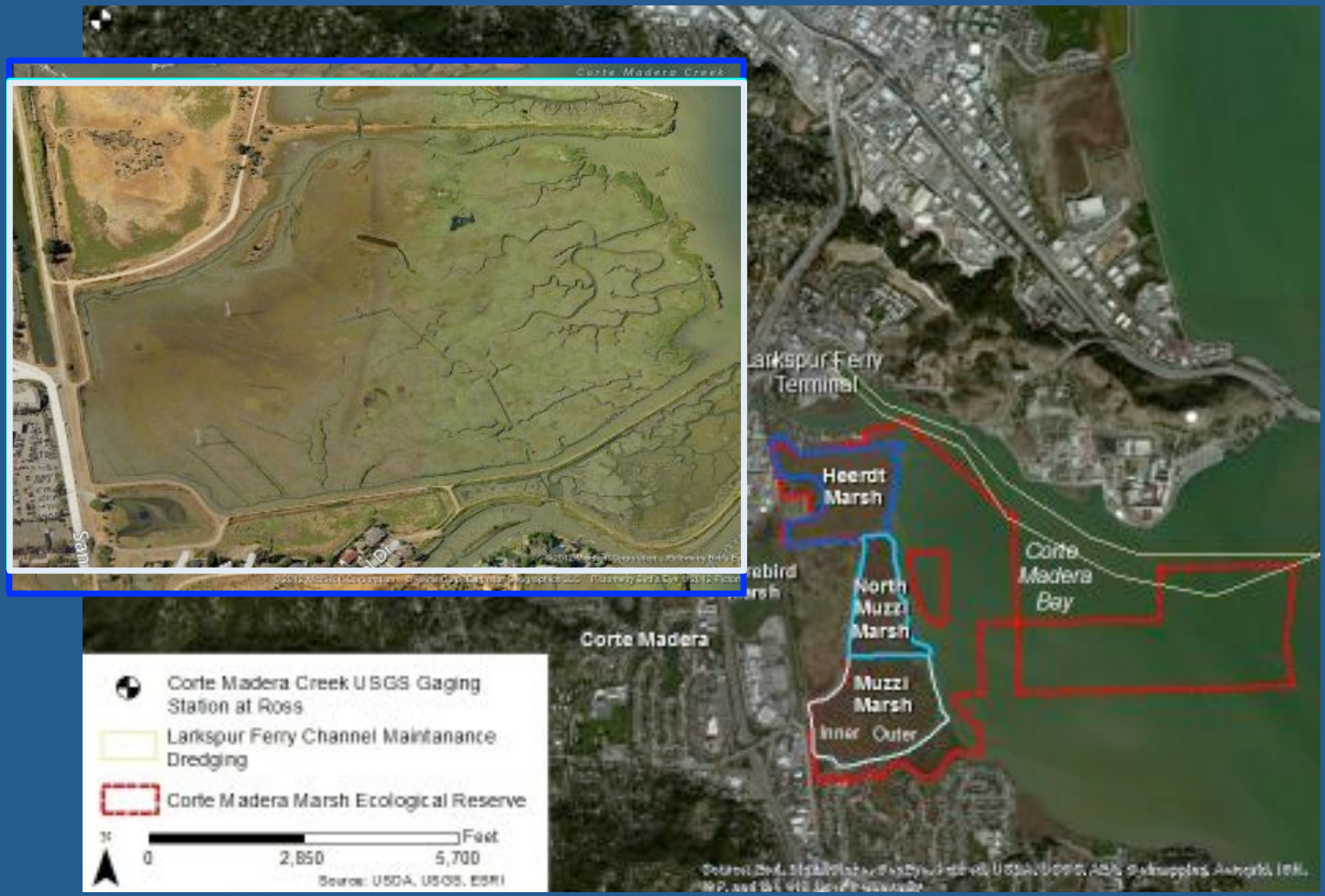
Rocks and walls or beaches and wetlands? Adaptation in between …

Photographs courtesy of Roger Leventhal and Peter Baye

How much do mudflats and marshes reduce wave height and energy?

Hayward Regional Shoreline (photograph courtesy of Matt Brennan)

Corte Madera Marsh Sea Level Rise Adaptation



Acknowledgements

USGS science for a changing world

ESA PWA

United States Environmental Protection Agency

Coastal & Marine Environments

USF University of San Francisco

County of Marin

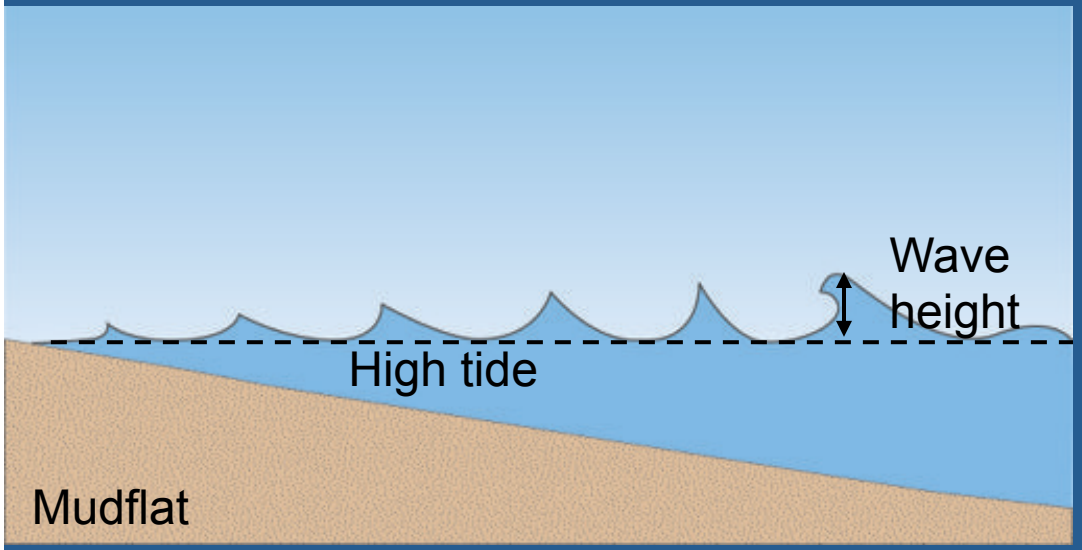
San Francisco Estuary Partnership

Sea Engineering, Inc.

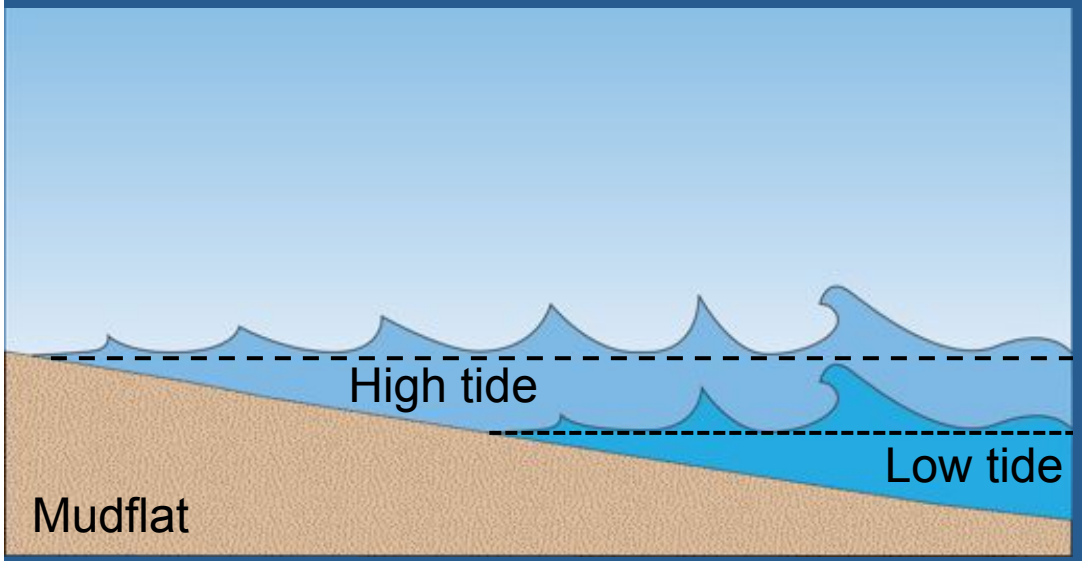
UNESCO-IHE Institute for Water Education

Corte Madera Findings

Shallow water reduces flood risk the most

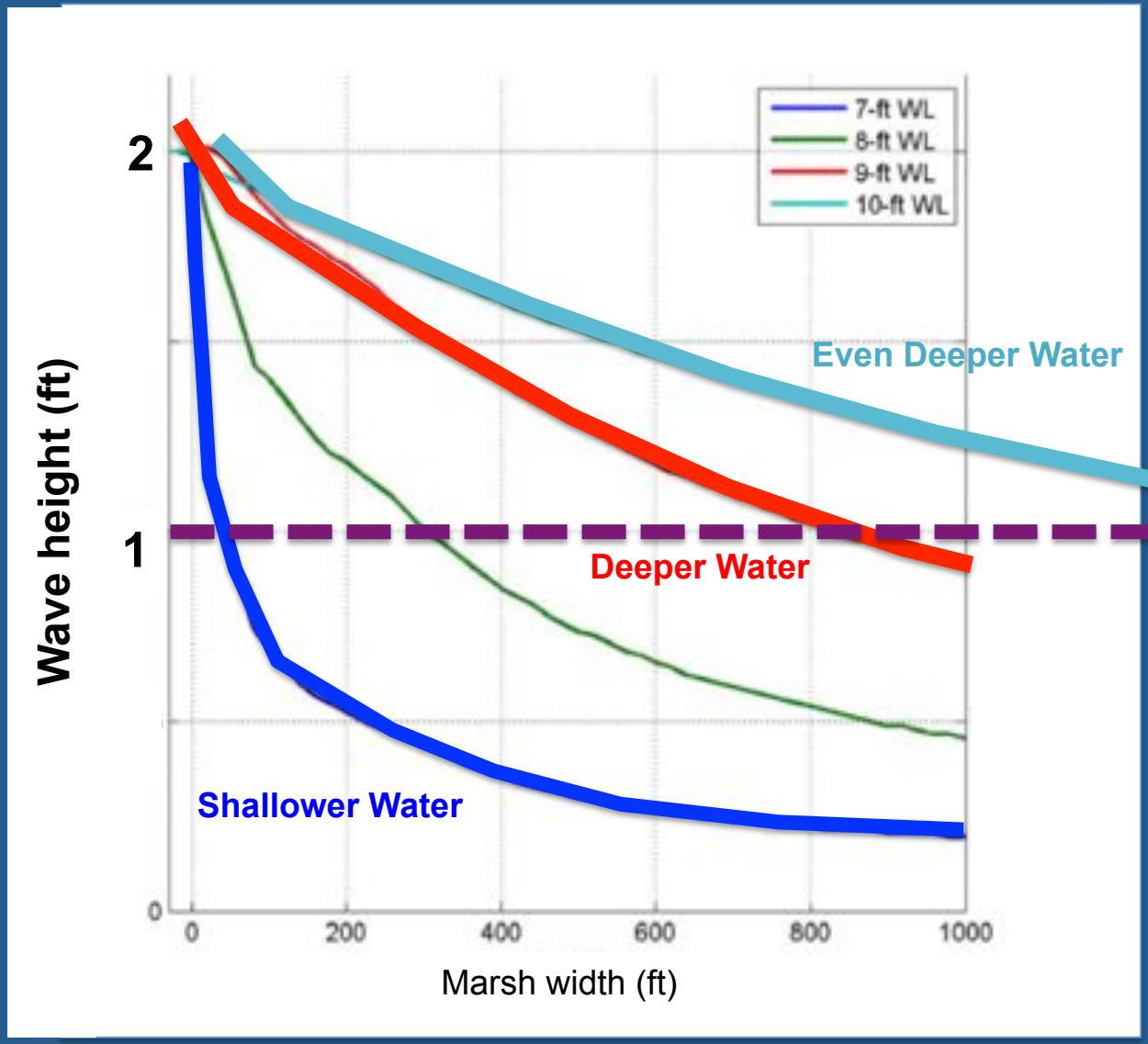


Largest waves offshore, decreasing towards marsh



Mudflats reduced wave heights on average by 66% and in shallow water, up to 80%

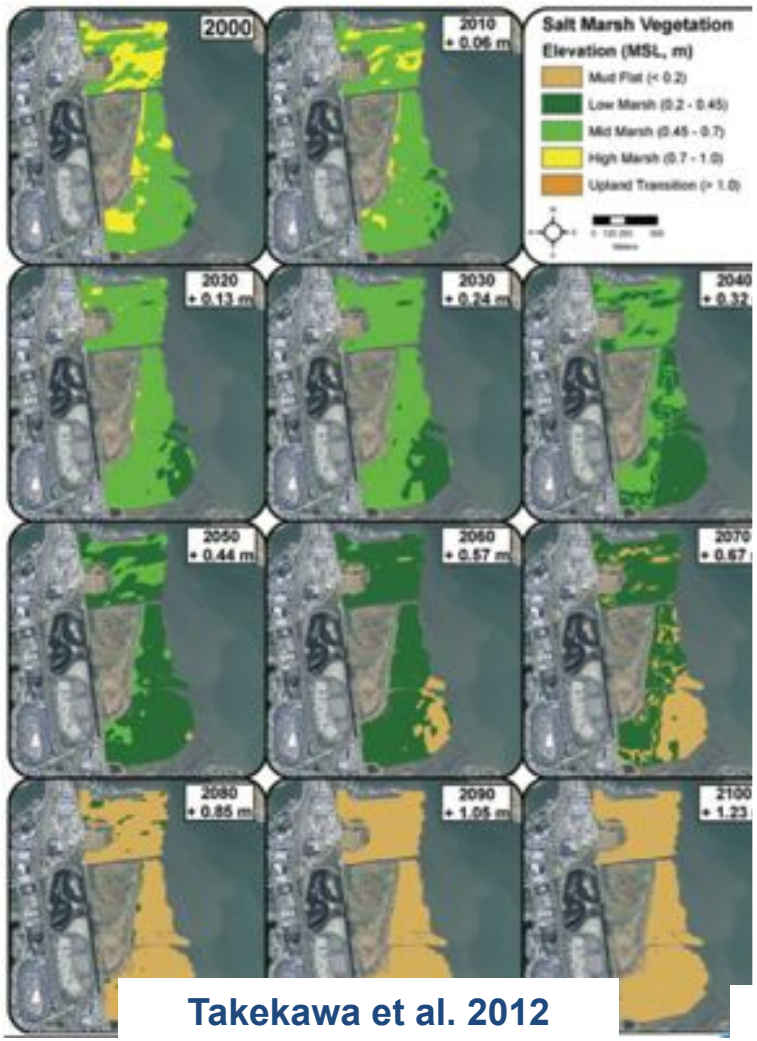
Deeper water requires a wider marsh



North Muzzi Marsh ~1,000 feet wide; Muzzi and Heerdt Marsh ~2,000 feet wide.

High, wide mudflat and marsh provide most flood risk reduction

Corte Madera Marsh projected to drown if we do nothing



Takekawa et al. 2012

2000 - 2100

Images courtesy of UC Berkeley Earth Sciences & Maps Library

1960

1853

Marshes have natural capacity to adapt

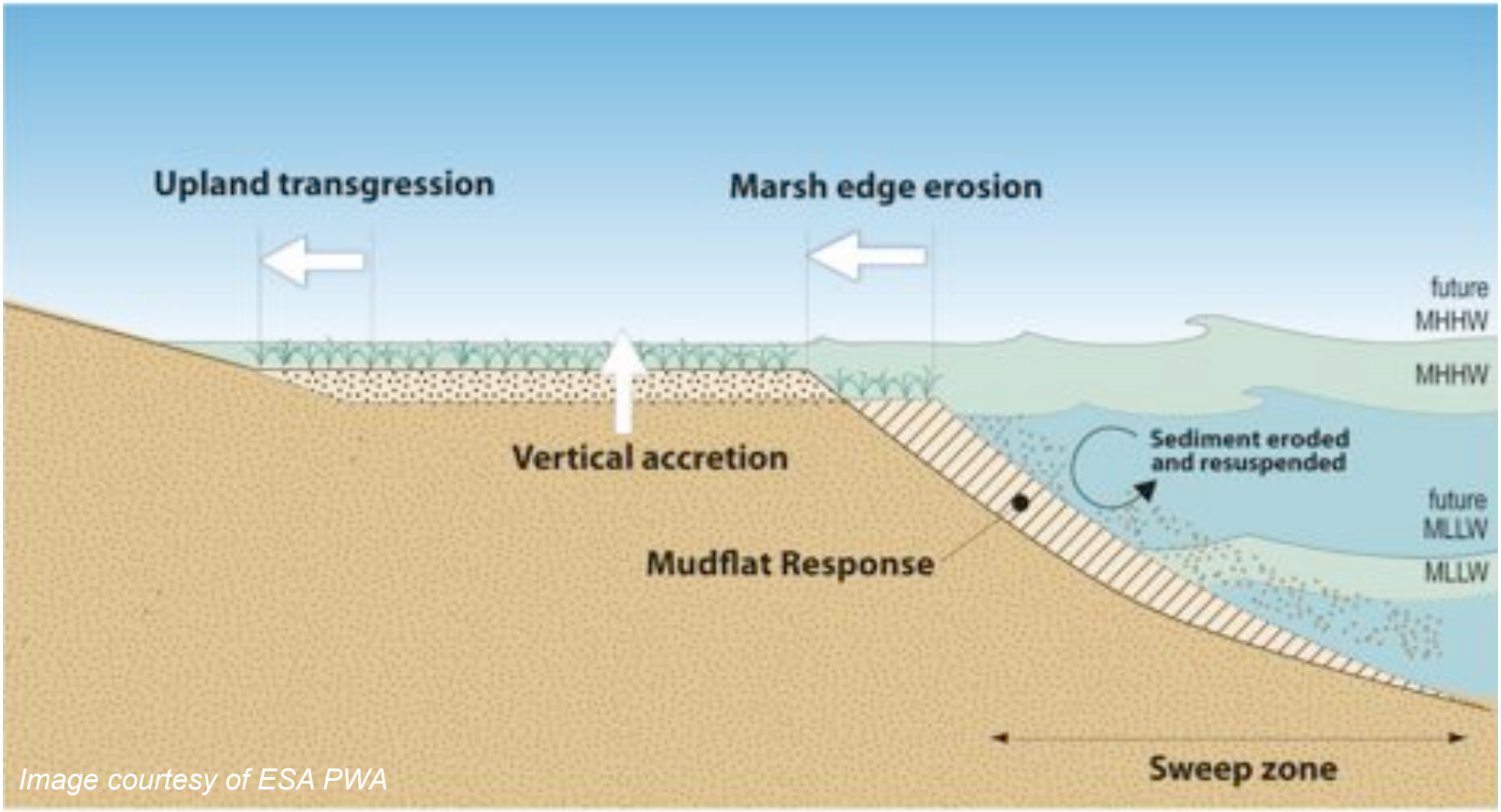


Image courtesy of ESA PWA

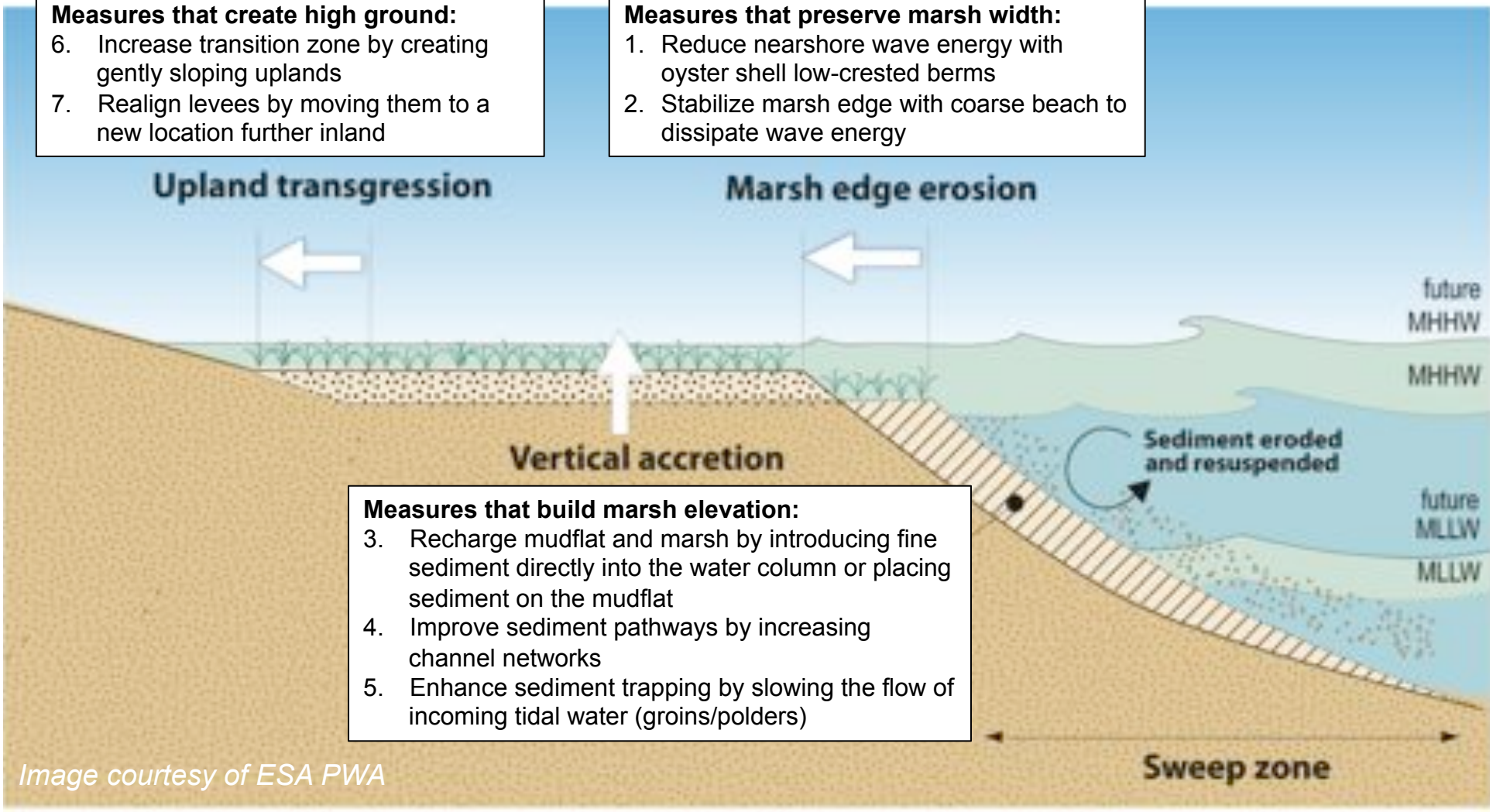
Suite of management measures

Measures that create high ground:

6. Increase transition zone by creating gently sloping uplands
7. Realign levees by moving them to a new location further inland

Measures that preserve marsh width:

1. Reduce nearshore wave energy with oyster shell low-crested berms
2. Stabilize marsh edge with coarse beach to dissipate wave energy



Measures that build marsh elevation:

3. Recharge mudflat and marsh by introducing fine sediment directly into the water column or placing sediment on the mudflat
4. Improve sediment pathways by increasing channel networks
5. Enhance sediment trapping by slowing the flow of incoming tidal water (groins/polders)

Image courtesy of ESA PWA

Marsh edge erosion

James Zoulas
(unpublished)

1. Mudflat has *generally* been eroding
2. Marsh edge has retreated on average 485 feet (due to tidal/ wave action, sediment supply, biological activity, etc.)

Measure to decrease marsh edge erosion

Coarse beaches buffer wave erosion and preserve wide marsh

Outer Bair Island, Redwood City
San Mateo County

Aramburu Island, Richardson Bay
Marin County

Vertical accretion

Photograph courtesy of John Callaway

1. Marshes are accreting enough sediment to keep up with current sea level rise
2. Sedimentation on the marsh has been decreasing over time (opposite of most marshes) → sediment-limited system

Measure to increase vertical accretion

Mudflat and marsh recharge increase local sediment supply

China Camp (photographs courtesy of Peter Baye)

Measure to increase vertical accretion

Increasing channel density also increases sedimentation

Two-phase sea level rise adaptation strategy

Measure to allow upland transgression

Create space to avoid coastal squeeze when sea level rise outpaces vertical accretion

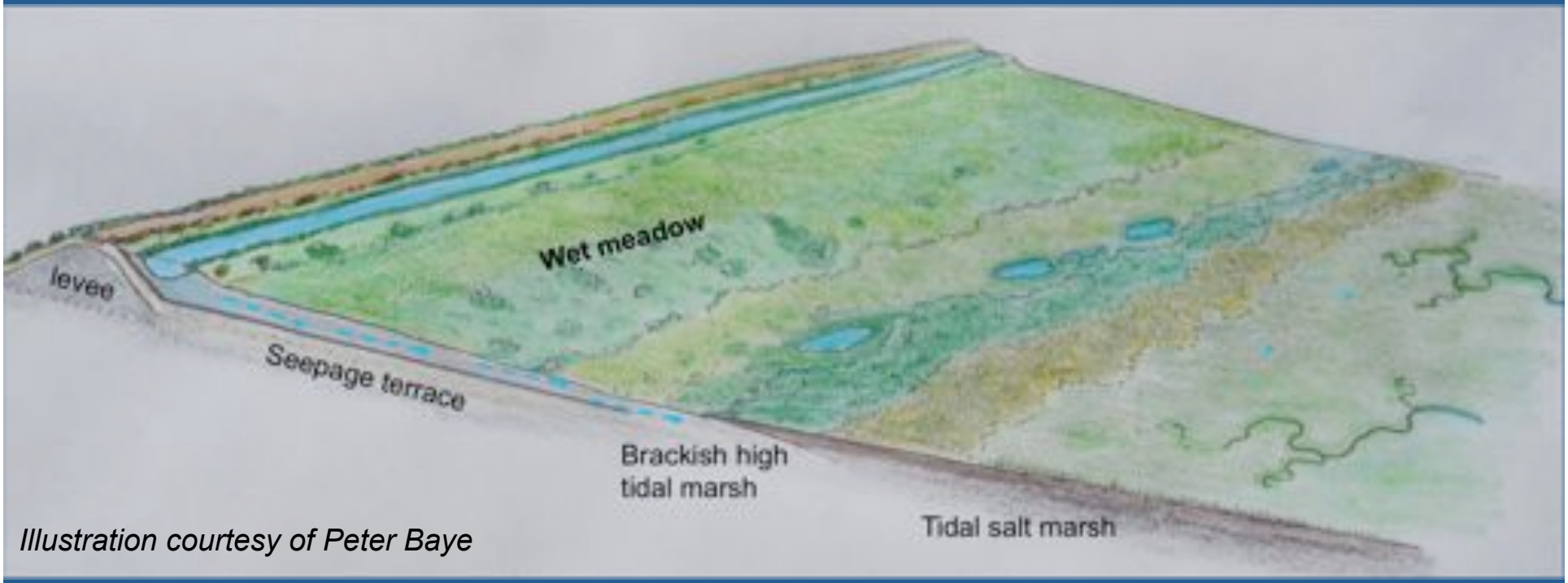


Illustration courtesy of Peter Baye

Conclusions

1. Wetlands can play a significant role in reducing coastal flooding and future investments in structural shoreline protection.
2. A high, wide mudflat and marsh mudflat maximize wave attenuation.
3. Appropriate management measures are based on site-specific geomorphic conditions.
4. Additional research is needed to better understand the efficacy of many of these measures.

The

Adapting to Rising Tides

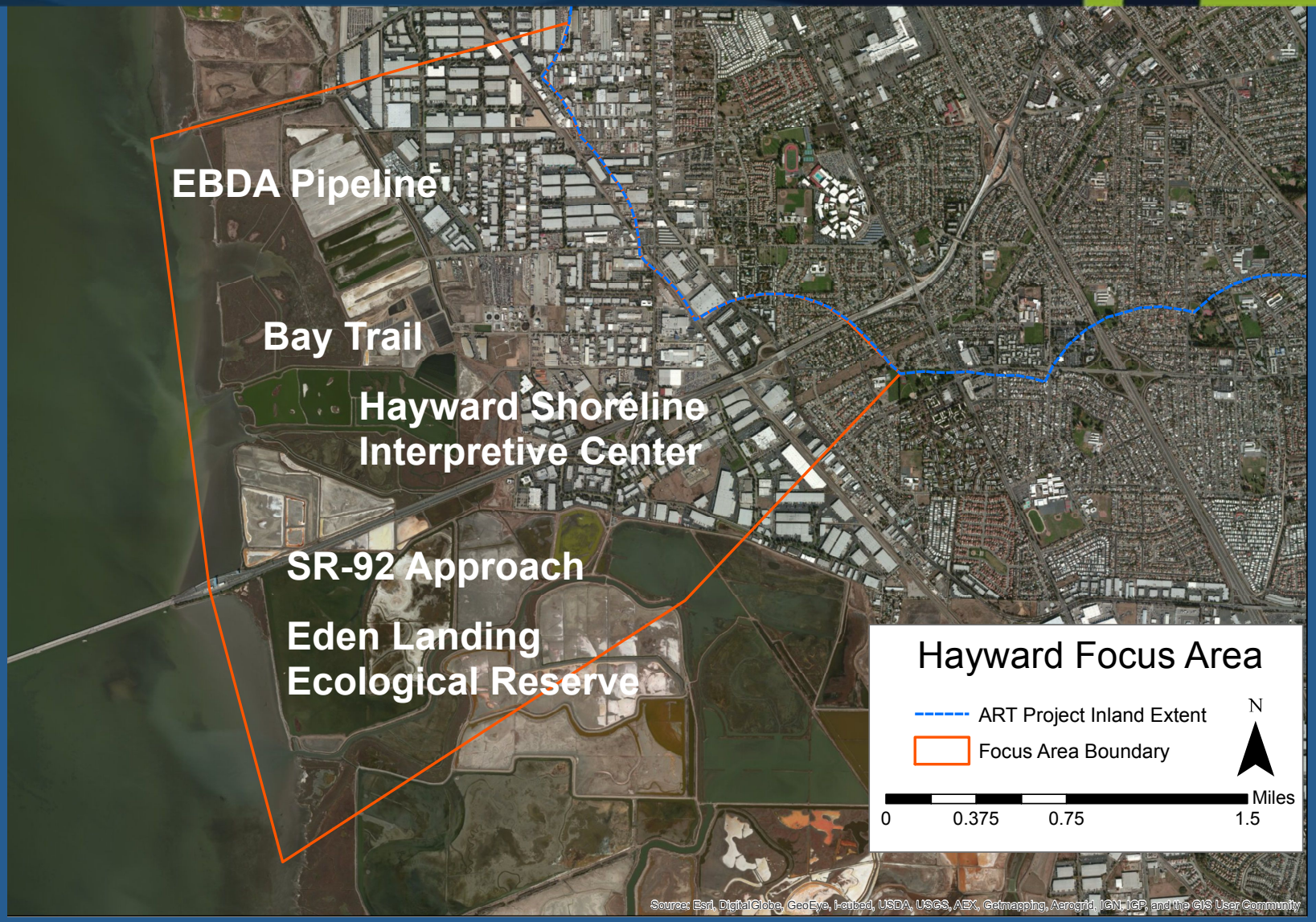
Program

Hayward Resilience Study

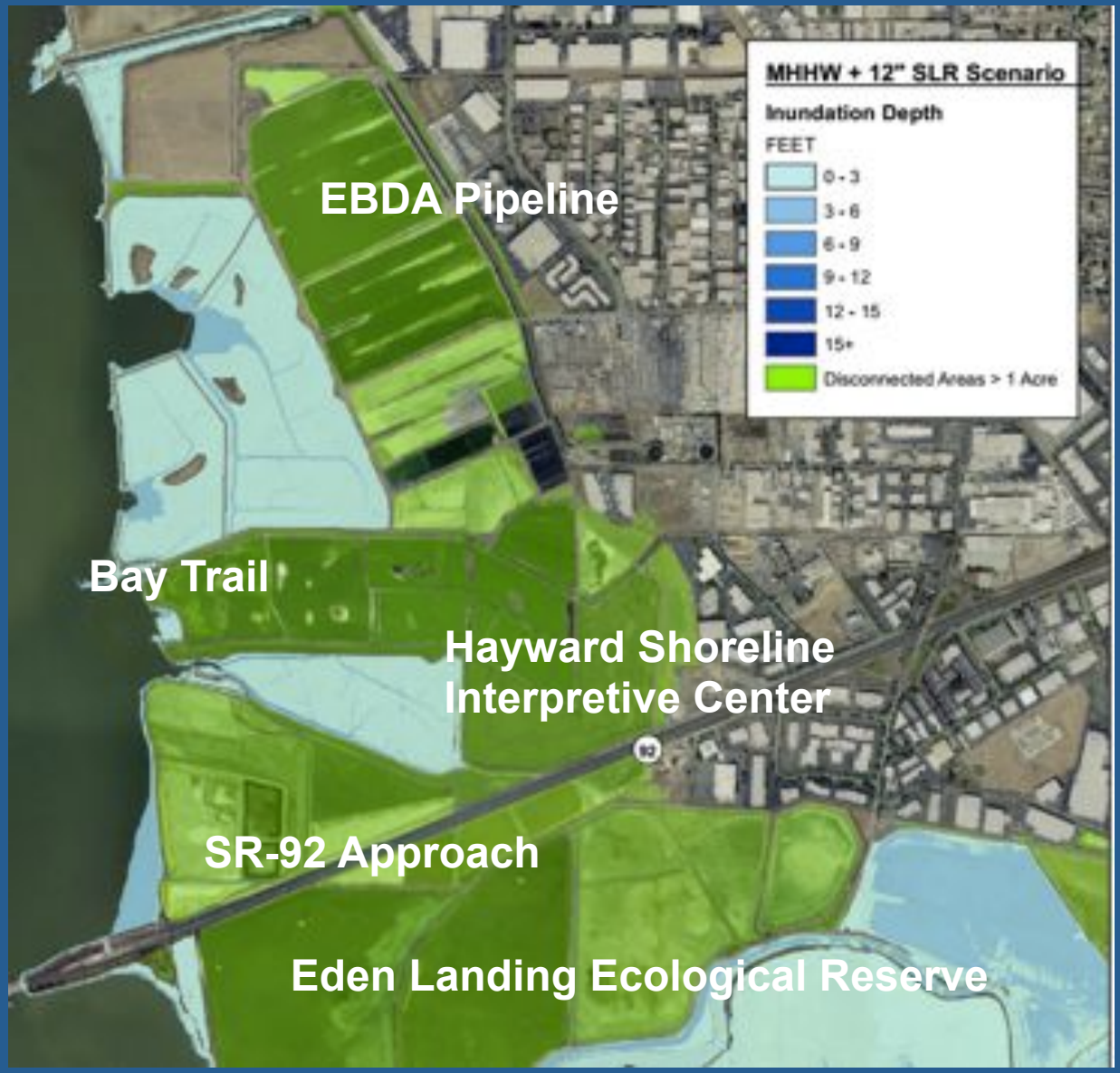
San Francisco Bay Conservation
and Development Commission

ART Program Zooms In on Hayward

Regionally Significant Assets



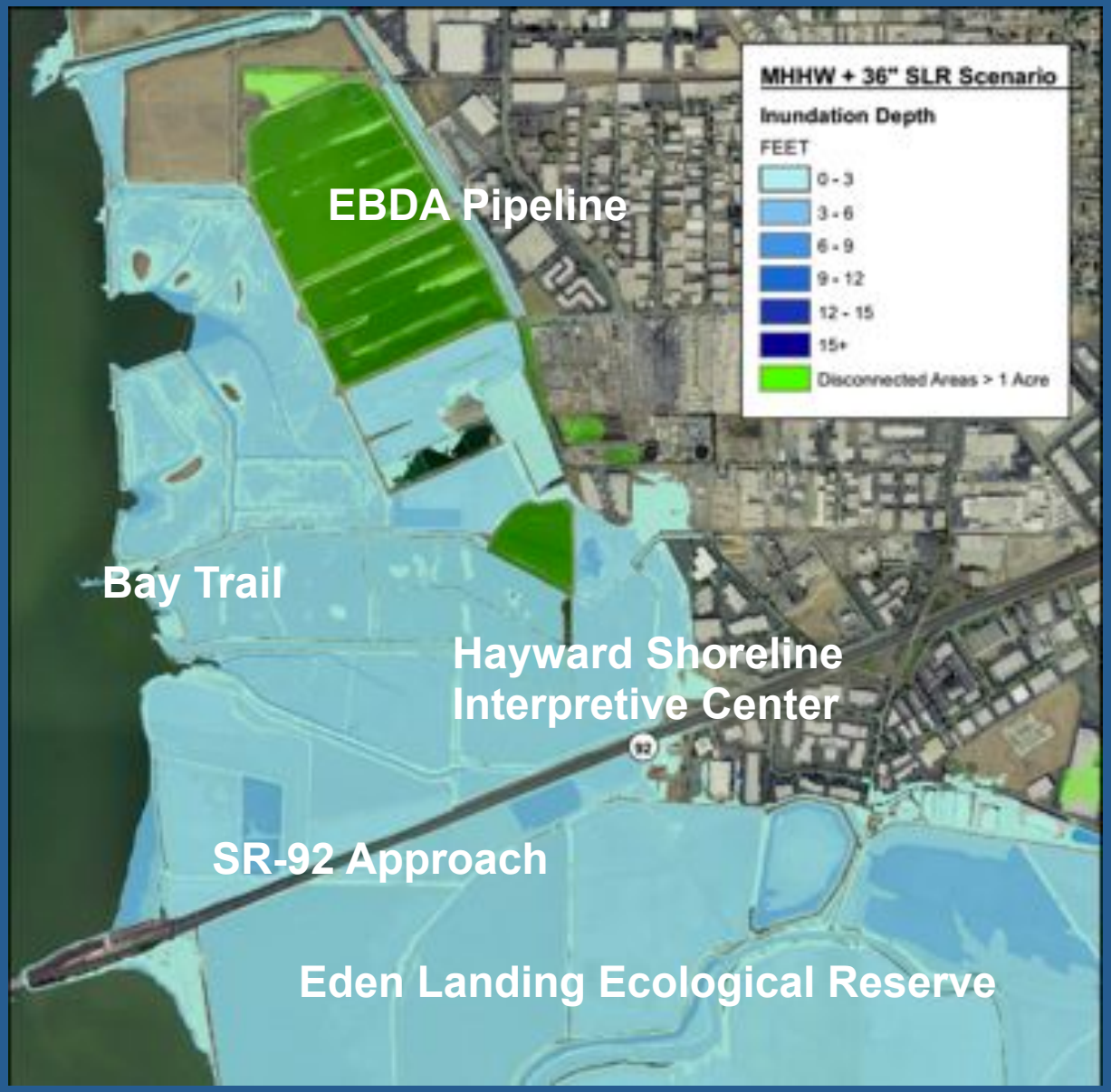
Sea Level Rise and Storm Event Exposure



Sea Level Rise and Storm Event Exposure

Sea Level Rise and Storm Event Exposure

Flooding in Developed Area



Planning Process

Working Group

- City of Hayward
- East Bay Regional Park District
- Hayward Area Recreation and Park District
- East Bay Dischargers Authority
- Union Sanitary District
- California Coastal Conservancy
- Alameda County Flood Control Water Conservation District
- CalTrans

Resilience Goals

1. Protect the health, safety, and welfare of those who live, work, and recreate in the Hayward Shoreline area

2. Prevent the disruption of key community services by protecting critical infrastructure

3. Protect the environmental value of the Hayward Shoreline area by preserving habitat, water quality, and endangered species

4. Build organizational and community capacity so stakeholders can work collaboratively to address future conditions

Vulnerability Assessment

1. Shoreline Protection is Too Low

- Shoreline protection is ad hoc levees and natural areas
- The natural areas are not predicted to keep up with rising Bay water levels due to low sediment supply and erosion
- The structural shorelines are all at about the same elevation and overtop between 36-48” over MHHW

2. Widespread Consequences

Vulnerable Regional Assets:

- SR-92 Approach
- EBDA Pipeline
- Hayward Water Pollution Control Facility
- Russell City Energy Center

Photographs (from left to right): Hayward Effluent Pump Station; EBDA Joint Outfall diffuser section being lowered into water, 1978 (Grace 2009); Russell City Energy Center

3. Governance Vulnerabilities

- Lack of organizational capacity to address long term issues
- Limited financial support for current maintenance and repairs as well as long term planning and improvements
- Current regulatory process does not account for unavoidable changes due to sea level rise

4. Unique Recreation and Education At Risk

- Environmental education for 9,000 students/year
- 80,000 Bay Trail users/ year
- Vulnerable natural areas, levees, and trails

5. Landscape Solution Requires Coordination

- Short term, individual actions can build resilience
- When water levels reach 36-48” above MHHW the Hayward Focus Area will need a coordinated, multi-benefit, landscape-scale effort for future coastal flood protection.

Business as usual

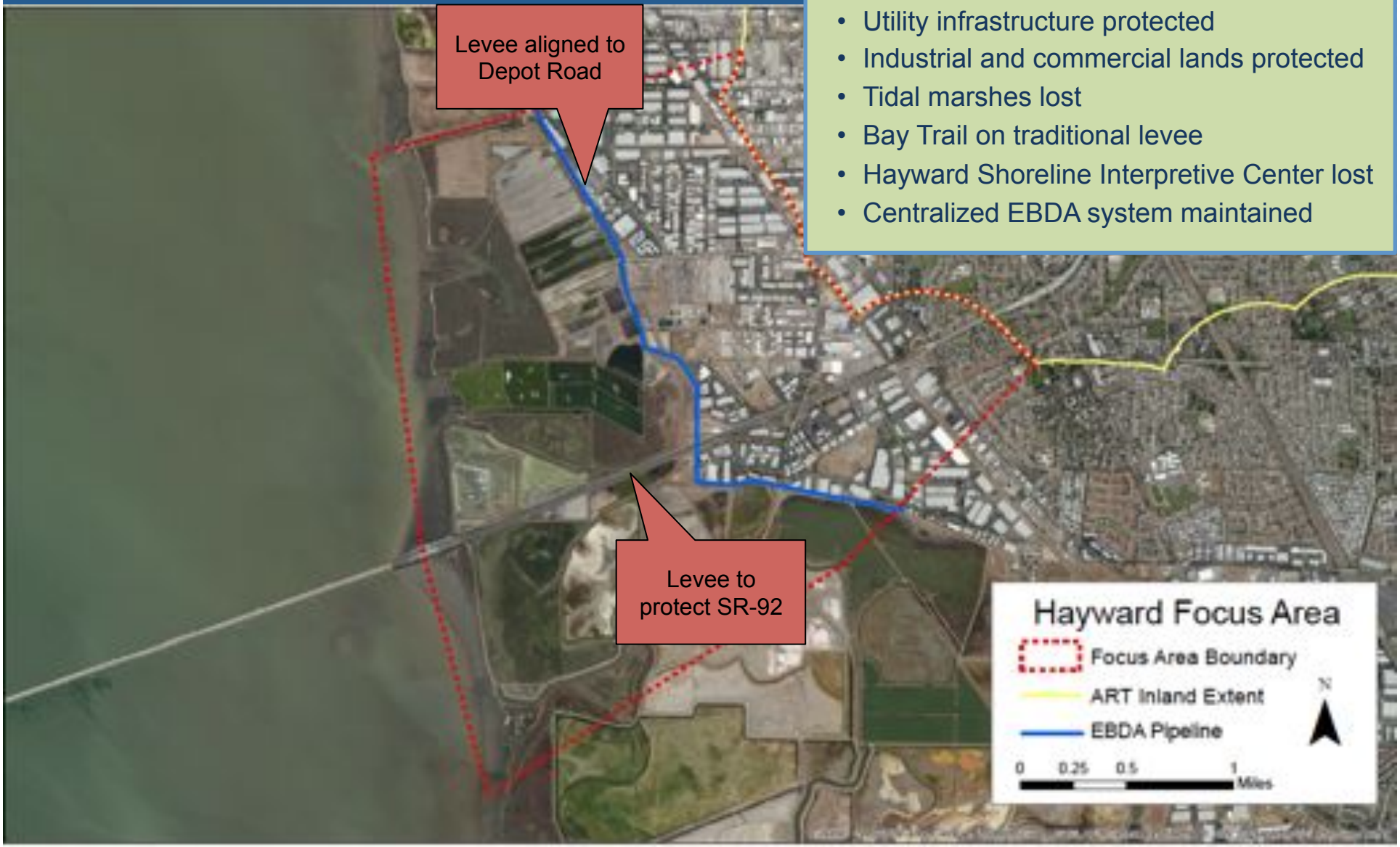
Key outcomes

- Costly flood damage and recovery
- Increased flood insurance premiums
- Tidal marshes lost
- Bay Trail lost
- Hayward Shoreline Interpretive Center lost
- Centralized EBDA system maintained

Traditional levee

Key outcomes

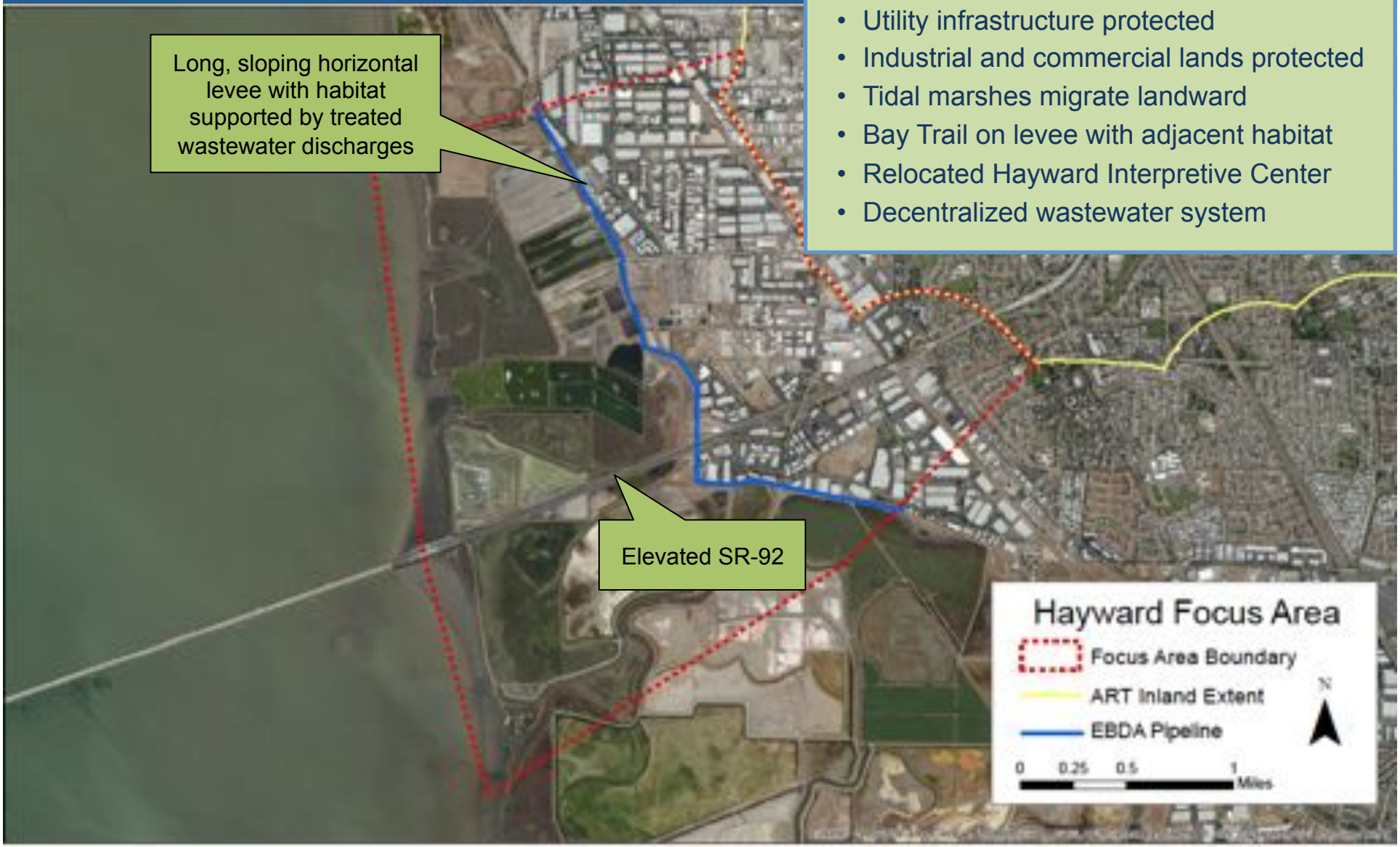
- Utility infrastructure protected
- Industrial and commercial lands protected
- Tidal marshes lost
- Bay Trail on traditional levee
- Hayward Shoreline Interpretive Center lost
- Centralized EBDA system maintained



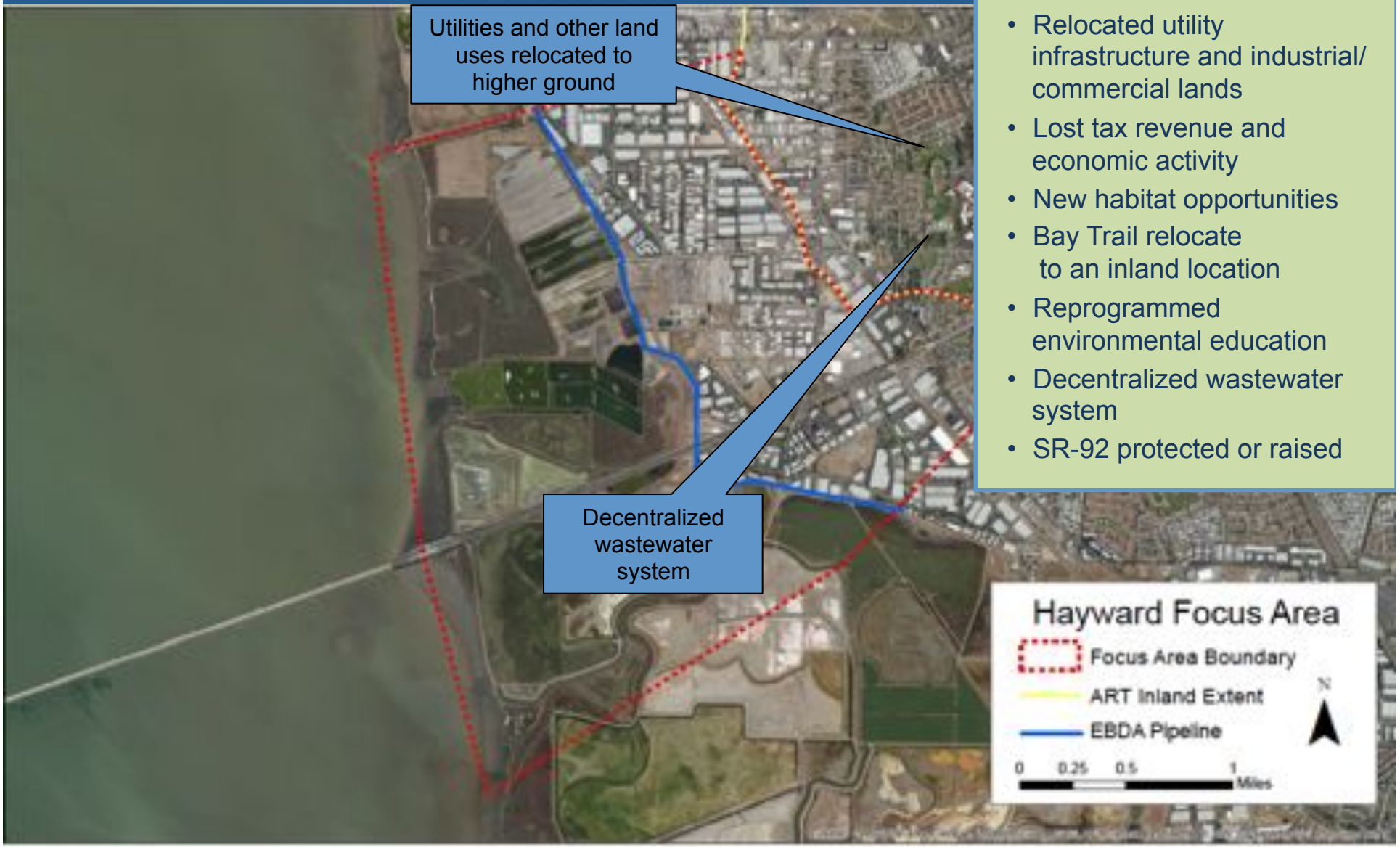
Horizontal levee

Key outcomes

- Utility infrastructure protected
- Industrial and commercial lands protected
- Tidal marshes migrate landward
- Bay Trail on levee with adjacent habitat
- Relocated Hayward Interpretive Center
- Decentralized wastewater system



Room for the Bay



Key outcomes

- Relocated utility infrastructure and industrial/ commercial lands
- Lost tax revenue and economic activity
- New habitat opportunities
- Bay Trail relocate to an inland location
- Reprogrammed environmental education
- Decentralized wastewater system
- SR-92 protected or raised

Next steps for Hayward

1. Evaluation of visions for feasibility and consequences
2. Agency and asset specific adaptation actions
3. Outreach to community members and decision-makers

What have we learned?

1. Scale matters

   Site characteristics and conditions matter and what is learned at the local scale can be applied regionally.

2. Thresholds instead of timing

   Rather than planning for 20 or 50 or 100 year increments, thresholds are a more meaningful planning tool and will vary around the region. For example, Hayward demonstrates that individual actions can be taken until the point that the shoreline is overwhelmed. Knowing the threshold will lead you to better near and long term actions.

3. Collaborative, comprehensive planning is our best bet

   Agencies and jurisdictions do not have the capacity or authority to address these issues alone. Working together brings a better understanding of the problems, the possible solutions and funding opportunities and strengthens relationships for addressing problems together.

For more information visit:
www.adaptingtorisingtides.org
www.bcdc.ca.gov/planning/climate_change/WetlandAdapt.shtml

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