Shallow groundwater response to sea-level rise

Alameda, Marin, San Francisco, and San Mateo Counties

San Leandro Bay/Oakland-Alameda Estuary Adaptation Working Group

April 19, 2023

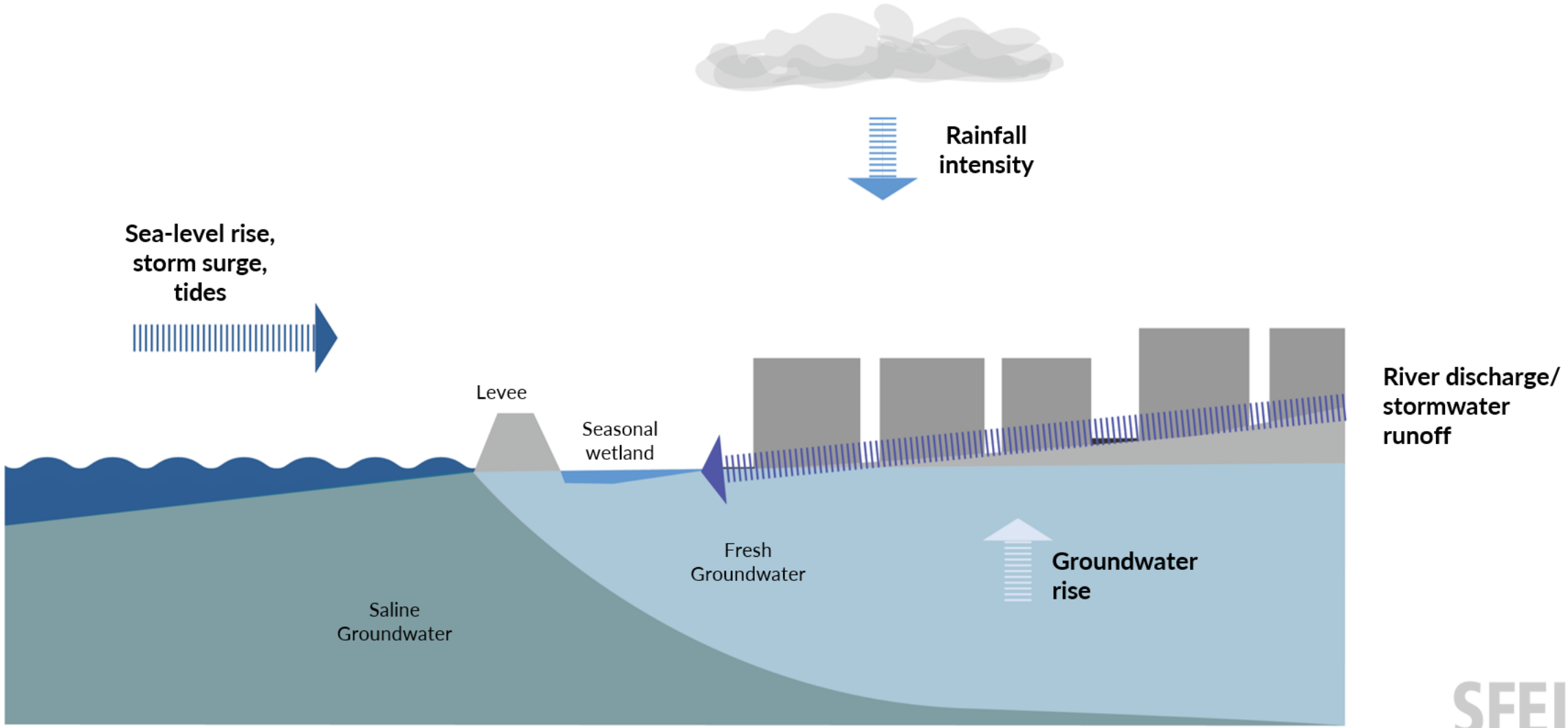
pathways CLIMATE INSTITUTE

SFEI AQUATIC SCIENCE CENTER
SAN FRANCISCO ESTUARY INSTITUTE & THE AQUATIC SCIENCE CENTER

Project team

- **Pathways Climate Institute** – Kris May, Abby Mohan, Daisy Ramirez Lopez, Lindsay Luchinsky, Michael Mak
- **San Francisco Estuary Institute** – Ellen Plane, Tony Hale
- **UC Berkeley** - Kristina Hill

Sources of flooding



SFEI

SF Bay groundwater rise: science timeline

water
MDPI

Article

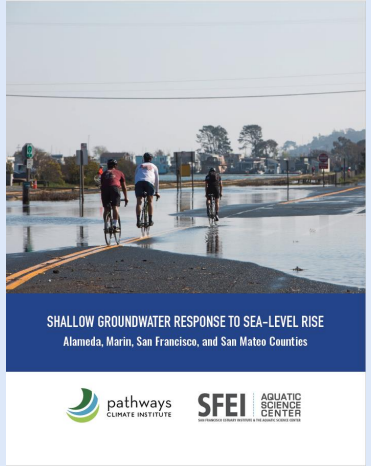
A Rapid Assessment Method to Identify Potential Groundwater Flooding Hotspots as Sea Levels Rise in Coastal Cities

Ellen Plane [1,*], Kristina Hill [1,*] and Christine May [2]

nature climate change
ARTICLES
https://doi.org/10.1038/s41558-020-0874-1
Check for updates

Increasing threat of coastal groundwater hazards from sea-level rise in California

K. M. Befus [1,2], P. L. Barnard [3], D. J. Hoover [3], J. A. Finzi Hart [3] and C. I. Voss [4]



2017 2018 2019 2020 2021 2022 2023

RESILIENT BY DESIGN
BAY AREA CHALLENGE

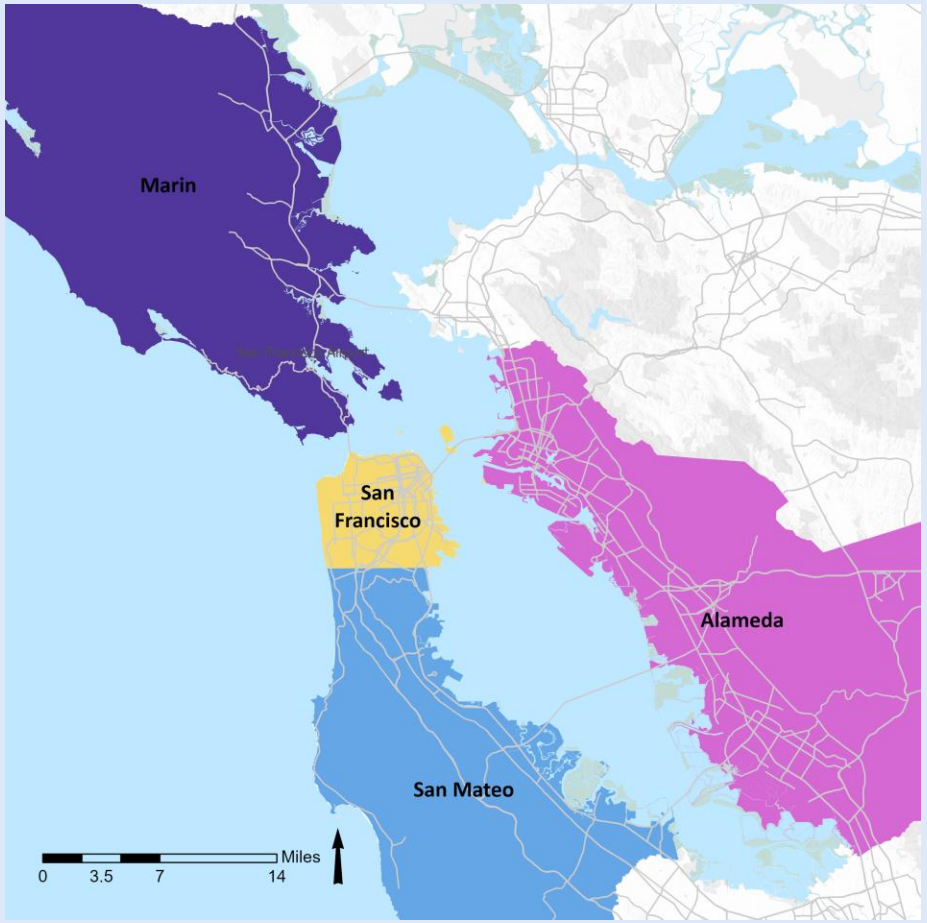
Workshop (co-hosted by BCDC)

CITY OF ALAMEDA
THE RESPONSE OF THE SHALLOW GROUNDWATER LAYER AND CONTAMINANTS TO SEA LEVEL RISE
SEPTEMBER 2020

silvestrum CLIMATE ASSOCIATES

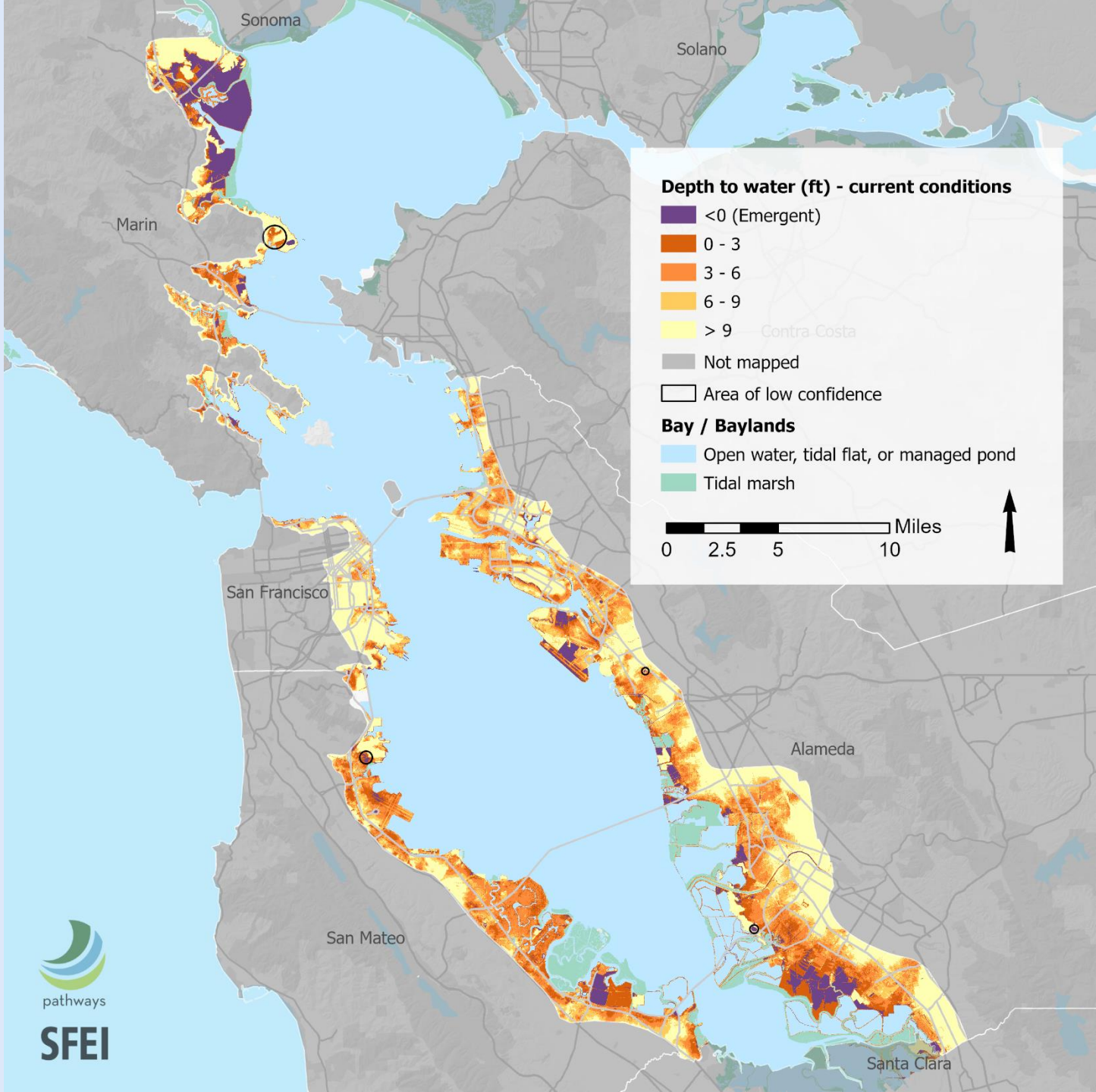
Project geography and scope

1. Map the existing wet season shallow groundwater surface
2. Project future shallow groundwater surfaces under multiple SLR scenarios
3. Overlay coastal inundation and emergent groundwater flooding layers
4. Enhance and refine the current list of potential adaptation strategies



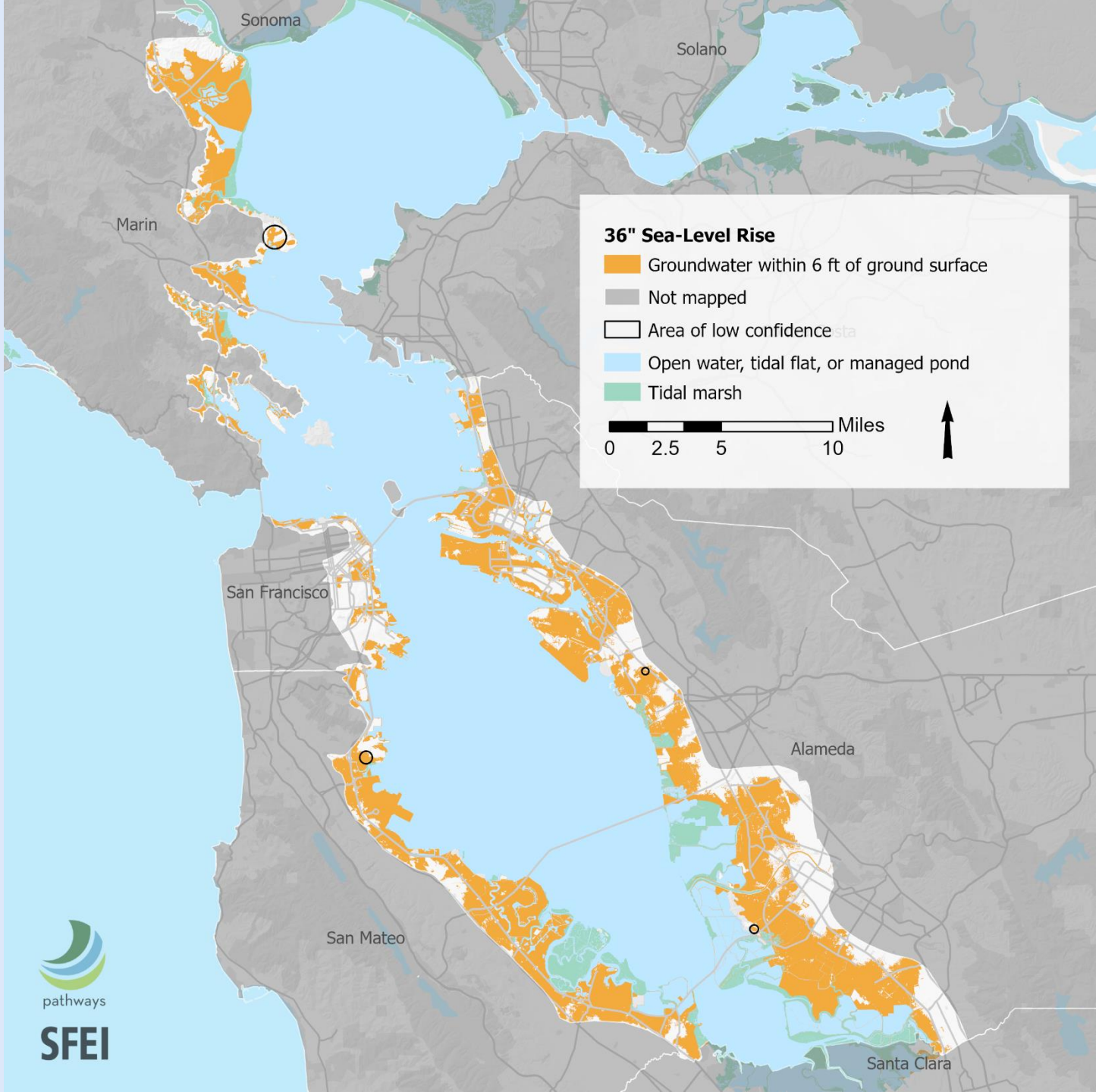
Depth to groundwater

- Constructed surface based on empirical data (monitoring wells and boring logs)
- Reviewed in county-by-county ground truthing meetings
- Baseline that is adjusted to show future groundwater conditions with sea-level rise.



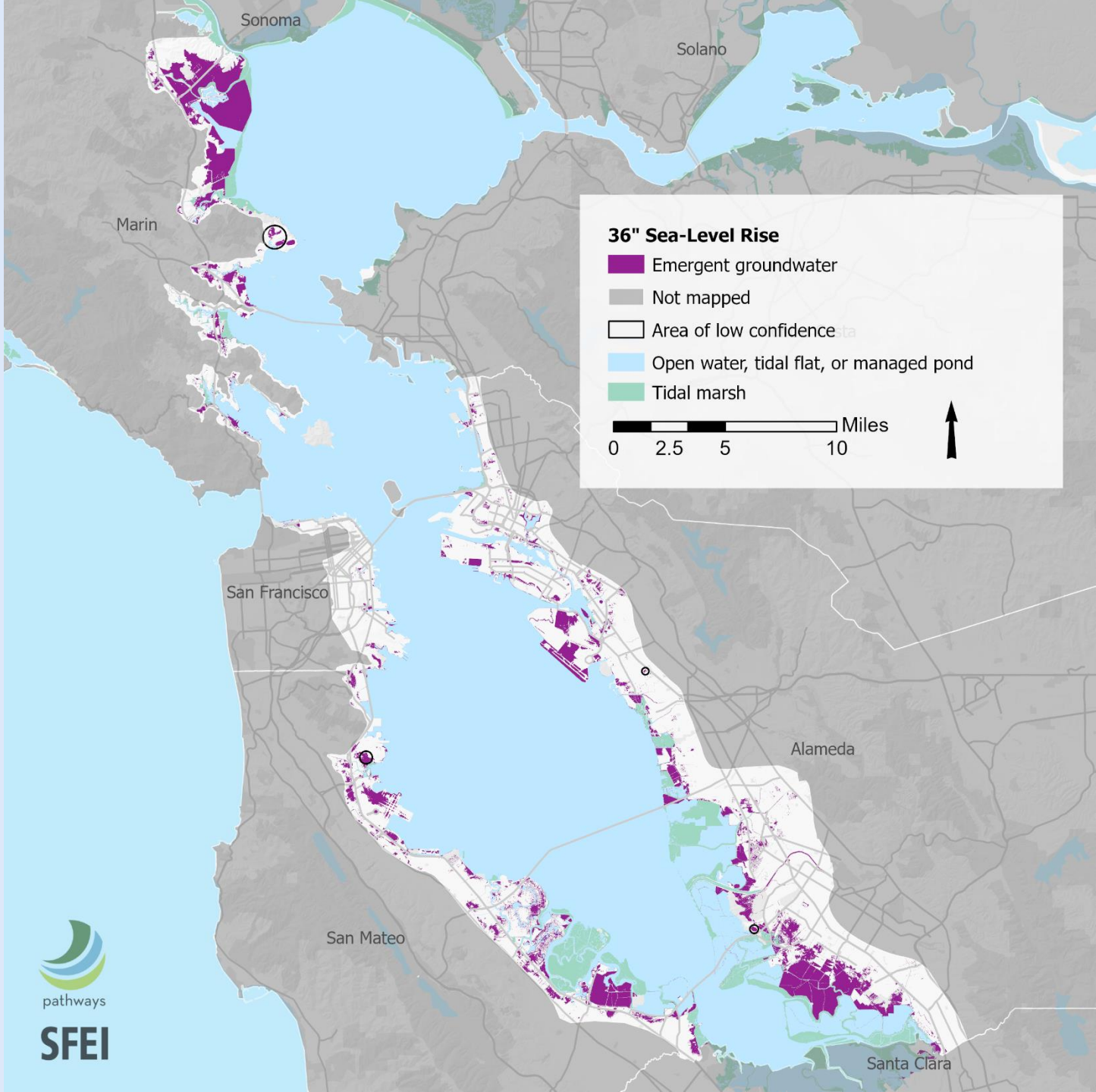
Shallow groundwater

- Developed future groundwater table zones where the groundwater table is within 6 feet of ground surface
- Zone of basements, buried utilities, road subgrades
- Important for evaluating infrastructure that may have not been designed for a high groundwater table
- Provided for 10 sea-level rise scenarios (aligned with ART Bay Shoreline Flood Explorer thresholds)

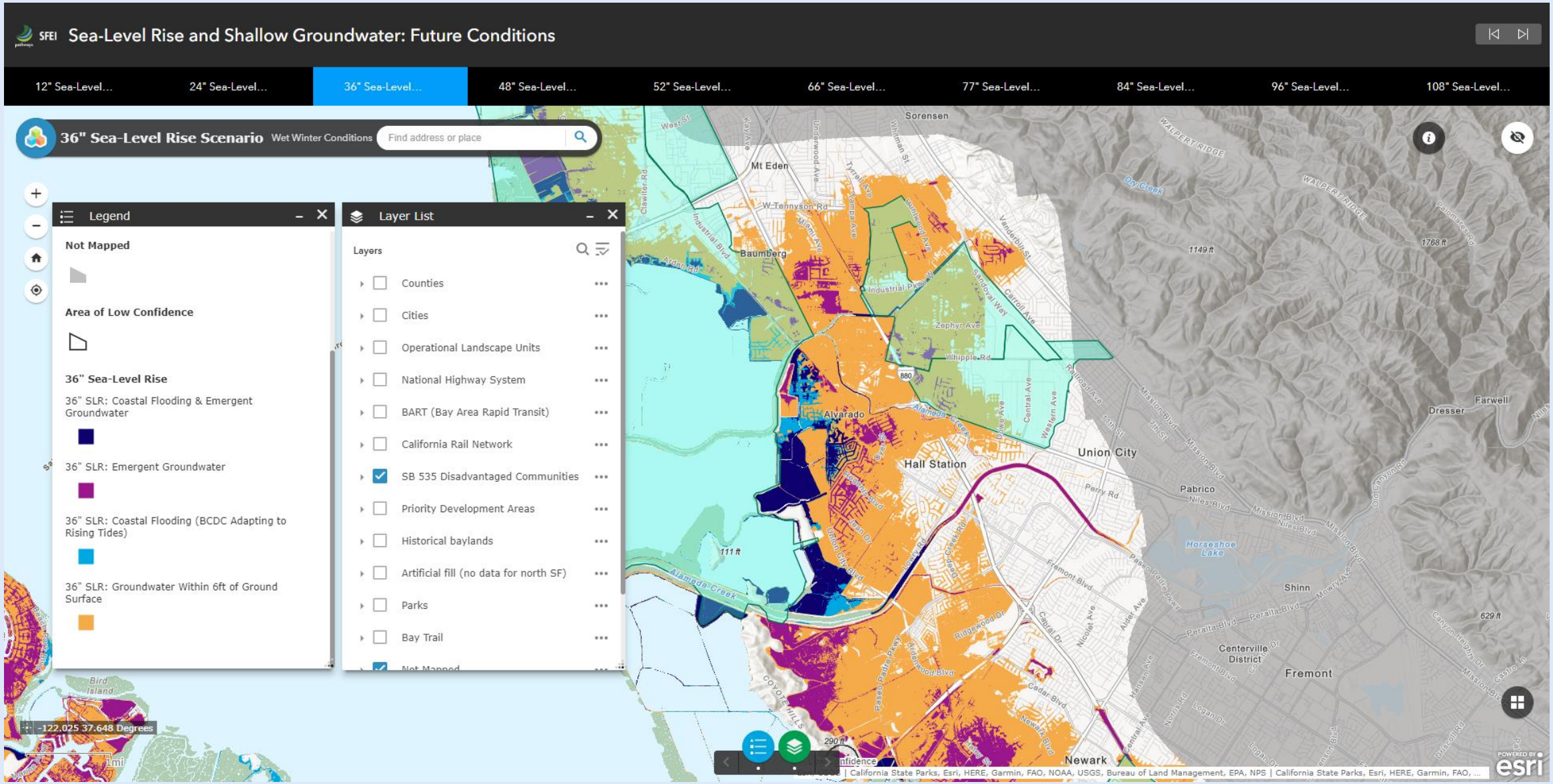


Emergent groundwater

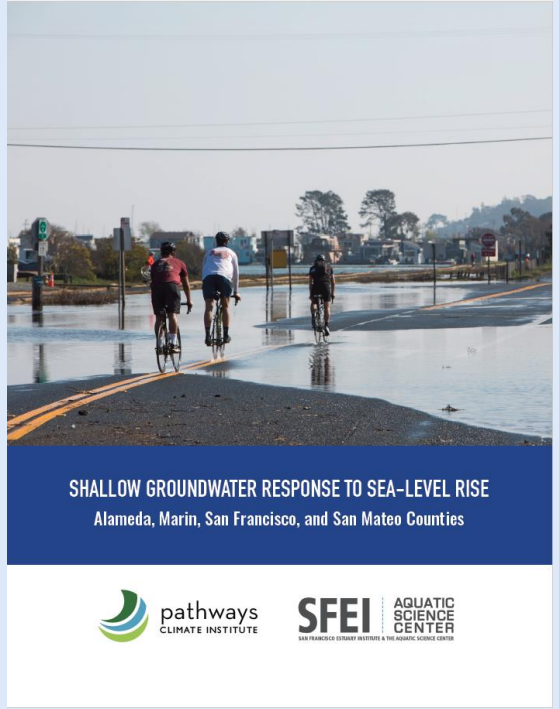
- Groundwater flooding above ground surface - wetlands
- First emergence during wet winter storm seasons
- Higher groundwater tables due to sea-level rise will expand the time period (season) and area of emergence
- Based on precipitation events between 2000 – 2020
- Dec 2022/Jan 2023 storms had inland flooding (with emergent groundwater) in many areas projected to have emergent groundwater with 24 – 36 inches of sea level rise



Overlay analysis



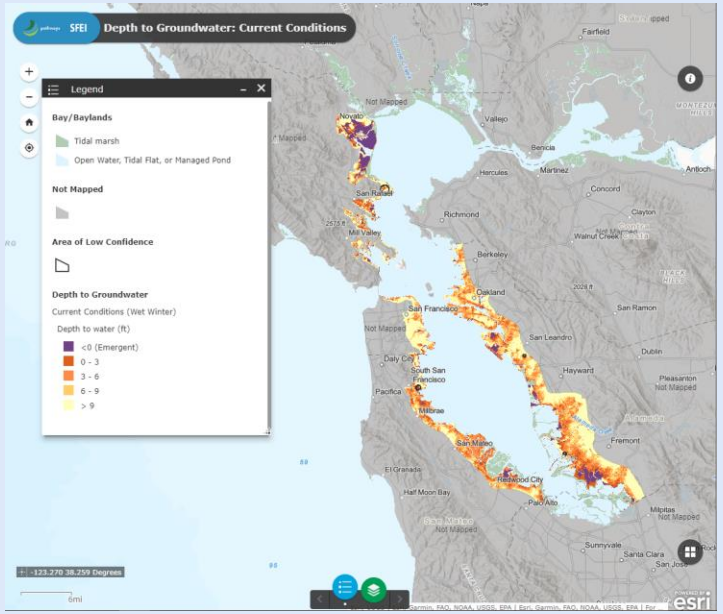
Products



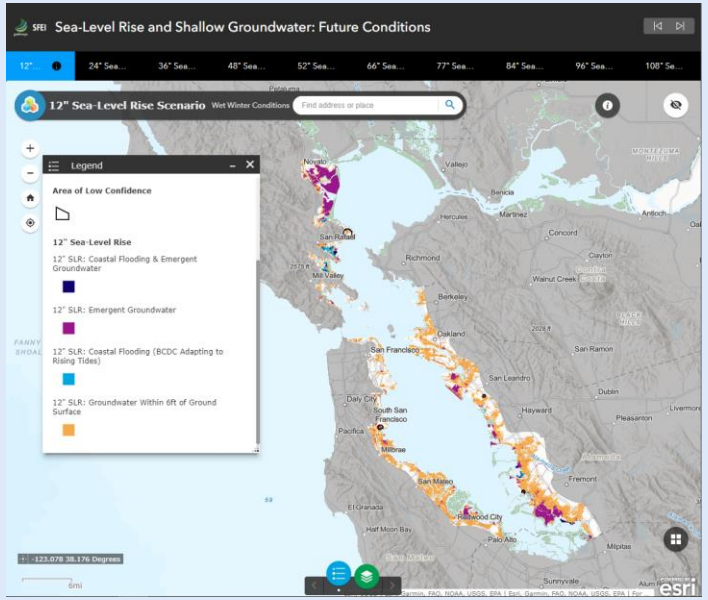
Report

Storymap

GIS downloads



Existing conditions webmap



Future conditions webmap

Adaptation challenges include…

- Increased liquefaction risk
- Infiltration & corrosion of underground infrastructure
- Damage to roads and structures
- Flooding from multiple sources including emergent groundwater
- Contaminated sites

Christchurch, NZ, 2011. Photo: Geoff Trotter

Photo: MA Water Resources Authority

Photo: Kristina Hill

Next Steps

- Contra Costa County groundwater mapping (funded by SF Bay Regional Water Quality Control Board; contracting in progress)
- Continuing to seek funding for remaining unfunded tasks:
  - Mapping of Sonoma, Napa, Solano, and Santa Clara counties
  - Flood Explorer Integration, including coordination and outreach with community-based organizations
- Also essential:
  - Refined local-scale dynamic modeling (e.g. MODFLOW)
  - Understanding impacts on contaminant plumes