

# Adapting to Rising Tides

## Adapting to Rising Tides (ART) Bay Area Sea Level Rise Analysis and Mapping Project

The Adapting to Rising Tides (ART) Program partnered with the Metropolitan Transportation Commission (MTC) to develop robust, locally-relevant maps of the San Francisco Bay shoreline's current and future flood risk. These integrated regional shoreline maps are designed to support detailed and consistent sea level rise assessment and adaptation in the region.

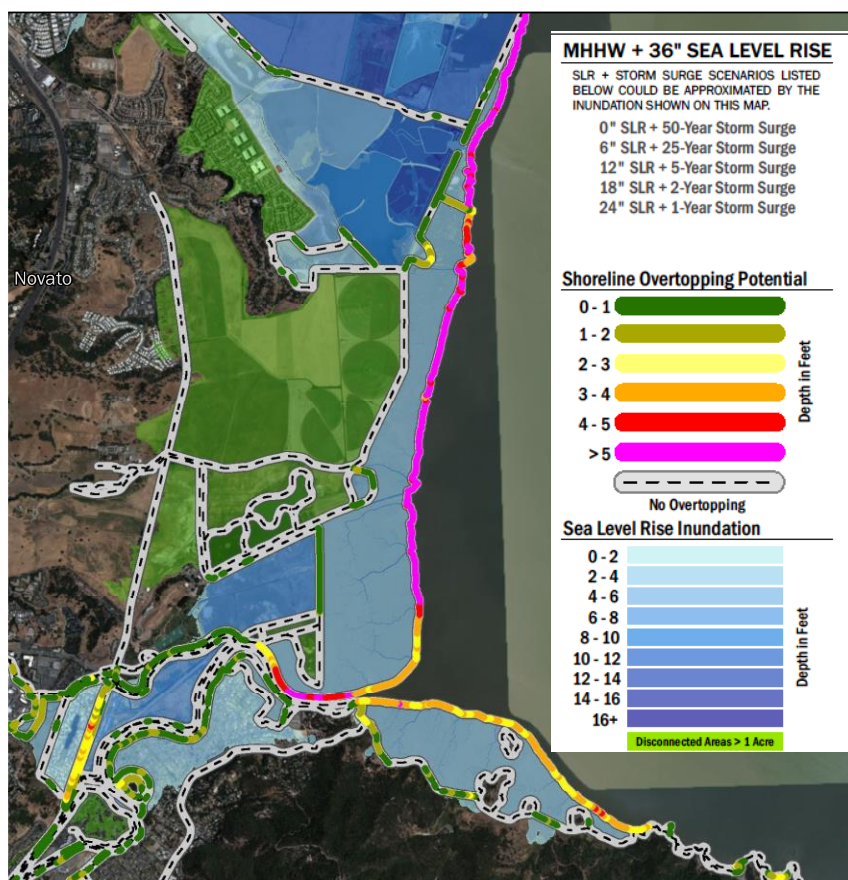
The ART regional shoreline mapping and analysis results in:

- The most locally-refined and locally-relevant tool available for sea-level rise adaptation planning in San Francisco Bay, in part, due to the maps' intensive local stakeholder review process, fine-scale resolution, and overtopping assessment.
- The ability to communicate that some areas will be temporarily flooded before they are permanently flooded as seas rise, enabling local jurisdictions and agencies to develop thresholds for early-, mid-, and long-term actions.
- The capacity to identify low points in the shoreline that can lead to inland flooding. This enables users to identify the shoreline locations for additional investigation, analysis, and adaptation strategies, allowing limited resources to be directed to the locations that pose the largest risk to shoreline communities.

### One Map = Many Futures

Sea level rise is often visualized using maps that represent specific scenarios (e.g., 12 inches) or extreme water levels (e.g., the 100-year storm), however selecting the most appropriate scenarios to support project planning and analysis is not always simple. One Map = Many Futures eliminates the need for pre-determined scenarios. This approach relies on equivalent water levels so that each ART map reflects a variety of possible sea level rise and extreme tide level combinations (i.e., 0 to 66 inches of sea level rise coupled with extreme tides from 1 to 100 years), and can be used to approximate impacts from either (1) permanent inundation from daily high tides or (2) temporary flooding from sea level rise and extreme tides likely to occur within the next decade.

This One Map = Many Futures map of the Novato area in Marin County depicts inundation and potential shoreline overtopping for 36 inches of sea level rise during a high tide (MHHW). This water level is also equivalent to 24 inches of sea level rise during a 1-year extreme tide (King Tide); and therefore the map can be used to understand either scenario.



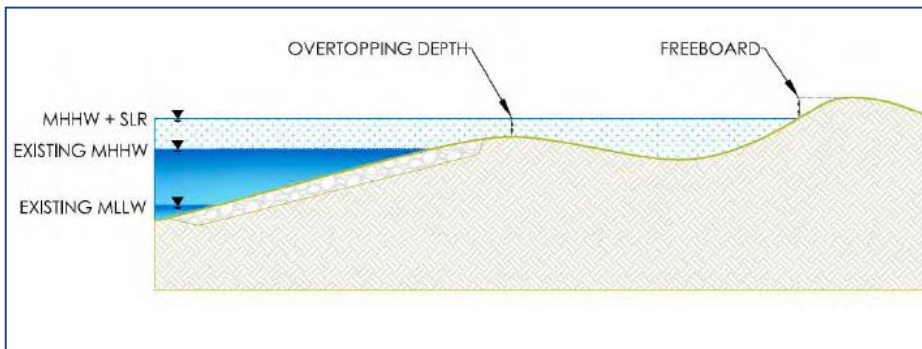
Mapbooks, geodatabases, and full report on methods and findings for all 9 counties are available at:  
<http://www.adaptingtorisingtides.org/project/regional-sea-level-rise-mapping-and-shoreline-analysis/>

## Ten Map Scenarios

The first six of the ten (10) map scenarios range from 12 to 66-inches of sea level rise (SLR). They also reflect Bay water levels ranging from the daily high tide (mean higher high water, MHHW) to a 100-year extreme tide. The remaining four maps (ranging from 78 to 108-inches of SLR) reflect Bay water levels that are above the California Ocean Protection Council's (OPC) 2100 SLR predictions (as of 2013), but are helpful in illustrating short-term flooding that could occur during future extreme tides. Because these maps are tied to equivalent water levels as opposed to sea level rise projections linked to specific years, they are highly adaptable. As OPC and the California Ocean Science Trust update the State's SLR guidance in 2017 and 2018 based on their recently released projections, these maps will remain just as applicable. For example, the State's recently released "[Update on SLR Science](#)" (2017) states that the likely range for SLR in the Bay is between 7.2 and 13.2 inches by 2050. When the "[Update to the State of California's SLR Guidance](#)" report is released to accompany the "Update on SLR Science", it will be simple to use the "One Map = Many Futures" approach to explore the scenarios that are identified due to the wide range of climate scenarios that are already included in the approach.

## Overtopping Assessment

Shoreline overtopping can occur when Bay water levels rise higher than the shoreline, allowing water to flow inland. The ART maps include an analysis of the type and elevation of the shoreline that results in an overtopping potential map, illustrating not only where overtopping may occur, but how deep the water may be, on average, over each 100-foot section of shoreline. Overtopping potential maps are a powerful tool that is unique to the ART maps as no other regionally



available sea level rise mapping products include it. Coupled with the inundation maps, the overtopping potential maps help users quickly identify the shoreline locations and flowpaths that could lead to inland flooding so that additional analysis, investigation, and adaptation strategies can be focused on the locations that pose the largest risk to shoreline communities and infrastructure.

## Frequently Asked Questions

- How do these maps relate to the FEMA Flood Insurance Rate Maps (FIRM) maps?: Both the ART and FEMA maps rely on the same underlying topographic and hydrodynamic modeling data from FEMA's [San Francisco Bay Coastal Study](#). The topographic data underlying the ART maps have undergone additional refinement through the stakeholder review process. The FIRMs delineate communities' regulatory flood risk zones under the National Flood Insurance Program.
- Do the ART maps have regulatory implications?: No. These maps are intended only to provide additional guidance to public and private agencies and organizations.
- What existing data and analysis are you drawing on?: This analysis leverages the latest LiDAR topographic data sets, the [FEMA San Francisco Bay Area Coastal Study](#) and [San Francisco Tidal Datums and Extreme Tides Study](#), and the regional shoreline delineation originally developed as part of the ART Alameda County Project and refined and completed for the rest of the region by the San Francisco Estuary Institute.
- Do these maps account for riverine flooding or show impacts of sea level rise on tidal creeks and channels?: Given that the San Francisco Bay Area Coastal Study includes historical inputs of freshwater into the Bay and the accompanying extreme tide during storms, these events are partially accounted for in our analysis. The ART maps show how sea level rise and extreme tides will cause coastal flooding to move up tidally influenced rivers and creeks. However, the maps do not show combined coastal-riverine flooding which needs to be investigated on an individual creek-by-creek basis. In cases where flood managers have conducted flood analysis of individual creeks, their analysis will represent the best available data. Please see the report "[Up a Creek? Guidance on assessing flood control risk](#)" for guidance on assessing the vulnerability of tidal creeks and flood control channels to sea level rise.