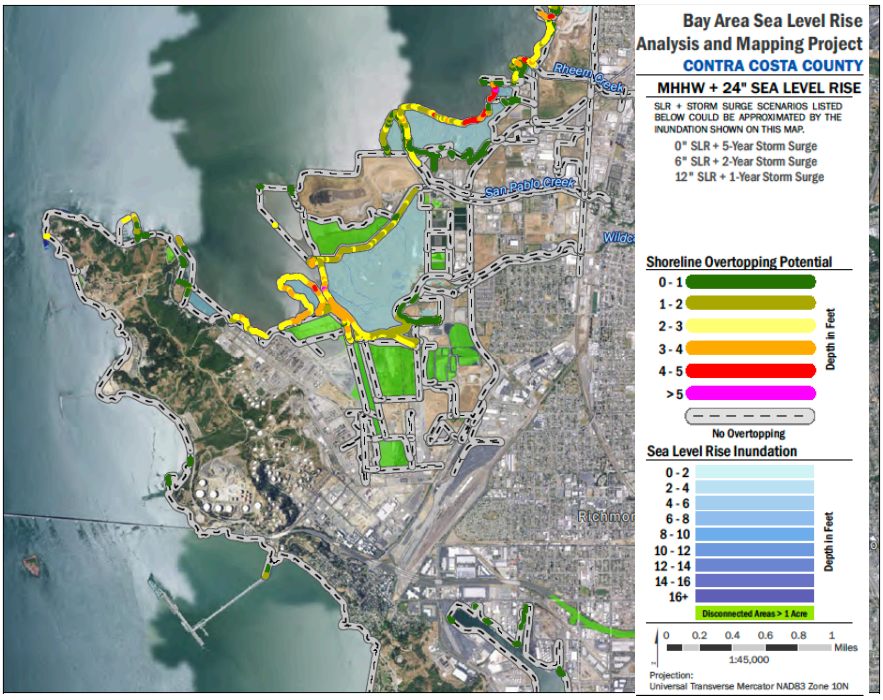
Adapting to Rising Tides

California State Sea Level Rise Guidance and the ART Maps

In March 2018, the Ocean Protection Council adopted updated guidance for state and local governments on how plan for and to adapt to rising sea levels. The report updates the 2013 sea level rise guidance with new science on ice sheet melt in Antarctica and Greenland, and provides improved, probabilistic, projections of sea level rise. For the San Francisco Bay Area, the new guidance recommends sea level rise projections to use for projects with low, high, or extreme risk aversion, along with projections for decades ranging from 2030 to 2150.. The water levels range from 6 inches for low risk aversion in 2030 to 21.9 feet for extreme risk aversion in 2150 (the full guidance document is available here. See Table 1 for these projections). The wide ranges of potential sea level rise and the changing projections, as scientists improve their understanding of the drivers of sea level rise, require flexible mapping and modeling of flood scenarios to guide planning. The ART maps accomplish this through our One Map, Many Futures approach.

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), or time horizons (e.g., 2050), however because there is uncertainty in sea level rise projections, selecting the most appropriate scenarios to support project planning and analysis is not always simple and often requires to planners looking at large number of maps all depicting futures scenarios that could be relevant, including possible sea level rise amounts that could occur during their planning horizon as well as maps of additional elevated water levels that occur during extreme events. One Map, Many Futures solves this problem by relying on equivalent water level approach. 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 permanent inundation from daily high tides or temporary flooding from sea level rise and extreme tides that may occur at any time. For example, you can look at a map of a single total water level above today's high tide, such as 24-inches (see above map), and see the flooding that could result from 1) 24-inches of permanent sea level rise in the long term, 2) 12-inches of permanent sea level rise plus a 1-year storm in the short term, or 3) a 5-year storm today. All three of these scenarios will result in water levels 24-inches above today's high tide. This approach is especially useful because our region needs to be planning not only for permanent flooding from future sea level rise, but also for temporary flooding that can happen today due to king tides and storms.

Ten Map Scenarios

The ART Maps illustrate many of the expected sea levels laid out in the State Guidance, along with associated extreme water levels that might cause temporary flooding. The flood scenario included in the ART maps range from 12 to 108 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. Because these maps are tied to equivalent water levels as opposed to sea level rise projections linked to specific years, they are highly adaptable. For example the above map illustrates 24 inches of sea level rise which could illustrate approximately the recommended medium-high risk aversion planning level for a project with a lifespan of 2050.

ART Maps and the State Sea Level Rise Guidance

The table below illustrates which ART Map corresponds to water levels recommended in the 2018 State Sea Level Rise Guidance (ART Maps water levels are mapped using a tolerance of ± 3 inches to increase the applicable range of each scenario). The table also shows what temporary water levels may occur due to storms in each future scenario.

Which ART Map water level best matches State Guidance

		Likely range (high end of the 67% probability range)	1-in-200 Chance	H++
		Low-risk aversion	Medium-High Risk aversion	Extreme Risk Aversion
2030	2030 State Guidance (High emissions)	6"	9.6"	12"
	ART Map Approximate Match (permanent)	*	MHHW+12"	MHHW+12"
	2030+5-yr Flood	NA	MHHW+36"	MHHW+36"
	2030+50-yr Flood	NA	MHHW+48"	MHHW+48"
	2030+100-yr Flood	MHHW+48"	MHHW+48"	MHHW+52"
2050	2050 State Guidance (High emissions)	13.2"	22.8"	32.4"
	ART Map Approximate Match (permanent)	MHHW+12"	MHHW+24"	MHHW+36"
	2050+5-yr flood (ART Map temporary)	MHHW+36"	MHHW+48"	NA
	2050+50-yr flood (ART Map temporary)	MHHW+48"	NA	NA
	2050+100-yr flood (ART Map temporary)	MHHW+52"	MHHW+66"	MHHW+77
2070	2070 State Guidance (High emissions)	22.8"	42"	62.4"
	ART Map Approximate Match (permanent)	MHHW+24"	NA	MHHW+66"
	2070+5-yr flood (ART Map temporary)	MHHW+48"	MHHW+66"	MHHW+84"
	2070+50-yr flood (ART Map temporary)	NA	MHHW+77"	MHHW+96"
	2070+100-yr flood (ART Map temporary)	MHHW+66"	MHHW+84"	MHHW+108"
2100	2100 State Guidance (High emission)	40.8"	82.8"	122.4"
	ART Map (permanent)	MHHW+36"	MHHW+84"	**
	2100+5-yr flood (ART Map Temporary)	MHHW+66"	MHHW+108"	**
	2100+50-yr flood (ART Map Temporary)	MHHW+77"	**	**
	2100+100-yr flood (ART Map temporary)	MHHW+84"	**	**

MHHW= Mean Higher High Water

Mapped water levels are applicable for +/- 3”

*ART Maps Start at 12” of sea level rise

** The ART Maps go up to 108” above current MHHW, equivalent to 66” of sea level rise plus a 100 year flood. This level was chosen based on the National Research Council estimates (NRC 2012) which informed the 2013 State Sea Level Rise Guidance.