

Appendix H
Sea Level Rise Analysis

DRAFT

Sea Level Rise

March 4, 2024

Introduction

Although the *South Orange County Regional Coastal Resilience Strategic Plan* (Strategic Plan) focuses on the current beach erosion issues, beach nourishment and coastal resilience projects can also be used for adapting to rising sea levels. This appendix summarizes sea level rise (SLR) projections and effects of SLR on beaches and coastal resources for South Orange County.

Historical Sea Level Rise in South Orange County

The National Oceanic and Atmospheric Administration (NOAA) evaluates relative sea level trends at tide gauges. Monitored water levels at the La Jolla tide gauge (Station 9410230) have shown an increase of 0.08 inch per year (2.04 millimeters per year) based on monthly mean sea levels from 1924 to 2021 (NOAA 2023). The relatively small increases in sea levels over the past several decades suggest that beach erosion currently occurring is attributed to reductions in the fluvial sand supply from drought conditions or dams, and not from increases in sea levels.

Sea Level Rise Projections

The state has provided a statewide guidance for local agencies in analyzing and assessing risks associated with SLR (CNRA and OPC 2018). This guidance uses a science-based methodology representing the “best available science” for SLR projections. The latest SLR projections for California are based on advances in SLR modeling and understanding of global SLR (Griggs et al. 2017). The state’s guidance provides a range of SLR projections at the 12 active NOAA tide gauges along the California coast. Probabilistic projections of SLR from 2030 to 2150 are included for four scenarios with different probabilities of occurring, as well as an extreme H++, or high-end climate change scenario. Projections between 2030 and 2050 are based on a high greenhouse gas emissions scenario, whereas projections from 2050 onward are provided as a range between low and high greenhouse gas emissions scenarios. The state’s guidance recommends the use of three probabilistic projections corresponding to three risk aversion scenarios: low, medium-high, and extreme risk aversion scenarios.

The SLR projections for La Jolla are listed in Table 1. In general, the low risk aversion scenario is recommended for resources with low impacts, such as recreation facilities including an unpaved coastal trail, whereas the medium-high risk aversion scenario is recommended for resources lower ability to adapt, such as residential and commercial structures. The extreme risk aversion scenario is recommended only for development that poses a high risk to public health and safety, natural resources, or critical infrastructure.

Table 1
Sea Level Rise Projections for La Jolla

Year	Projected SLR (feet)		
	Low Risk Aversion	Medium-High Risk Aversion	Extreme Risk Aversion
2030	0.6	0.9	1.1
2040	0.9	1.3	1.8
2050	1.2	2.0	2.8
2060	1.6	2.7	3.9
2070	2.0	3.6	5.2
2080	2.5	4.6	6.7
2090	3.0	5.7	8.3
2100	3.6	7.1	10.2
2110	3.7	7.5	12.0
2120	4.3	8.8	14.3
2130	4.9	10.2	16.6
2140	5.4	11.7	19.2
2150	6.1	13.3	22.0

Notes:

Low risk aversion: Upper limit of "likely range" (approximately 17% probability SLR exceeds this level)

Medium-high risk aversion: 1-in-200 chance (0.5% probability SLR exceeds this level)

Extreme risk aversion: Single scenario (no associated probability)

SLR projections based on high greenhouse gas emissions scenario.

Source: CNRA and OPC 2018

Effects of Sea Level Rise

The potential future effects of SLR on beaches and coastal resources in South Orange County have been identified in prior SLR vulnerability assessments for the City of Dana Point (2019) and City of San Clemente (2019). The SLR vulnerability assessments provide information on the potential impacts of SLR, key SLR thresholds, and potential adaptation strategies for improving coastal resiliency. Impacts of SLR were determined using a combination of the Coastal Storm Modeling System (CoSMoS) for coastal flooding and the CoSMoS Coastal One-Line Assimilated Simulation Tool (CoSMoS-COAST) for shoreline erosion. CoSMoS contains predicted coastal flooding maps, whereas CoSMoS-COAST provides predicted future shoreline positions. Both models are based on a predefined increment of SLR, wave conditions, and management scenarios. A summary of the SLR vulnerability assessments for South Orange County is provided below.

Existing structures such as oceanfront homes, the Los Angeles-San Diego-San Luis Obispo Rail Corridor (LOSSAN Corridor), and Pacific Coast Highway would prevent the natural landward migration of the beach that would occur with projected rising sea levels. For beaches in South Orange County, SLR would worsen the already chronic beach erosion and reduce recreational beach

areas. The effects of storm waves are projected to increase in magnitude with higher sea levels. Key SLR thresholds were identified at 1.6 feet of SLR, which could occur between 2040 and 2060 and at 3.3 feet of SLR, which could occur between 2050 to 2100 (City of Dana Point 2019; City of San Clemente 2019).

Based on the SLR vulnerability assessments (City of Dana Point 2019; City of San Clemente 2019), coastal flooding is anticipated to occur with regular frequency even during non-storm conditions with SLR greater than 1.6 feet. In Dana Point Harbor, Baby Beach could lose up to 50 feet of beach area during high tides. Low-lying area of the harbor—such as parking lots, walkways, and bulkheads—could experience temporary flooding during extreme storm events and high tides, as well as damage to marina infrastructure, such as boat launch ramps, gangways, and docks. With 1.6 feet of SLR, it is anticipated that the east side of Doheny State Beach and Capistrano Beach Park would only have a seasonal beach area with no beach during a portion of the year. Over half of the Capistrano Bay District oceanfront homes along Beach Road could be subject to seasonal erosion impacts, particularly for homes on shallow foundation and without shoreline protection. Beach access to Poche Beach would be permanently inundated. Portions of the LOSSAN Corridor where riprap protection has already been installed, would be exposed to direct wave action and erosion and experience more frequent coastal flooding. In areas where there is no riprap protection along the railroad, such as between Linda Lane Park and T-Street Beach, beach erosion could reach the railroad starting at 2.5 feet of SLR.

A 3.3-foot rise in sea levels represents a significant threshold for the South Orange County shoreline. Dana Point Harbor could be inundated regularly at high tides, including the surrounding walkways and parking lots. At this 3.3-foot SLR threshold, a permanent loss of beach would occur at the east side of Doheny State Beach and Capistrano Beach Park. The sand berm protecting the camping grounds would no longer be effective. The shoreline along the Capistrano Bay District would be at or landward of the oceanfront homes, with permanent beach loss and homes regularly exposed to wave action. Permanent beach loss would also occur from Poche City Beach to T-Street Beach with 3.3 feet of SLR. This stretch of coastline includes Capistrano Shores, North Beach, Linda Lane Park, and San Clemente Municipal Pier. San Clemente State Beach and Cyrus Shore also have a high risk of permanent beach loss with 3.3 feet of SLR, and almost all beach access tunnels in San Clemente would also be impacted. For the LOSSAN Corridor, the entire length of railroad would be exposed to direct wave action and erosion.

Adaptation Measures

The best available science of SLR projections indicate that 3.5 feet of SLR could occur between 2060 and 2100. However, the California Ocean Protection Council (OPC) Strategic Plan and Proposition 68 require state-funded projects to evaluate potential SLR of 3.5 feet by the year 2050. Potential adaptation measures to protect the coastline from SLR include beach nourishment, living shorelines,

or shoreline protection. These adaptation measures could be implemented in combination for additional benefits and flexibility in project design (City of Dana Point 2019).

Both the Cities of Dana Point and San Clemente's SLR adaptation measures recommend participating in a regional beach nourishment program to increase efficiency and cost-effectiveness (City of Dana Point 2019; City of San Clemente 2019). A regional beach nourishment program could be effective and feasible to offset beach erosion, but only with SLR projections of up to 3.3 feet. The fifth climate change assessment for California is currently being prepared, so current SLR projections and time horizons may change when it is finalized.

Beach nourishment enables beaches to maintain or increase in width, providing wave protection while maintaining recreational and environmental resources. In addition, beach nourishment has been successfully implemented throughout Southern California. Major challenges for implementing a regional beach nourishment program include obtaining funding and environmental permits.

Living shorelines are shoreline stabilization techniques that use native material, vegetation, or other living elements in combination with a structural element to provide stability. Native vegetation is used to reduce coastal erosion and provide habitat resources. The structural element should be compatible with the existing ecosystem and natural coastal processes. Living shorelines could be implemented through habitat restoration to allow upward migration of habitat and enhancing protection of landward resources. A sand dune is an example of a living shoreline that has been identified as an adaptation measure for SLR (City of Dana Point 2019) and is being considered at Doheny State Beach, Capistrano Beach, and San Clemente as part of nature-based adaptation projects.

Higher rates of SLR would require adaptive management to increase the amount sand needed to retain a wide public beach and would have associated increased costs. Long-term adaptation measures would likely depend on what is done for the LOSSAN Corridor, such as reinforced coastal structures. Without shoreline protection of some type, the railroad would likely be inoperable from frequent coastal flooding and erosion damage with 4.9 feet of SLR (City of San Clemente 2019).

Shoreline protection is the use of structures such as seawalls, riprap, and revetments.

Thus, maintaining an ongoing regional Shoreline Monitoring Program is essential to understand the condition of the beaches in South Orange County as is closely monitoring the nearest local NOAA tide gauge at La Jolla, which is currently reporting a relative SLR trend of 0.08 inch per year (2.04 millimeters per year; NOAA 2023).

Local agencies, as well as individual organizations, are planning or actively implementing various projects and programs to enhance shoreline communities, to construct or repair shoreline protection structures, or to implement adaptation measures as described in Appendix G.

Regional coordination would serve to create consistency for implementation and planning regionwide moving forward.

State Targets for Sea Level Rise

This Strategic Plan is a beneficiary of OPC's Proposition 68 Coastal Resiliency grant solicitation and should advance implementation of the OPC's *Strategic Plan to Protect California's Coast and Ocean 2020–2025* (OPC Strategic Plan; 2020) and support the Principles for Aligned State Action on Making California's Coast Resilient to Sea Level Rise. The Strategic Plan should show progress in ensuring California's coast is resilient to a minimum of 3.5 feet of SLR by 2050 and use a more protective baseline 2050 and 2100 targets for road, rail, port, power plants, water and waste systems, and other critical infrastructure.

The OPC sets forth a series of Targets and Actions in their OPC Strategic Plan. Action 1.1.1 for 2050 states:

Ensure California's coast is resilient to at least 3.5 feet of SLR by 2050, as consistent with the State's Sea Level Rise Guidance Document as appropriate for a given location or project. This target will be modified periodically based on the best available science and updates to the State's Sea Level Rise Guidance Document.

This target is intended to be based on the best available science and updates to the state's Sea Level Rise Guidance Document. An update to this Guidance Document is anticipated in late 2023, which is based on data provided by NOAA in their *Sea Level Rise Technical Report* released in 2017 that suggests "an increased confidence in a narrower range of projected global, national, and regional SLR at 2050 than previously reported." Therefore, this best available science may eliminate the most extreme scenarios provided in the state's current Sea Level Rise Guidance Document. NOAA indicates that "by 2050, the expected relative sea level (RSL) will cause tide and storm surge heights to increase and will lead to a shift in U.S. coastal flood regimes, with major and moderate high tide flood events occurring as frequently as moderate and minor and high tide flood events occur today. Without additional risk measures, U.S. coastal infrastructure, communities, and ecosystems will face significant consequences." NOAA's document goes on to anticipate high scenario projections for SLR of 1.14 feet (0.38 meters) for the southwest region by 2050, significantly lower than the 3.5 feet currently identified by OPC's target.

A regional beach nourishment program could be effective and feasible to offset beach erosion due to high tide flood events and for SLR projections between 1.6 and 3.3 feet. Therefore, the current Strategic Plan objective to pursue regional beach nourishment shows progress toward meeting this target for resiliency by 2050 based on the current best available science. This Strategic Plan may serve as a continued networking opportunity for local and regional planning and coordination to

create a forum for the planning process for SLR adaptation. The underlying premise of this Strategic Plan is to build upon existing sand replenishment projects and develop an ongoing regional coordination for the beneficial use of sediment to restore the natural sediment supply to the South Orange County region. The amount of coastal resiliency (e.g., 3.5 feet) should be included as a design goal for the regional beach nourishment program. Thus, implementation of this Strategic Plan meets the OPC Strategic Plan (OPC 2020) and Proposition 68 goal to ensure California's coast is resilient to 3.5 feet of SLR by 2050. The amount of coastal resiliency (e.g., 3.5 feet) should be included as a design goal for the regional beach nourishment program.

References

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