INCORPORATING RESILIENCE INTO COASTAL HIGHWAY ADAPTATION
A SAN FRANCISCO BAY CASE STUDY

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Photo taken on February 14, 2019
Marin County DPW
COASTAL CALIFORNIA

• **Open coast:** exposed to ocean waves; winter storms (high tides, storm surge, and large waves); El Niño winters (storm frequency, wave direction)

• **Embayments:** protected from ocean waves; winter storms (high tides, storm surge, small waves); El Niño winters (storm frequency, coincident rainfall)
Global average:

- Since 1993: 3.4 inches (+3.2 mm/yr)
- Since 2000: 2.5 inches
Bay Area Sea Level Rise

9414290 San Francisco, California

1.96 ± 0.19 mm/yr

Long-term trend = ~2 mm/year
DRIVERS OF ADAPTATION

• Chronic flooding due to historical SLR, changes in storm intensity, and subsidence

• Projected future inundation and flooding due to SLR and groundwater

• Coastal erosion

• Aging infrastructure

• Traffic congestion / capacity

• Projected habitat loss
TRANSPORTATION CORRIDORS AS BARRIERS

Physical | Geomorphic | Ecological | Hydrological | Access
APPROACHES TO ADAPTATION

- **Protect** – resist the hazard (armor, harden)
- **Accommodate** – work with the hazard (elevate, attenuate, floodable spaces)
- **Retreat** – avoid the hazard (relocate, realign)

**Best practices:**
- Look for opportunities to incorporate co-benefits
- Integrate ecological enhancements into the design
- Collaborate with stakeholders
Making the Case... For a New Approach

How would these issues be solved using traditional approaches?

Widen the highway

Mitigation

Flood barriers and levees

Shoreline enhancement
CALIFORNIA STATE ROUTE 37 CASE STUDY: SAN FRANCISCO BAY
KEY ISSUES

Traffic Congestion | Flooding | Subsidence | Habitat | Connectivity | SLR Resilience
100 MINUTES TO TRAVEL HOME DAILY
SR 37 FLOODING AND SEA LEVEL RISE VULNERABILITIES

Disclaimer: The inundation maps and the associated analyses are intended as planning level tools to illustrate the potential for inundation and coastal flooding under a variety of future sea level rise and storm surge scenarios. The maps depict possible future inundation that could occur if nothing is done to adapt or prepare for sea level rise over the next century. The maps do not represent the exact location or depth of flooding. The maps relied on a 5-m digital elevation model created from LIDAR data collected in 2010. Although care was taken to outline all relevant topographical features and coastal structures that may impact coastal inundation, it is possible that some features that are not the 5-m digital elevation model may not be fully represented. In addition, the maps do not account for future construction or shoreline protection upgrades, or other changes to San Francisco Bay or the region that may occur in response to sea level rise. For more context about the maps and analyses, including a description of the data and methods used, please see the documentation for the State Route 37 Integrated Traffic, Infrastructure and Sea Level Rise Analysis Study (UC Davis Martin Ecology Center and Cameron District 4).
Integrate transportation, ecosystem, and sea level rise adaptation into one design

Improve **mobility** across all modes and maintain public access

Increase corridor **resiliency** to storm surges and sea level rise

RESILIENT SR 37

Project Lead: Metropolitan Transportation Commission
Project Partners: Solano, Sonoma, Napa, and Marin Counties and Caltrans
INTEGRATED PLANNING FOR A CONNECTED FUTURE
CURRENT HIGHWAY
EMBANKMENT
CAUSEWAY
HYBRID APPROACH

Legend
- Existing (100m)
- Historical (250m)
- Skaggs Short-term (355m)

Sonoma Creek
DESIGN ALTERNATIVES

Alt 1: 4-Lane Highway:
Combination of Causeway and Embankment Adjacent to Existing Roadway

Alt 2: 4-Lane Causeway:
Adjacent to Existing Roadway

Alt 3: 4-Lane Highway near SMART (Northern Alignment)
Uses Land Along Future SMART Route

Alt 4 & 5: 4-Lane Causeway in the Bay (Southern Alignments 1 & 2)
Connecting Mare Island and US 101 or SR 37 (SR 37 maintained as is)

Source: MIG, 2018
## Alternatives Matrix Summary

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</tr>
</tbody>
</table>

Legend:
- **Net benefit or minimal impact**
- **Moderate but mitigable / avoidable impact**
- **Moderate to significant impact**
- **Notable or significant impact**

Draft results only, subject to further refinement.
RESILIENT BY DESIGN VISIONS

Team Common Ground
THANK YOU

- Metropolitan Transportation Commission
- Caltrans
- Solano Transportation Authority
- Sonoma County Transportation Authority
- Transportation Authority of Marin
- Napa Valley Transportation Authority
- Coastal Conservancy
- Sonoma Land Trust
- SF Estuary Institute
- SF Bay Joint Venture
- Ducks Unlimited
- Point Blue
- Kimley-Horn/AECOM
- ESA
- CA Department of Fish and Wildlife
- U.S. Fish and Wildlife Service
- Marin Audubon Society
- Solano Land Trust
- The Nature Conservancy
- BCDC
- SF Bay Regional Board
- Army Corps of Engineers
- NMFS
- U.S. EPA
- State Lands Commission
- UC Davis
- San Francisco Bay Trail
- Alta Planning

by RBD Team Common Ground
ADDRESS CORRIDOR ISSUES THROUGH AN INTERIM PROJECT AND AN ULTIMATE PROJECT CONCURRENTLY

**Interim Project**
Environmental - Design – Construction

**Realize Interim Project Benefits Early**

**Ultimate Project**
Environmental - Design - Construction

Transition to Ultimate Project

Ultimate Project in Service

Today 2025 2040 2050