DRAFT
CITY OF SAN CLEMENTE
COASTAL RESILIENCY PLAN

October 2021

Table of Contents

LIST OF FIGURES

LIST OF TABLES

Executive Summary

The City of San Clemente (City) Coastal Resiliency Plan (CRP or Plan) serves as the City of San Clemente's long-range planning and guidance document to address future potential sea-level rise (SLR) and its effects on storm surge, shoreline erosion, and coastal flooding in the City. The purpose of the City of San Clemente Coastal Resiliency Plan (Plan) is to build on the findings and recommendations contained in the City's Final Sea Level Rise Vulnerability Assessment (SLRVA) completed in November 2019 to implement actions, strategies, plans, and programs to improve long-term coastal resiliency in San Clemente.

This Plan was funded in part by the California Coastal Commission (CCC) grant LCP-18-05 awarded to the City to support the City's Local Coastal Program (LCP).

Vulnerability to Sea Level Rise (SLR) is a product of several variables including:

- Exposure to coastal hazards including shoreline erosion, flooding, and inundation;
- Sensitivity to coastal hazards including potential for damage or loss of function; and
- Adaptive capacity, which is the ability to restore function or avoid damage.

Overview of Sea Level Rise (SLR) Hazards in San Clemente

The SLRVA included the following tasks as part of the CCC's guidelines to incorporate SLR planning into a City's Local Coastal Program :

- Evaluation of storm and non-storm scenarios using data from the Coastal Storm Modeling System (CoSMoS 3.0) published by the United States Geological Survey (USGS).
- Estimation of anticipated changes in beach width under future SLR scenarios.
- Assessment of SLR vulnerabilities by identifying existing infrastructure as well as public and private developments potentially at risk due to rising seas.
- Evaluation of SLR-related effects on existing and planned segments of the California Coastal Trail in the City.
- Qualitative evaluation of the feasibility and effectiveness of sediment management and beach nourishment using all applicable and relevant data including that generated by the City's Coastal Storm Damage Reduction Project (USACE, 2012).

Shoreline erosion is an existing challenge faced by the City and is anticipated to accelerate with SLR. In San Clemente, shoreline erosion is expected to be the primary hazard affecting coastal resources and existing structures and infrastructure. For San Clemente, the dry beach area and potentially the intertidal zone (i.e., area between the high tide and the low tide) landward of the existing railroad revetment are at risk of permanent loss with rising seas.

According to the Orange County Coastal Regional Sediment Management Plan (OCCRSM) prepared in 2013 by the County of Orange (in partnership with State Parks and the U.S. Army Corps of Engineers (USACE)), although the City's beaches are identified as critical erosion hot spots, the City's beaches are host to 3 million visitors per year, generating $87 million dollars in spending annually as of 2013.

Enhancements and additions to existing coastal hazard reduction measures are often necessary to account for potential increases in hazard levels due to SLR. Resiliency measures within this Plan focus on

direct protection from current hazards and future SLR hazards through both nature-based and potentially structural means.

Scenarios Evaluated in the San Clemente SLRVA

Due to the existing trends of shoreline erosion affecting San Clemente and many other jurisdictions throughout the region, any amount of SLR is anticipated to exacerbate existing (baseline) conditions creating impacts due to the long-term reduction in littoral sediment delivered to the coastline south of Dana Point from the San Juan Creek.

In the absence of active, comprehensive, and long-term beach sand replenishment efforts, this net reduction of sediment delivery to the coastline results in a shoreline condition that is erosive. As sea levels rise over longer time horizons, there are notable thresholds with progressively greater impacts that will drive the need for one or more resiliency or adaptation measures to be implemented.

Below are key thresholds identified in the City's SLRVA for each SLR scenario evaluated and the resources most at risk from coastal hazards. A discussion of the SLR timing follows in the next section of the report.

- **0.8 feet SLR (25 cm)**: Existing sandy beaches erode and lose about half their width, some areas (North Beach and Mariposa Point) erode completely to the railroad impacting coastal access, recreation, and the environmental resources seaward of the railroad. Structures on the beach, including the City's Municipal Pier and Marine Safety Building, are vulnerable to more frequent storm-related flooding, damage, erosion, scour, and undermining.
- **3.3 feet SLR (100 cm):** Most sandy beaches are eroded up to the railroad, small beaches may exist seasonally and at low tide. Shoreline erosion projections indicate this may be close to a threshold point for the railroad corridor as the railroad would be subject to repeated wave attack and flooding during high tides and storm events.
- **4.9 feet SLR (150 cm)**: In the SLRVA, this scenario assumed the railroad and revetment was relocated / removed from its current location. Under this assumption shoreline erosion could reach the coastal bluffs landward of the railroad. Bluff top land and existing structures would be vulnerable to bluff failures resulting from increased wave action at the toe in the absence of the protective railroad revetment and assuming no other resiliency building actions are taken by the City or others.

Future SLR Timing and Uncertainties in the Model Projections

The California Coastal Commission (CCC) recognizes the *State of California Sea-Level Rise Guidance,* (OPC 2018), released in March 2018 by the Ocean Protection Council (OPC), as the "best available science" on SLR along the coast of California. The OPC 2018 Guidance uses a probabilistic approach to generate a range of SLR projections at a given time horizon.

For the 2050 time horizon the "likely range" of SLR is between 0.7 to 1.2 feet which means there is a 66% probability that SLR will fall within this range during this time horizon. The OPC 2018 guidance document also acknowledges the potential for less likely or less probable scenarios that result in higher amounts of SLR. For example, the OPC 2018 document indicates there is a 0.5% chance that SLR reaches 2 feet by 2050. In other words, the 0.8-foot SLR scenario would most likely occur in the 2040-2050 timeframe, but there is a very slight chance it could occur sooner.

The "likely range" of SLR for the 2100-time horizon is 1.8 to 3.6 feet, but there is a 0.5% chance SLR reaches 7.1 feet by 2100. The range of projections at these more distant time horizons increases significantly due to uncertainties associated with (1) future Greenhouse Gases (GHG) emissions, (2) the physical processes affecting how the Antarctic ice sheets may respond to such scenarios, (3) and many other factors/variables.

Based on the OPC 2018 projections, a 3.3-foot SLR scenario would most likely occur near the end of this century, but there is a very slight chance (0.5% chance) it could occur by 2070. The 4.9-foot SLR scenario is projected to occur in the 2130-2140 timeframe most likely, but there is a very slight chance (0.5% chance) it could occur in the 2080-2090 timeframe.

The OPC 2018 Guidance also lays out a risk decision framework around which SLR projections to use. In general, the guidance suggests projects involving critical infrastructure, consider the upper range of SLR projections and impacts associated with these scenarios. For projects where potential consequences from SLR damage would be more tolerable, the lower SLR projections can be used for planning and design purposes. The OPC Guidance provides SLR projections for low, medium-high and critical risk aversion applications but these three categories alone do not reflect the entire range of probabilistic projections which continue to be highly dynamic both in magnitude and probability of occurrence. The range between the low risk and medium-high risk aversion projections should be thoroughly considered when trying to align SLR projections with risk tolerance of a specific project. In these instances, a more detailed assessment of risk tolerance may be warranted with local site specific analyses and input from the community. It may also be useful to evaluate the joint probability SLR and a natural hazard event (e.g. 100-year coastal storm or tsunami) can provide in understanding the potential probability and consequence of each SLR planning scenario.

All of these uncertainties in the model projections, combined with our growing understanding of the complex inter-relationships and feedback loops associated with global climate change, underscore the vital importance of closely monitoring local and regional sea levels, tracking local shoreline conditions, and developing a plan of action to ensure that the City of San Clemente remains resilient to SLR.

Coastal Resiliency Building and Adaptation Planning in San Clemente

The SLRVA identified the City's SLR related vulnerabilities from coastal hazards and outlined potential adaptation strategies generally categorized as "Protect", "Accommodate" or "Retreat" strategies. This Plan takes that initial analysis contained in the SLRVA and expands it to include a description of the phased approach the City is taking in terms of actions, plans, and programs that the City has already begun to implement to improve coastal resiliency as well as additional measures recommended for consideration by the City over a longer planning horizon.

The City's phased implementation approach to coastal resiliency is based on close monitoring of the nearest local tide gages for SLR signals that the thresholds identified in the SLRVA are being approached. This Coastal Resiliency Plan (Plan) sometimes referred to as an "Adaptation" Plan identifies various municipal actions, regional actions and coordination activities, and various SLR adaptation strategies that can be pursued by the City to supplement the existing coastal resiliency plans, programs, and projects currently implemented or planned to be implemented in the City.

Most cities will likely consider a range of options in their adaptation strategy toolbox, and San Clemente is no exception to this. Retaining a wide range of options on the table helps to ensure that the City retains

maximum flexibility in determining how best to carry out its long-term vision for its community. Considering a range of options is also prudent as the understanding of climate science continues to improve in terms of both its predictive capabilities and its ability to identify the most probabilistic local scenarios. Monitoring of SLR is an important component of adaptation planning, and future updates to the LCP will reflect updated climate science, predictions, scenario probabilities, and possibly a wider range of adaptation strategies to consider.

Adaptation to climate change involves a range of small and large adjustments to natural and/or human systems that occur in response to already experienced or anticipated climate change impacts. Adaptation planning involves a wide range of policy, programmatic, and project-level measures that can be implemented in advance of, or reactively to the potential impacts depending on the degree of preparedness and risk tolerance. Good adaptation planning should enhance community resilience to hazards and natural disasters and should stem from full disclosure and a solid understanding of the City's specific risks, the projected timing of impacts, and the physical processes responsible for causing the risk, now and in the future.

While the City has a long history of addressing existing coastal hazards, this is the first focused endeavor by the City to identify possible responses to climate change impacts at the coast, including adaptation strategies based on preparedness, avoidance, and/or protection from the risks projected to occur over time. Ideally, this planning will lead to securing a dedicated funding source to protect the community and natural resources, which make San Clemente such a desirable location to live, work, play, and visit.

Adaptation planning requires consideration of the various vulnerabilities and taking effective and timely action to alleviate the anticipated range of impacts. The City is currently working with the USACE and State Parks to implement a 50-year beach sand replenishment program to address shoreline erosion, and this is anticipated to remain one of the primary adaptation tools utilized by the City to maintain its shoreline and public beaches. Given that this 50-year project has been in development by the City since 2000 (i.e., Reconnaissance Phase), San Clemente is ahead of many other cities who are just beginning the process of coastal resiliency planning. Conversely, the fact that this project has been in development for two decades underscores the long lead times associated with implementing a coastal resiliency project due to all of the necessary steps and funding commitments that must be secured federally from the state and well as the City.

The SLRVA leveraged existing coastal engineering reports and SLR hazard information and was guided by the CCC's Sea Level Rise Policy Guidance document (2018) and Safeguarding California: Reducing Climate Risk (Natural Resources Agency, 2014).

This Plan provides a framework for the City to manage risks and take actions based on monitoring of sea-level rise and its effects, all of which are guided by the City's long-term vision for the community. This Plan provides flexibility for the City to choose from an array of adaptation measures over time as specified events or levels of SLR are met. Therefore, the Coastal Resiliency Plan provides scenarios or paths towards managing risks, rather than prescribing a specific plan of action.

Project-level planning and approvals will be required to further develop and implement some of the adaptation measures included in this Plan. Although as noted above, the City has been working to implement its preferred resiliency strategy of beach sand replenishment with the USACE and State Parks since 2000.

The Coastal Resiliency Plan is based on the best science and adaptation practices available today; however, the Plan acknowledges that SLR science and practices are evolving, and the intent of this Plan is that the City will evaluate future decisions and take action based on the best-available science and technology available at the time.

The Plan includes components and adaptation measures to reduce risks associated with future sea-level rise and identifies high priority adaptation measures for City assets for which near-term actions are recommended to reduce high vulnerabilities and risks.

HIGH PRIORITY ADAPTATION

High priority sea-level rise adaptation measures for the City to begin planning now for all structures located on the public beach and landward seaward of the existing railroad and revetment including:

- Protection of the public beach and related public amenities
- Protection of public beach accessways
- Evaluate resiliency measures for the City's Marine Safety Division Headquarters
- Evaluate resiliency measures for other critical City infrastructure and utilities

The Coastal Resiliency Plan has been developed with the input of CCC staff and designed to be consistent with the California Coastal Act and relevant City and State policies, plans, and guidelines. The guiding principles behind the Plan are to minimize risks to San Clemente's assets, including property, utilities and infrastructure, and protect local coastal resources, which, as defined by the California Coastal Act, include coastal development; public access and recreation; coastal habitats; Environmentally Sensitive Habitat Areas and wetlands; water quality and supply; archaeology and paleontological resources; and scenic and visual resources. A key coastal resource is the sandy beach, which is valued both for public enjoyment and community well-being, but also for ecosystem services such as storm damage protection and reduction.

The Plan includes a range of sea-level rise adaptation measures within the following general categories of adaptation:

- **Accommodation:** "Accommodation strategies refer to those strategies that employ methods that modify existing developments or design new developments to decrease hazard risks, and, thus, increase the resiliency of development to the impacts of sea-level rise." (CCC 2018)
- **Protection:** "Protection strategies refer to those strategies that employ some sort of engineered structure or other measure to defend development (or other resources) in its current location without changes to the development itself." (CCC 2018)
- **Retreat:** "Retreat strategies are those strategies that relocate or remove existing development out of hazard areas and limit the construction of new development in vulnerable areas." (CCC 2018)

Consistent with the California Coastal Commission Sea-Level Rise Policy Guidance (2018) including the *2021 Draft CCC SLR Guidance for Critical Infrastructure* and current environmental practice, the Coastal Resiliency Plan includes hybrid strategies which combines elements of these approaches, nature-based adaptation strategies including hybrid structures or living shorelines or green infrastructure solutions, and multi-objective measures that incorporate environmental considerations, rather than focusing on single-purpose or single benefit solutions.

Chapter 1 Coastal Resiliency and Adaptation Planning Overview

The Coastal Resiliency Plan provides a range of adaptation options that the City may implement to address existing and future SLR-related vulnerabilities within its jurisdiction. The adaptation strategies included within this Plan are developed specifically with the intent of minimizing damage to critical infrastructure, resources and assets that are projected to be vulnerable as identified within the City's 2019 Sea Level Rise Vulnerability Assessment (SLRVA). These strategies have been developed with consideration of recommended strategies within California Coastal Commission (CCC) *Sea-Level Rise Policy Guidance* (2018) and input from stakeholders, the Planning Commission, City Council, and the public.

During the course of the multi-year public outreach effort on the SLRVA, conducted from November 2017 through October 2021, the City received comments, input and suggestions from the public, members of the City's Coastal Advisory Committee, Planning Commission, City Council, and CCC staff, which have been used by the City to refine the scope and contents of this Coastal Resiliency Plan:

- The City should continue to move forward with the federal sand replenishment project in partnership with the USACE and State Parks.
- The City should pursue regional partnerships to address SLR and coastal resiliency and should consider partnerships with the County of Orange, OCTA, Caltrans, City of Dana Point, SANDAG, Camp Pendleton, and California State Parks to implement regional SLR resiliency strategies.
- The City should pursue additional education and public outreach opportunities within the community, including in schools, to inform citizens about the risks of SLR.
- The City should reestablish a shoreline / beach monitoring program that is conducted each spring and fall on an annual basis.
- The City should make a commitment to future SLRVA updates on a ten-year basis.
- The City should identify a beach nourishment strategy for North Beach.
- The City should pursue additional technical studies including participating in an update of the Orange County Coastal Regional Sediment Management Plan.
- The City should pursue other adaptation measures such as building offshore sand retention structures like artificial reefs similar to those already constructed offshore of the City.

- The City should commit to providing education to the constituents on the impact from SLR to the beaches and shoreline. This could occur through the City website and/or City-sponsored lectures, printed educational materials, etc.
- The City should develop a comprehensive adaptation approach and develop a plan that looks at utilization of the watershed to restore natural sediment flows in conjunction with an update to the 2013 Orange County Coastal Regional Sediment Management Plan.
- The City may consider relocating roadways, railways, and infrastructure from the shoreline and allowing coastal processes to be restored to a more natural state.
- Benefit - cost analysis must be conducted for any adaptation strategies considered by the City in the Coastal Resiliency Plan.
- Loss of beaches means loss of the coastal economy and recreational opportunities.
- The City should use the LCP process to ensure consistency with the Coastal Act and address SLR.

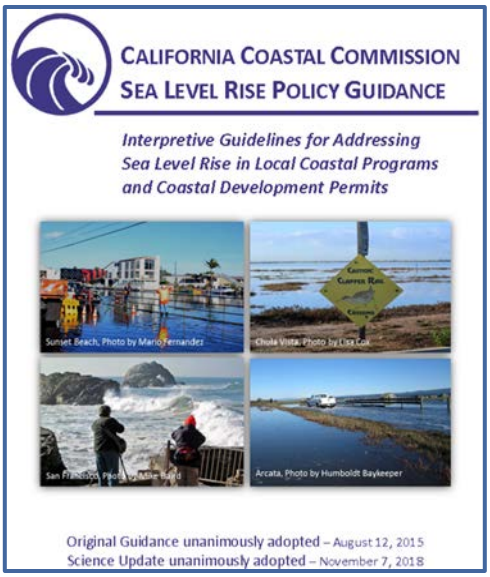
- The City should prioritize “soft” or “green” strategies such as cobble, sand and dune restoration, living shorelines, and hybrid approaches to protect development.
- The presence of the railroad revetment uniquely constrains the City and its ability to respond to SLR.
- The SLRVA did not include the extreme SLR scenario now recommended by the OPC and CCC (H++). While the likelihood of this scenario is unknown, there is critical infrastructure along the coast and potential impacts under an extreme scenario should be evaluated.

The Plan identifies both strategies that are programmatic that could be applied regionally and specific strategies that could be applied locally. Policy approaches to adaptation would be implemented through the certified Local Coastal Program (LCP), Land Use Plan (LUP), and/or Implementation Plan (IP). Other strategies include approaches or projects that are based on regional coordination, planning, and implementation with other organizations. Several of the City’s adaptation strategies address regional transportation assets outside of its jurisdiction that are of great importance to the City. Such strategies would benefit regional assets such as the Los Angeles–San Diego–San Luis Obispo Rail Corridor (LOSSAN Corridor) and Pacific Coast Highway. Successful implementation relies on regional, state and federal coordination and funding.

A goal of this Plan is to increase the understanding of the vulnerabilities associated with coastal hazards and encourage consideration of these impacts. As this is the beginning of the City’s process of developing its adaptation responses, many initiatives are exploratory in nature at this time and aim to identify potential actions to respond to the impacts of concern. Recommendations and next steps are identified within Chapter 10, although resiliency / adaptation measures are subject to change and further refinement over time.

The Coastal Resiliency Plan is intended to establish a process in which new data and information are assessed to inform adaptation decisions and actions. As such, it is anticipated that the Plan may be re-evaluated and updated based on new science, technology, and practices. For example, the Coastal Resiliency Plan may be re-evaluated and updated every 10 to 15 years or when new major developments in the field of SLR best available science or SLR adaptation occur.

Chapter 2 State of California Guidance

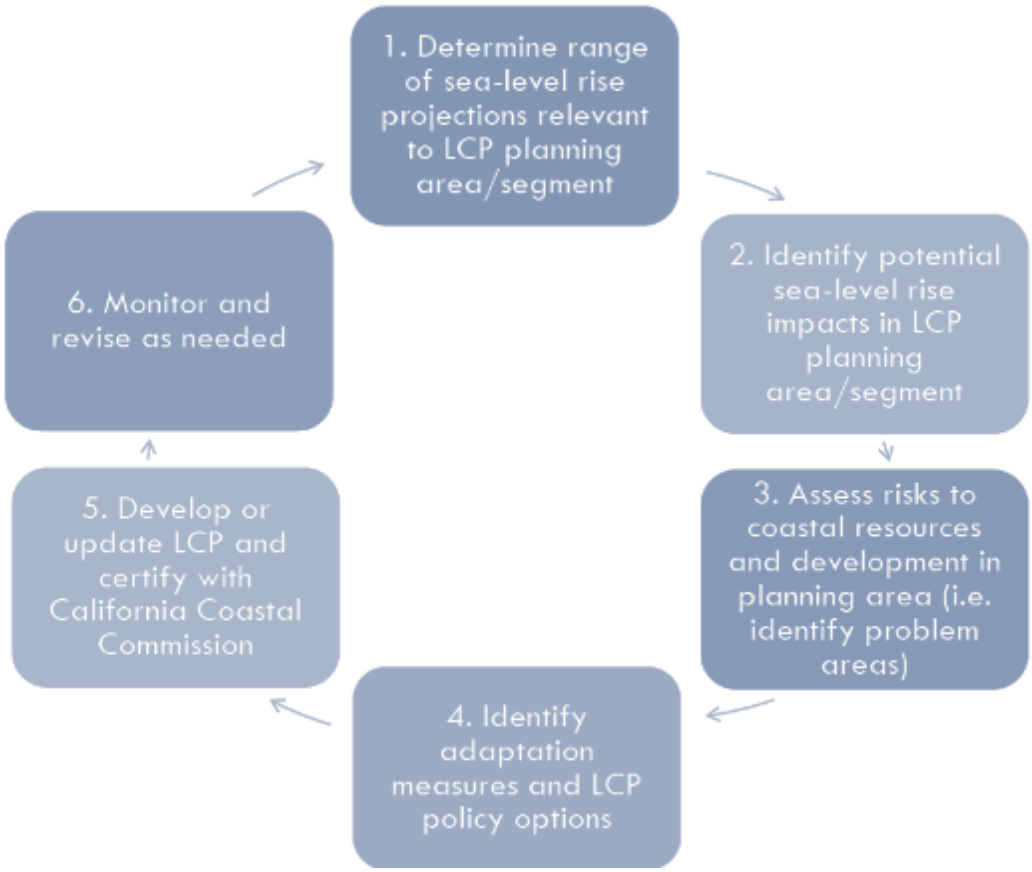


The California Coastal Commission (CCC) issued guidance in August 2015 and revised/updated SLR Guidance in 2018 on how to apply the Coastal Act to the challenges presented by SLR through Local Coastal Program (LCP) certifications and updates and Coastal Development Permit (CDP) decisions. The CCC 2018 SLR Guidance organizes current science, technical, and other information, and practices into a single resource intended to support implementation of the Coastal Act by coastal managers at the state and local level. The CCC Guidance generally categorizes adaptation measures as Protect, Accommodate, or Retreat based measures as described further below.

- **Protection:** "Protection strategies refer to those strategies that employ some sort of engineered structure or other measure to retain development (or other resources) in its current location without changes to the development itself. Protection strategies can be further divided into "hard" and "soft" measures. "Hard" refers to engineered structures such as seawalls, revetments, and bulkheads that defend against coastal hazards like wave impacts, erosion, and flooding. "Soft" refers to the use of natural or "green" infrastructure like beaches, dune systems, living shorelines, and other systems to buffer coastal areas. Strategies like beach nourishment, dune management, or the construction of "living shorelines" capitalize on the natural ability of these systems to protect coastlines from coastal hazards while also providing benefits such as habitat, recreation area, more pleasing visual impacts, and the continuation or enhancement of ecosystem services."
- **Accommodation:** "Accommodation strategies refer to those strategies that employ methods that modify existing developments or design new developments to decrease hazard risks and thus increase the resiliency of development to the impacts of sea-level rise."
- **Retreat:** "Retreat strategies are those strategies that relocate or remove existing development out of hazard areas and limit the construction of new development in vulnerable areas. These strategies can include land use designations and zoning ordinances that encourage building in more resilient areas or gradually purchasing or removing and relocating existing development."

The San Clemente Coastal Resiliency Plan was prepared consistent with the guidelines in the CCC 2018 SLR Guidance document.

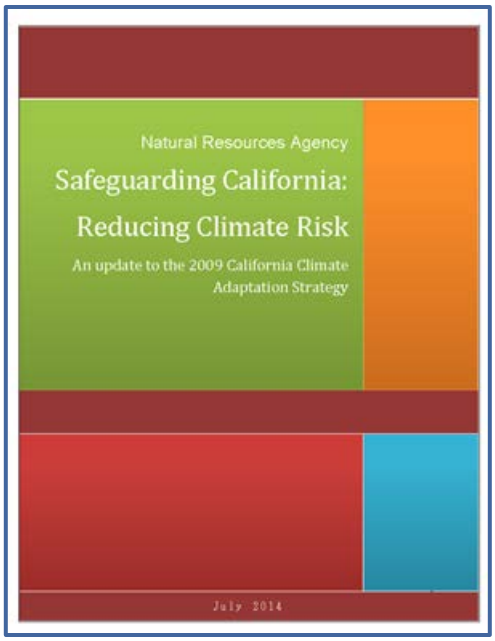
Figure 2-1. CCC Overview of SLR Planning Process



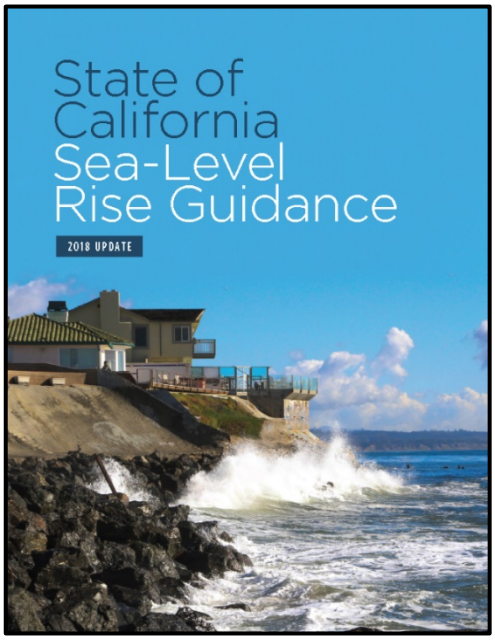
This graphic shows the basic SLR planning process provided in the Coastal Commission's *Sea Level Rise Policy Guidance*, with steps 1-3 conducted as part of the San Clemente Sea Level Rise Vulnerability Assessment and steps 4-6 occurring as part of the Coastal resiliency planning and adaptation planning efforts.

Safeguarding California Plan: Reducing Climate Risk

The 2014 Safeguarding California Plan (California Natural Resources Agency) provides policy guidance for state decision makers to address climate risks in nine sectors in California, describes progress to date, and identifies sector-specific recommendations. Risk management strategies to reduce climate risk are identified for the following nine sectors: agriculture, biodiversity and habitat, emergency management, energy, forestry, ocean and coastal ecosystems and resources, public health, transportation, and water. Applicable risk management strategies from this document were incorporated into this Plan.



Ocean Protection Council 2018 Sea-Level Rise Guidance



This updated document, the "State of California Sea-Level Rise Guidance" (OPC 2018) , provides a bold, science-based methodology for state and local governments to analyze and assess the risks associated with SLR, and to incorporate SLR into their planning, permitting, and investment decisions. This Guidance provides a synthesis of the best available science on SLR projections and rates for California; a step-by-step approach for state agencies and local governments to evaluate those projections and related hazard information in decision making; and preferred coastal adaptation approaches. The OPC OPC Sea-Level Rise Guidance Document was also used as a key resource in both the development of the SLRVA as well as the companion Coastal Resiliency Plan.

Chapter 3 Approaches to Building Coastal Resiliency

Understanding Coastal Processes

Coastal processes are the forces that drive the movement of sand (littoral sediment), leading to beach stability, beach erosion, or beach accretion (growth). These processes are directly affected by SLR. Coastal erosion and accretion patterns have always existed, and these coastal processes have long contributed to the present coastline that exists in San Clemente.

Coastal processes that affect SLR hazards often extend beyond the local scale. Participating in regional hazard mitigation planning can substantially increase the efficiency and cost-effectiveness of SLR resilience measures. Resiliency measures within this Plan include a focus on potential regionally coordinated programs that could benefit coastal resources in San Clemente and beyond.

The California coast is separated into discrete geographic areas called "littoral cells." Littoral cells are the areas where sediment moves in various directions such as up coast or downcoast or onshore or offshore. Other features such as submarine canyons and headlands are also part of the coastal environment. The City of San Clemente is located in the Oceanside Littoral Cell.

The Oceanside Littoral Cell extends approximately 50 miles from Dana Point Harbor south to La Jolla and Scripps Submarine Canyons. The Oceanside Littoral Cell is physically divided by Oceanside Harbor's north jetty, which effectively eliminates significant transport of littoral sand from the northern portion of the littoral cell to down coast of the Harbor. The shoreline of this cell consists of a continuous, narrow beach backed by sea cliffs or bluffs with the exception of the mouths of coastal rivers, streams, and harbors. Rocky headlands form the northern and southern boundaries of this cell. Sand entering the Oceanside Littoral Cell moves southward in the direction of the net alongshore transport and eventually enters the heads of La Jolla and Scripps submarine canyons, which are offshore within a few hundred yards offshore of the shoreline.

Depending on whether a littoral cell has a net positive or negative sediment budget, beaches will either be in a widening (accretion) or eroding condition. The Oceanside Littoral Cell has a net sediment deficit, which is why beaches are generally in an erosive condition. This condition is anticipated to worsen with SLR and is the main reason that steps need to be taken to ensure the beaches continue to function as a natural protective buffer from wave action and naturally protects the beaches and bluffs.

A study by Coastal Environments (2014) provided an assessment of littoral sediment transport patterns and a sediment budget for the coast between Dana Point and San Mateo Point (Dana Point Sub-cell). Data was aggregated from sediment studies spanning the 1980s to the 2000s, and it was estimated that the sediment budget for the Dana Point Sub-cell is in a 56,000 CY per year deficit (erosion) in dry years, and in a 3,000 CY per year surplus (accretion) in wet years. This disparity between wet and dry years is part of the reason that droughts affect shoreline erosion by further limiting the amount of sediment that is delivered to the beach from fluvial sources such as the San Juan Creek.

Beach nourishment has not provided a significant source of sediment to the littoral cell since the 1960s when over 1.6 million cubic yards of sediment was placed at the San Juan Creek mouth from upland and sea cliff sources, construction activities along San Juan Creek, and Dana Point Harbor construction. Other sediment management programs have included San Clemente's Opportunistic Beach Fill Program with project #1 adding 5,000 CY in 2005 and project #2 adding 12,000 CY of sand in December 2016. In

2019, the City put opportunistic beach sand projects on hold due to the rising costs of regulatory compliance, which makes small opportunistic projects no longer cost effective for the City.

The CCC approved the USACE San Clemente 250,000 cubic yard nourishment project in 2014. The USACE project EIR/EIS has been completed with all regulatory permits having been secured, and the project has been authorized by the U.S. Congress under the federal Water Resources Reform and Development Act (WRRDA) of 2014. The project is currently in the Pre-Construction, Engineering and Design (PED) Phase and construction could begin as early as 2022 and would extend through a federally authorized 50-year period through 2072 or beyond depending on the start date.

Resiliency Project Planning and Project Lead Times

The Coastal Resiliency Plan identifies adaptation measures at a conceptual planning-level of detail and discusses potential benefits and effects of adaptation measures. Additional detailed project-level planning and design would be required to implement adaptation measures. For adaptation measures involving construction, the project-level planning and design may include:

- Feasibility study including additional technical analyses, development and assessment of project alternatives and details, conceptual and preliminary engineering design, and cost estimating.
- California Environmental Quality Act (CEQA) and possibly National Environmental Policy Act (NEPA) environmental review and regulatory permitting.
- Final engineering design.

Lead time is required to perform project-level planning, environmental review and permitting, design, securing funding, and implementation or construction. All resiliency options discussed in this Plan require substantial lead time. For example, the City has been working to develop the USACE project for approximately 20 years with anticipated lead times in mind, the City will be able to begin advanced planning before adaptation measures need to be in place to limit risks and exposure.

Managing Development in Hazard Areas – LUP Policies

The City's 2018 comprehensive LUP Update addressed this topic extensively. Siting and construction standards in new coastal development or redevelopment projects represent key opportunities to reduce SLR hazard impacts to new and existing development. Adaptation measures within this Plan focus on encouraging development to reduce exposure to coastal hazards over the duration of development.

The City has established a policy that new development must be sited in a way that avoids coastal hazards, protects coastal resources, and minimizes risk to life and property to the maximum extent possible for the anticipated life of the development, accounting for future hazards due to SLR. New development must be sited in a manner that does not require construction of new shoreline protective devices that substantially alter natural landforms to provide geologic stability.

New development along bluff tops must meet a required setback from the bluff top inland of which stability can be reasonably assured for the duration of development without need for shoreline protective devices.

Major redevelopment thresholds within hazard areas will become subject to the standards of new development if a structure is altered in a manner that equals or exceeds 50% of the structure before the start of construction or results in the demolition of 50% of the structure.

Improvements to existing legally non-conforming structures in hazard areas must not increase the hazardous condition of the structure by developing seaward or extending the anticipated duration of development in a non-conforming location.

Community Outreach and Involvement

Maximizing public participation is a core principle in the CCC *Sea Level Rise Policy Guidance* (CCC 2018 SLR Policy Guidance). While engaging members of the public in SLR planning requires considerable investment of time and resources, the following best practices are considered essential for successful outreach efforts:

- Gain common understanding by making SLR science tangible. Using layperson's terminology and avoiding technical discussions is key to engaging the general public.
- Emphasize public safety to develop an understanding of the urgency.
- Conduct both targeted outreach and community-wide engagement to obtain valuable feedback from a variety of perspectives.
- Ensure regular updates throughout the process to maintain public and political support. Once members of the public and political leadership have engaged in the process, it is important to continue and maintain the engagement with regular updates and opportunities to provide feedback throughout the resiliency building process.

Chapter 4 Overview of Vulnerabilities in San Clemente

The goal of the Coastal Resiliency Plan is to manage potential future sea level rise-related risks by keeping risks within an acceptable limit. The SLRVA identified resources and assets in the City at risk in the future from SLR with approximate SLR timing and probabilities from the 2018 OPC Guidance shown in Table 4-1 below. As indicated in this table, the timing of each SLR scenario varies greatly within the probabilistic projections of the 2018 OPC Guidance. The guidance lays out a risk decision framework around which SLR projections to use. In general, the guidance suggests high risk decisions, such as those involving important infrastructure evaluate the upper range of SLR projections due to the potential future consequence of impacts from hazards associated with these scenarios. Lower risk applications, where consequences from potential future coastal damage would be more minimal may use lower SLR projections for design and planning.

Table 4-1. Resources and Assets at Risk in San Clemente

SLR Scenarios	0.8' of SLR	3.3' of SLR	4.9' of SLR
Resources and Assets At Risk	Coastal access & recreation Environmental resources Beach structures & amenities	Railroad operations Pier structure Access under-crossings Utilities (storm drain outlets and wastewater collection system)	Bluff top development All resources seaward of bluffs (if railroad removed) Beach Trunk Sewer Line, sewer pump stations and recycled water line
Timeline for Projected Occurrence and Associated Probabilities	2040-2050 is likely range 0.5% chance in 2030	2100-2150 is likely range 0.5% chance in 2070	2130+ is likely range 0.5% chance in 2080

The San Clemente shoreline was divided into three reaches in the City's SLRVA for presentation and discussion of the potential hazards by area. These geographic areas are described below:

- **North Reach**: The North Reach extends from the northern City boundary with Dana Point to the Linda Lane public beach access point and consists of the North Beach recreational area and LOSSAN railroad revetment to the south. Capistrano Shores mobile home park community is excluded from the study area. North Beach varies in width from 15 to 100 feet (from 2017 aerial imagery) and is popular for recreational activities. The beach area is subject to seasonal erosion that has recently threatened the restroom building. Previously existing sand volleyball courts are no longer present.
- **Central Reach**: The Central Reach is a focal point of coastal recreation in the City and extends from Linda Lane to T-Street and includes the main beaches around the Pier and other facilities like the Marine Safety Building and restaurants at the base of the Pier. The beach in this area is relatively wider than in other areas of the City and varies from 80 to 130 feet (from 2017 aerial imagery). T-Street is a popular surfing area, and the nearshore reef helps dissipate storm wave energy and stabilize the sandy beach in this area (USACE, 2012).
- **South Reach**: The South Reach extends from just south of T-Street at the Boca Del Canon beach access point to the southern City boundary. There is little development seaward of the LOSSAN Railroad Corridor along this reach. The beach width varies from 80 to 200 feet (from 2017 aerial

imagery) with primary coastal access points at Avenida Calafia and San Clemente State Beach Park.

The North Reach and Central Reach are shown in Figure 4-1. The South Reach is shown in Figure 4-2.

Figure 4-1. North and Central Reach – San Clemente

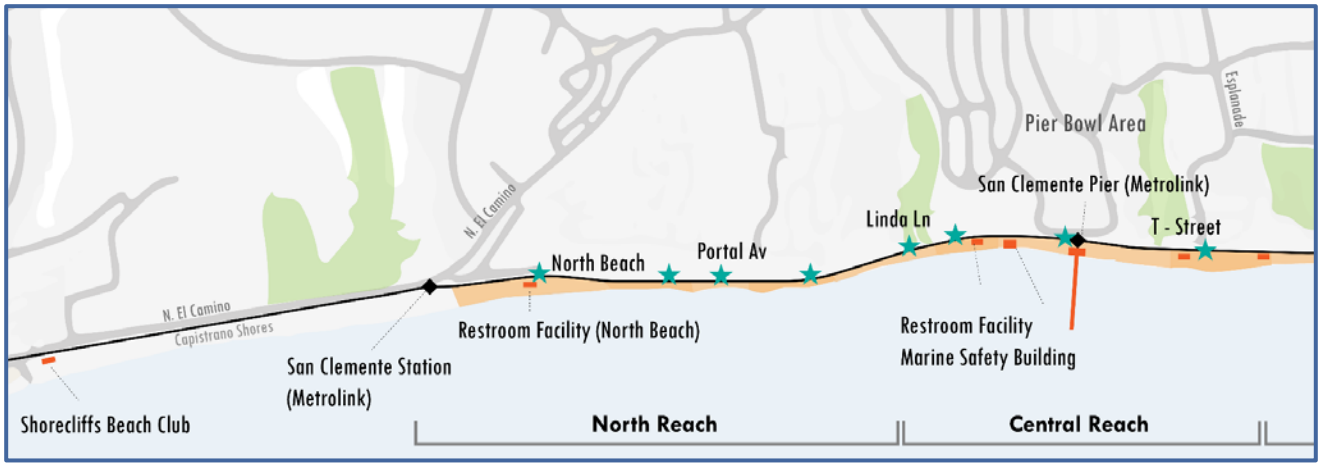
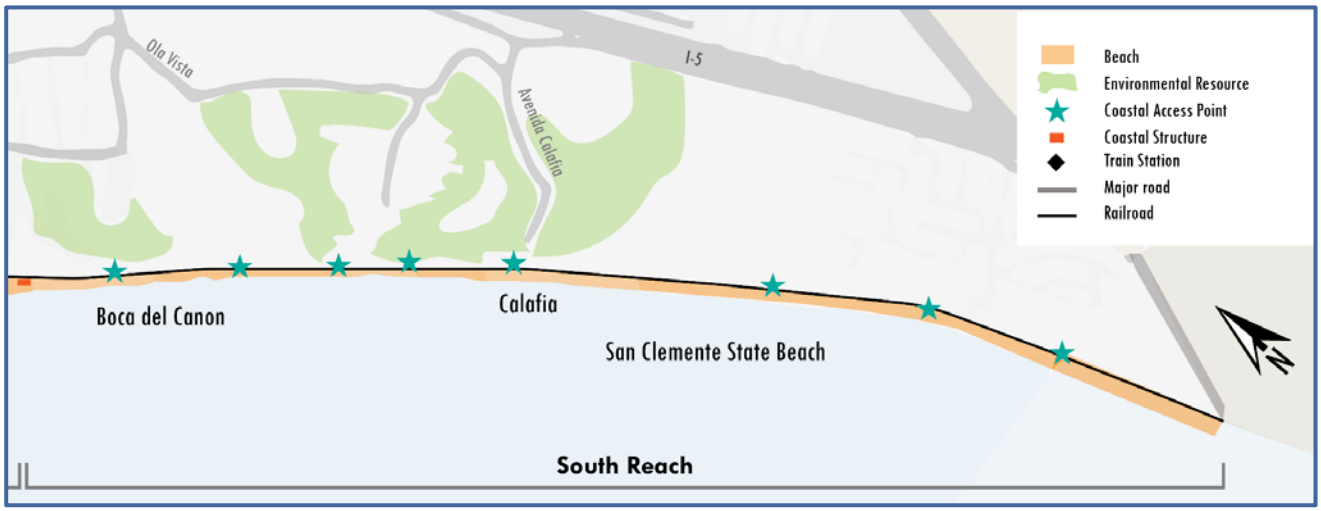


Figure 4-2. South Reach – San Clemente



San Clemente Sea Level Rise Exposure – North Reach

The exposure of resources along the North Reach were evaluated in the SLRVA using worst case "No Hold-the-Line, No Beach Nourishment" shoreline erosion projections from CoSMoS-COAST. The results indicated 0.8 feet (25 cm) of SLR would cause 20 to 40 feet of shoreline erosion at North Beach and an additional 10-20 feet of storm erosion potential. Similar amounts of erosion are predicted at Poche Beach and the Shorecliffs Beach Club.

Sandy beach areas and access points along the North Reach are most exposed to impacts from shoreline erosion resulting from 0.8 feet (25 cm) of SLR. The LOSSAN railroad will also experience increased wave action against the existing revetment. Nearly all assets have moderate to high exposure under a 3.3-foot (100 cm) SLR scenario. The CoSMoS shoreline projections indicate the active shoreline will be at or very close to the railroad corridor during non-storm conditions. The shoreline projections for a 4.9-foot SLR

scenario indicate the shoreline would erode landward of the railroad corridor to the bluffs (using an assumption that the railroad is relocated or removed from service in the future). Under this scenario the bluffs would be subject to wave action exposing the bluff-top development to erosion hazards.

Sea Level Rise Exposure – Central Reach

The results indicate 0.8 feet (25 cm) of SLR would cause about 30 feet of shoreline erosion and an additional 20 feet of storm erosion potential near the City's Municipal Pier. The City's Marine Safety Division Headquarters building has the highest non-storm exposure under this scenario due to its location on the beach. It is also projected that, given its past history of storm damage, rising seas will also increase exposure of the City's Municipal Pier to damage from large wave events.

Nearly all resources have moderate to high exposure under a 3.3-foot SLR scenario. The CoSMoS shoreline projections indicate the active shoreline will be at or very close to the railroad corridor during non-storm conditions impacting the coastal trail, access points such as the T-Street pedestrian bridge, and public restrooms. The railroad is not protected along much of the central reach. Therefore, SLR would subject the railroad to storm-related erosion in this scenario and, likely to be a catalyst for implementation of a resiliency strategy to prevent undermining.

The shoreline projections for a 4.9-foot feet SLR scenario indicate the shoreline would erode landward of the railroad corridor, to the bluffs (assuming the railroad is relocated or removed from service in the future). Under this scenario the bluffs would be subject to wave action exposing the bluff-top development to erosion hazards.

Figure 4-3. Existing Railroad and Revetment in San Clemente

Sea Level Rise Exposure – South Reach

For the 0.8-foot SLR scenario, the sandy beach is exposed to some shoreline erosion but to a lesser degree than projected for the North and Central reaches. However, the 3.3-foot SLR scenario indicates significant exposure of all assets seaward of the railroad corridor. Roughly 100 feet of shoreline erosion is predicted under this scenario along with another 50 feet of storm erosion potential. The CoSMoS shoreline projections indicate the active shoreline will be at or very close to the railroad corridor during non-storm conditions potentially impacting the California Coastal Trail, public beach access points, and public restrooms. The railroad would be subject to storm-related erosion in this scenario, likely triggering the need for some type of resiliency / adaptation measures to be implemented.

The shoreline projections for a 4.9-foot feet SLR scenario indicate the shoreline would erode landward of the railroad corridor to the bluffs in the event that the railroad was relocated or removed from service in the future. The potential for shoreline erosion and the projections included in the SLRVA also were based on a worst-case analysis whereby no future USACE or other long-term or comprehensive beach nourishment program occurred. Under this worst-case scenario, the coastal bluffs would be subject to wave action exposing the bluff-top development to SLR-related erosion hazards.

Range of Resource Categories Potentially Vulnerable to Sea Level Rise

The City identified potential SLR vulnerabilities for a wide range of resource categories in the City including the following which are generally summarized below. For additional detailed information on these resource categories, please refer to Chapter 5 of the City's 2019 Final SLRVA.:

PUBLIC BEACHES AND PUBLIC TRUST RESOURCES

The Public Trust doctrine provides that tide, submerged lands, and other navigable waterways are to be held in trust by the State for the benefit of the people of California. In addition to Public Trust lands (i.e., tidelands and submerged lands, from the shore out three nautical miles) there are at risk resources that include the public beach. San Clemente is known for its world class beaches. Beach width in the City varies spatially and temporally, with narrower beaches typical of the north reach and wider beaches typical of the South Reach. The beaches provide public recreation activities for residents and visitors, as well as protection for the bluffs and railroad behind them. San Clemente City Beach and State Beach have combined annual attendance of 3,103,581 and are responsible for over $67 million in annual spending and over $130,000 in annual City tax revenue (OCCRSMP, 2013). SLR will worsen already chronic erosion rates resulting in beach loss throughout San Clemente. With a decreasing natural supply of sediment, the narrow beaches are very sensitive to storms. The effects of storms will increase in magnitude with higher water levels. Beach nourishment will help to maintain beach width in the short term, but higher water levels will make sandy beaches very difficult to retain, impacting the recreational opportunities available on the dry beach areas (i.e., towel area, fire pits, volleyball courts and amenities). Access to the beach and ocean, including parking, paths, and trails, are also expected to be affected.

BEACH & COASTAL PUBLIC ACCESS POINTS

There are 19 access points in the City, 15 of which are accessible by public and four of which are private. Access points vary in accessibility and consist of a mix of paved trails, steps on the bluff, railroad over- and under-crossings, and stairs to the beach. The most accessible of these points is the San Clemente Municipal Pier, which allows for semi-paved access directly to the sandy beach and pier. The vulnerability of public access points in the City varies depending on the configuration of the access path and proximity to current and future coastal hazards. Dije Court and Mariposa are most vulnerable due their high exposure to potential erosion where frequent wave uprush against the railroad revetment can inhibit

beach access. Below grade crossings exist at many of the popular beach access points and are often co-located with stormwater outfalls. These access points are more sensitive to SLR because the upward and landward migration of the beach profile could reduce vertical clearance and reduce stormwater conveyance capacity, both of which could inhibit access. Nearly all access points are projected to be vulnerable under the 3.3-and 4.9-foot SLR scenarios in the absence of any City action to enhance resiliency or adapt to SLR. Access stairways or paths located on bluffs could be exposed to erosion under the higher SLR scenarios if the railroad is relocated and no adaptation strategies are implemented to mitigate bluff erosion.

CALIFORNIA COASTAL TRAIL

The California Coastal Trail (CCT) runs approximately 2 miles from North Beach to San Clemente State Beach and is a valued resource for the City and the region. The first 0.8 miles in the northern reach runs along the railroad on the landward side, then crosses to the beach side for the central reach near the Marine Safety Building. It then runs for 0.6 miles along the beach until it crosses the railroad again after T-Street. It then continues along the landward side of LOSSAN for 1 mile, crossing several small access tunnels and stormwater outflows. A portion of the trail along the north reach is shown below. The CCT is part of a Statewide CCT network and a high City and CCC priority for implementation and protection. The first portion of the coastal trail to be affected is in the north reach where erosion and flooding could extend beyond the railroad to the trail via the culvert near W. El Portal Avenue. This location may be subject to storm exposure at +0.8 feet of SLR and exposure to (non-storm) wave erosion around +1.5 feet of SLR according to CoSMoS shoreline projections. Maintaining continuity of the coastal trail will become increasingly difficult in the long-term as trails on the beach side (Central Reach) will be exposed to direct wave action seasonally or year-round. Relocation may be difficult due to physical space limitations, private land ownership, public easements/infrastructure and the LOSSAN right-of-way which that protects the CCT.

PUBLIC RESTROOMS AND PICNIC FACILITIES AND RELATED CONCESSIONS

There are five locations of restrooms on the beach in the City: North Beach, near Linda Lane Crossing, south of the Pier, T-street, and Boca del Canon. Additionally, there are picnic facilities on each side of the Pier and at T-Street. These facilities range in date of construction and are built on sand foundations. The T-Street and Boca del Canon restrooms were recently renovated within the last few years, and renovations to the North Beach and Linda Lane crossing restrooms were just completed. The North Beach restroom's history of damage is an example of the kind of exposure expected for restroom facilities exposed to potential hazards with SLR. The North Beach restroom is currently exposed to storm related erosion, with the Linda Lane restroom exposed with 0.8 feet of SLR. Erosion near or underneath the bathrooms could impact public safety and access for visitors. All restroom locations are vulnerable under the 3.3-foot SLR scenario.

SAN CLEMENTE MARINE SAFETY DIVISION HEADQUARTERS AND RELATED FACILITIES

The Marine Safety Division Headquarters was originally built in 1968 and is an iconic coastal structure for the City. The San Clemente Marine Safety Division Headquarters is approximately 5,000 square feet in size and stores equipment for beach maintenance. The structure has suffered damage from El Niño storms due to wave attack and erosion beneath the piles. The City completed repairs to this existing structure in 2020 to enhance the facility's existing shoreline protection system.. The Marine Safety building is at risk to erosion, wave run up, and overtopping during large storms. Even small amounts of SLR will subject the building to more frequent storm damages from moderate to extreme storm events. During winter storms the parking lot and amenities closest to the shore may be at risk at +0.8 feet of

SLR. In 2021, the City initiated efforts to evaluate the feasibility of keeping the structure in the current same location as well as identifying several potential alternative locations for this critical public facility. The City's draft facility relocation study is anticipated to be completed in early 2023.

Below are some potential impacts to Marine Safety operations that may need to be addressed in the future due to the sea level rise concerns:

- Relocating lifeguard headquarters may be necessary depending on the level of SLR. The City's priority would be to keep Marine Safety Headquarters on the west side of the railroad tracks and redesigning and relocating the building towards the back parking lot. Other options for locations may need to be considered.
- Consideration of designing a first aid room/office below the pier tower may be necessary if the Marine Safety Headquarters is relocated east of the railroad tracks.
- Emergency response vehicles responding on the beach could potentially be limited due to the sea level rise. Consideration of utilizing a rescue boat and/or purchasing a second personal watercraft (PWC) may be necessary for emergency water response versus beach response. Staffing the rescue boat or PWC's on a daily basis during the busy season may be necessary.
- Emergency vehicles responding to emergencies on beach would be limited. Certain areas of City beach may require emergency vehicles to respond via streets to beach and water related emergencies. Consideration to purchase a four-passenger emergency response command vehicle (that seats four passengers) may be necessary. A command vehicle would provide transportation mode that would accommodate multiple lifeguards to respond and carry all necessary equipment to an emergency.
- Alternative communications system with beach towers needs to be considered. Hard line phone lines are currently used for tower phones that are buried in the sand. Consideration of wireless phone system for beach tower communication systems may be necessary.
- Consideration of looking into smaller designed beach towers that could be relocated more easily than the current beach towers. Some of the beach towers may need to be relocated off the beach depending on sand supplies and levels of SLR. Consideration should be made to look at designing and potentially replacing some beach towers in the rip rap that separates the railroad tracks from the beach.
- Junior Lifeguard program that enrolls over 800 participants each summer may need to be restructured if the City's Marine Safety Headquarters is relocated off the beach and the beaches continue to erode.

CITY OF SAN CLEMENTE MUNICIPAL PIER

The San Clemente Municipal Pier is an iconic structure in the City and region for visitors and residents. In 2016, the second largest employer in the City was Fisherman's Restaurant, located on the San Clemente Pier and employs 260 people (City of San Clemente, 2016). The Municipal Pier underwent a $2.9 million refurbishment in 2010. Businesses currently operating on the Pier include Fisherman's Bar & Restaurant, and San Clemente Pier Grill and Tackle. Beach loss due to SLR is predicted to be greatest around the Pier. Loss of sediment, a steepening of the shoreline, and higher water levels could expose the pier deck to damage during winter storms, as wave crests could reach the underside of the main deck. A more detailed analysis is needed to assess the potential damage to the timber pier segments that have a lower deck elevation than the outer Pier segment. Increased maintenance or retrofitting of the pier could be required to maintain safety and/or function. In a +3.3-foot SLR scenario, the beach could erode entirely past the base of the pier towards the pedestrian tunnel under the railroad. This access tunnel sits at

around +2.75 feet MLLW (mean lower low water) and could experience flooding and damage during high tides. Erosion could also undermine the nearby pavement and structures. Under +4.9 feet, these hazards would intensify, and shoreline migration could expose the landward side of the railroad to erosion.

HISTORIC AND CULTURAL RESOURCES

Casa Romantica is a bluff top nationally registered historic building (designated in 1991) located adjacent to Parque del Mar. It is owned by the City and operated by Casa Romantica Center and Gardens, a non-profit 501(c)3. It serves as the main cultural institution of the City and is open to the public. Ole Hanson Beach Club is a nationally registered historic building built in 1928 and designated in 1981. San Clemente is within the historical territory of the Juaneño (Acjachemen) Tribe of American Indians. The group is known to have had coastal settlements in the area, although the majority of the bluff tops within the coastal zone are already developed. Recent projects such as the Marblehead development have gone through archeological surveying with no findings of archeological artifacts in the development site. There are four recorded archaeological sites near the coast. If the railroad were to be relocated, the bluffs of Casa Romantica could be exposed to erosion under a +4.9-foot SLR scenario, posing potential risk to structural damage and erosion of garden space. The Ole Hanson Beach Club sits inland of the North Beach parking lot. While the lower range of SLR conditions (i.e., +0.5 to 3.3 feet) pose low potential exposure, +4.9 feet of SLR in the CoSMoS model predicts coastal erosion up to the seaward edge of the Ole Hanson Beach Club site in the event the LOSSAN railroad is removed.

SURFING

San Clemente is known worldwide as a cultural hub for surfing. People of all ages participate in the sport in San Clemente recreationally and professionally. The City has multiple breaks along the coast including the famous T-Street Beach located immediately south of the Pier. Regardless of future adaptation strategies, SLR will shift the tide range and beach profile, altering the wave breaking patterns over the T-Street reef. While beach loss at T-street Street could be less than other areas, according to the CoSMoS shoreline projections, a landward and upward shift of the beach profile in combination with higher water levels will alter the surf conditions at T-Street and other surf locations. Depending on the sediment source supply and sandbar formation, the waves may focus on a different part of the T-Street reef (likely closer to shore) with the outer reef becoming more sensitive to the tide.

CRITICAL PUBLIC INFRASTRUCTURE, PUBLIC FACILITIES AND PUBLIC UTILITIES

City-and County-operated infrastructure includes various stormwater inlets, outfalls, headwalls, potable water supply/conveyance lines, recycled water facilities (lines and pump stations), and gravity wastewater mains, as well as electrical infrastructure supplying the pier and other coastal facilities along the public beach. Stormwater outfalls could see increased sand deposition, lowering capacity and potential increased exposure to undermining from higher shoreline erosion rates. Water mains, which run parallel to the beach, such as the recycled water main adjacent to the Marine Safety Building, could experience damage from shoreline erosion at around 3.3 feet of SLR. Additionally, gravity mains, which lie on the landward side of the railroad, face flooding during high tide events and storms, presenting exposure to the less protected landward side of the railroad. The Beach Trunk Sewer Line and associated pump stations will necessitate redesign to convey raw wastewater through a series of new pump stations and pipelines to redirect raw wastewater inland at a significant cost.

LOSSAN RAIL CORRIDOR

The LOSSAN Rail Corridor follows an alignment along the toe of the coastal bluff and is protected by a revetment in many locations. Coastal hazards and the effects of SLR on coastal assets in the City will largely depend on the condition of the revetment lining of the railroad corridor in the future. The railroad

sits at elevations ranging from 20-25 feet (as measured in the North American Vertical Datum of 1988 or NAVD 88) (e.g., 17.5 to 22.5 feet above mean sea level). At this elevation, the tracks are not exposed to long-duration flooding but are within the wave run up and overtopping zone. The lowest points are located at the San Clemente Station, the Pier, and San Clemente State Beach and the highest are when the railroad lies closest to the bluff in the north and southern portions of the City.

Within the City, the Northern reach of the corridor is highly exposed to future SLR. At present, this segment of railroad is protected by a revetment that experiences direct wave action year-round and erosion of the backside via an opening at the W. Portal access point. The railroad itself would experience more frequent flooding and potential for damage during large wave events due to SLR. Modest amounts of SLR would be anticipated to increase the frequency of overtopping and flooding. SLR related vulnerabilities along the LOSSAN corridor are the subject of the OCTA "*Rail Infrastructure Study*" that was completed in January 2021. The OCTA study identified implementation strategies to reduce the risk to rail infrastructure from mudslides, flooding, severe storm/weather events, coastal surge, and SLR. The final OCTA report established a plan for OCTA to respond to and prepare for future climate-related risk. The recommendations indicate which strategies should be prioritized in the near-term to mitigate climate risks and which strategies can be implemented in the long-term to further strengthen the resilience of the rail system.

Much of the potential for damage is first focused on the W. Portal Stormwater Culvert, which allows further erosion landward of the railroad. Similarly, further south at the narrowest stretch, where the coastal trail is already elevated, erosion and wave attack against the revetment and railroad is predicted to be severe for SLR greater than 3.3 feet. The San Clemente rail station could see exposure to erosion and flooding from the limited capacity to the North Beach storm drain channel during winter storm events. If left in place at the current elevation, the railroad would likely be inoperable due to frequent flooding and erosion damage under a +4.9-foot SLR scenario unless it was protected from erosion and flooding by an engineered seawall or revetment.

Along the Central Reach within the City the railroad is not protected by a revetment in places, rather a sandy beach protects it. Under a +3.3-foot SLR condition, beach loss could extend into and at points past the rail corridor. In the CoSMoS model, beach erosion could reach the rail corridor as soon as +2.5 feet of SLR. Without protection, shoreline erosion would threaten to undermine the railroad. While the southern reaches of the railroad are protected by a revetment, shoreline migration could leave the revetment exposed to direct wave attacks starting at Calafia Beach and Boca Del Canon as soon as +1.6 to 2.5 feet of SLR with potentially the entire revetment exposed at +3.3 feet of SLR. The southern portion could see the same potential damage and erosion dynamics similar to the rest of the railroad in the other reaches. The ability of the existing revetment to withstand these erosive forces was evaluated by the Orange County Transportation Authority (OCTA) entitled the "*Rail Infrastructure Study*" as part of their SLR vulnerability assessment completed in January 2021.

EXISTING BLUFFTOP STRUCTURES AND INFRASTRUCTURE

The San Clemente coastline above the beach is extensively developed with residential and commercial developments as well as infrastructure such as public roads and utilities. The remaining proportion is primarily comprised of Calafia State Park and San Clemente State Beach's bluff top camping and recreation area. If the railroad were to be relocated and the revetment removed, the bluffs underlying coastline development would be subject to coastal erosion under SLR scenarios higher than 3 feet. Limited bluff top areas would be at risk at +3.3 feet of SLR, primarily due to intensified erosion during storm events. Significant impacts across the full extent of the coastline would be expected at +4.9 feet of

SLR. Sustained erosion due to wave action at the base of bluffs would induce slope failure up the bluff face, eventually causing erosion of the bluff top and potentially undermining the foundations of existing development. Bluff erosion, therefore, presents a considerable threat to the safety of any development situated on the bluff if the railroad and revetment are removed from their existing location.

TRANSPORTATION INFRASTRUCTURE AND PUBLIC ROADWAYS

Much of the City's transportation infrastructure is at elevations high enough to be considered a low concern with respect to future SLR. Most roads in the City (except those noted below) are above an elevation of ~25 feet NAVD88 and setback from the potential SLR affected areas and, therefore as such, are a low concern for SLR impacts. The lower lying roads are found at El Camino Real in the North Reach, in the San Clemente Pier Bowl area, Boca del Canon, and near Calafia State Park. This section includes traffic signals or electric infrastructure associated with the City's road network. No current bike infrastructure (including bike lanes) is within the exposed areas in the range of SLR evaluated by the SLRVA. Low lying, coastal roads such as El Camino Real, Avenida Victoria, Boca del Canon (private), Plaza A La Playa, and Avenida Calafia could be exposed to shoreline migration in the case of a relocated railroad and SLR greater than 4.9 feet. Damage to these roads presents access and safety concerns. Additionally, bus stops on the OCTA 1 and 90 lines would be at risk and are one of the central lines providing access to the San Clemente Metrolink Station and beaches. The City's North Beach parking lot sits lower than the railroad by 1-4 feet, which leaves it exposed to flooding during large storm events in a +3.3 feet SLR condition. If the railroad and revetment are removed in the future, the exposure of this parking lot would be expected. El Camino Real, along the North Reach study area, is one of the lowest lying (20-23 feet NAVD88) roads in the City. According to CoSMoS erosion projections, the road is not exposed to shoreline erosion for the scenarios evaluated. Exposure to erosion or flooding for higher SLR increments would depend on how development seaward of the road (LOSSAN railroad and Shorecliffs Beach Club) adapts to future coastal hazards.

ENVIRONMENTAL RESOURCES/ENVIRONMENTALLY SENSITIVE HABITAT AREAS (ESHA)

San Clemente's shoreline is predominately sandy beaches bordered by the railroad corridor and coastal bluffs, with sparse rocky outcroppings offshore. Subtidal habitats include the federally designated Habitat Areas of Particular Concern, canopy kelp beds and rocky reefs, as well as soft-bottomed reefs, and surfgrass beds. Offshore resources are beyond the jurisdiction of the City and beyond its management capabilities to plan for. Above the beach, coastal scrub and developed land dominate, with coastal dunes present in the southern reaches of the City. Stands of eucalyptus trees along and within Calafia Canyon constitute monarch butterfly ESHA. Sensitive biological resources are found in the City, which can be potentially affected by SLR, including subtidal, intertidal, and bluff habitats. Any resiliency planning measure would be required to evaluate the potential for effects on these resources as well as and consider what would occur in a no-action scenario.

SCENIC RESOURCES

The City has identified several scenic vistas and view corridors in its Centennial General Plan and LCP, which center on North Beach and the Pier Bowl area. These public view corridors center on the City's coastal canyons and beach areas. Loss of sandy beach due to erosion could affect the aesthetic quality of San Clemente's beaches. Views of the ocean and areas further offshore would not be expected to be impacted by SLR.

SALTWATER INTRUSION

As SLR occurs, the fresh-salt groundwater interface is pushed upwards. Over-pumping of groundwater can amplify this effect by pulling seawater inland. The City has experienced some salinity issues in its

groundwater in the past, including a groundwater well for public use, which was no longer used after 1958 due to seawater intrusions. The City's Urban Water Management Plan notes that as of 2015, one of two wells in the City (well No. 8, located outside of the Coastal Zone and near Vista Bahia Park) appears to display initial stages of saltwater intrusion. According to the San Clemente 2015 Urban Water Management Plan (UWMP), the City's main source of water supply is imported water from Metropolitan Water District of Southern California. Imported water is supplemented by local groundwater extracted from City-owned wells, and recycled water produced at the City's recycled water treatment facility. Ground water accounts for less than 10% of the City's water supply, and in the future, the water supply mix is expected to shift to more recycled water use as a result of the City's recycled water treatment facility expansion.

SOCIOECONOMIC IMPACTS AND ENVIRONMENTAL JUSTICE

The beaches of San Clemente provide significant tax revenue for the City and County. Due to a narrow coastal typology, beach loss becomes a direct threat to these major economic drivers. Residents, and non-residents such as workers and tourists whose work or visit is related to industries such as hospitality, food services, retail, and others dependent on San Clemente's 3 million annual beach attendance could be economically vulnerable with rising seas. For example, in 2016 the second largest employer in the City was Fisherman's Restaurant, which is located on the Pier, employing 260 people (City of San Clemente, 2016). The 2018 OPC SLR report defines "environmental justice" as follows: The structures, policies, practices, and norms resulting in differential access to the goods, services, and opportunities of society by "race." It is normative, sometimes legalized, and often manifests as inherited disadvantage. Examples include differential access to quality education, sound housing, gainful employment, appropriate medical facilities, and a clean environment.

The CCC adopted an "Environmental Justice Policy" on March 8, 2019 which encourages the prioritization of actions that promote equity, foster community resilience, and protect the most vulnerable and to explicitly include communities that are disproportionately vulnerable to climate impacts in adaptation planning. Unlike in low-lying cities where SLR typically threatens homeowners to flooding, SLR in San Clemente first threatens the public resource of the sandy beach. The recreational, habitat, and coastal access benefits provided by the sandy beach will be most vulnerable to SLR. Depending on management and adaptation strategies, the erosion of bluffs could put property owners and renters at risk to structural hazards.

SLR may require the City to acquire new access points, parks, or easements in the case of erosion. Additionally, the LOSSAN rail corridor presents trade-offs between regional and local environmental impacts. The corridor's position along the beach has impacts on current and future coastal dynamics in the City, while also having a large regional importance by connecting the larger Southern California metropolitan areas. Continued coordination with OCTA and other stakeholders and further analysis of local and regional costs, benefits, and trade-offs is expected to help inform the coastal resiliency planning process. None of the affordable housing properties in the City are directly threatened by erosion due to SLR, although the larger economic impacts of different adaptation or management scenarios could be considered to assess the impact to socioeconomically vulnerable populations.

Chapter 5 Sea Level Rise Monitoring and Resiliency Project Phasing

The Coastal Resiliency Plan calls for the implementation of resiliency building and adaptation measures to limit or reduce risks and exposure to SLR hazards. The Plan describes conceptual planning-level measures that can be implemented to reduce risks before an acceptable level of risk is exceeded. The City will need to monitor and evaluate the trajectory towards the implementation timelines of SLR and coastal hazards to track whether and when to begin implementing additional coastal resiliency plans and programs beyond those currently in place and those already being pursued.

The Coastal Resiliency Plan recommended monitoring effort is summarized below.

- **Amount of sea level rise** (e.g., 0.8 feet, 3.3 feet, and 4.9 feet of sea level rise). Certain adaptation measures will be implemented when sea level rise has risen by a certain amount. King Tides are considered a preview of what rising seas will look like in the City on a more sustained basis. To monitor SLR and progress towards certain amounts of SLR, the City will follow SLR reports from the State and Scripps Institution of Oceanography (SIO) and SLR data from the NOAA tide gage at Scripps Pier at La Jolla Shores and Los Angeles Outer Harbor, which are updated annually. Sea level is inherently variable in response to predictable astronomical tides and less-predictable atmospheric events such as El Nino and individual storms; however, given that extreme flooding occurs infrequently, SLR may occur without any concomitant extreme flooding. Tracking SLR, therefore, allows the City to anticipate and act in advance of the effects of SLR.
- **Flooding and storm damage frequency**. In addition to the amount of sea level rise, the frequency or risk of flooding and storm damage can be used as a data point that signals the need to implement actions in the Coastal Resiliency Plan. To monitor the frequency of flooding and storm damage, the City will track and keep records of coastal and inland/upland flooding and storm damage events and information. This could be a collaborative effort between City staff and residents in which reports, pictures, and videos are collected. The date, type, location, and severity of flooding (e.g., depth, duration, wave height), and damages can be collated into a file. The intent will be to track the frequency, extent, and severity of flooding to assess if and how the frequency of flooding is increasing. If significant and/or extreme flood events occur, then storm data (e.g., water levels and, wave conditions) can be collected, and storm frequencies can be recalculated to quantify the increase in flood risk for comparison against risk-based implementation timelines or horizons.
- **Beach profile monitoring.** Given that a guiding principle is to maintain a walkable beach, beach width is used as a proxy for considering when beach adaptation measures need to be implemented. Specific beach widths need to be further detailed as part of subsequent analyses. The City should consider re-establishing its beach profile surveys to monitor beach width. The USACE proposes to collect some of this data; however, it is largely limited to the areas where the beach sand project would be located and would exclude areas to the north and the south. For a truly comprehensive and useful data set, additional monitoring efforts should be established as soon as possible so that the City can create a baseline against which future SLR can be tracked.

The City may want to consider preparation of a brief SLR Shoreline Monitoring Report on a regular cycle (e.g., every five years) and/or when significant changes occur or progress towards an implementation effort are enacted. The City may conduct this process in consultation with technical experts and with opportunities for public input and review. The City will also consider participating in regional efforts, if initiated, to monitor and track SLR and related effects in the region, littoral cell, or watershed.

The Coastal Resiliency Plan identifies measures at a conceptual planning-level of detail and discusses the potential benefits and effects of the measures. Additional detailed project-level planning and design will be required to implement the projects. For measures involving construction, project-level planning and design would include:

- Feasibility study, including technical analyses, development and assessment of project alternatives, conceptual and preliminary engineering design, and cost benefit analysis
- CEQA and possibly NEPA environmental review and regulatory permitting
- Identification of a funding source
- Final engineering design
- Construction
- Post construction monitoring

The lead times required for performing project-level planning, securing funding, and implementing or constructing a resiliency measure will vary. The Coastal Resiliency Plan approximates lead times to allow for the City to begin planning in anticipation of when additional measures would be required to be in place to limit risk and exposure within the City.

Chapter 6 Resiliency Building and Planning Principles

The Coastal Resiliency Plan identifies high-priority, near-term adaptation measures and includes the following components to address specific areas, vulnerabilities, and risks. Resiliency planning involves a range of policies, funding mechanisms, and engineered projects that can be implemented in advance of or reactively to potential impacts depending on the degree of preparedness and the willingness to tolerate SLR-related risk. Since SLR resiliency planning is anticipated to require significant multi-jurisdictional coordination and funding, advanced planning is essential. Developing a range of options, or a "toolbox," provides local and regional entities with flexibility to choose from an array of short-and long-term strategies to integrate into their planning processes.

Given the uncertainty in timing and severity of impacts, it is important to identify events or SLR thresholds that, once reached, indicate that certain adaptation strategies have run their course, and planning for new adaptation strategies is needed. For example, thresholds related to the extent of flooding or frequency of damages might be used to initiate implementation of a specific engineered project.

Note that for all the strategies in this toolbox, project level analyses and approvals evaluating strategies' effectiveness, as well as environmental, economic, and social impacts, will be required.

High-priority SLR adaptation measures/projects for the City to begin planning for and implementing now as part of the City's CIP Program include those focused on evaluating, monitoring and reducing risks to critical public infrastructure and facilities, including the City's existing Marine Safety Division Headquarters, Municipal Pier, roads, sewer infrastructure, storm drainage system, and other essential public infrastructure and public structures.

Planning Principles

An objective of the City is to protect the community, public beach and other natural resources that make San Clemente a desirable location to live, work, recreate, and visit. The City's public beach and shoreline are a significant source of the community's quality of life and generate revenue from both community and visitor-recreational activities. Ensuring the City's beaches and shoreline are resilient to SLR over time is integral to the City's community character, healthful livability, and economic viability.

Through the LCP Update and the SLRVA public outreach process, the City and its residents have identified several priorities to accomplish or balance when planning for adaptation to identified coastal vulnerabilities. Above all, the City and its residents choose to prioritize the following:

- Maintaining the City's small beach town character and high quality of life;
- Maintaining a wide sandy beach offering lateral beach access and a variety of recreational opportunities, such as surfing, paddle boarding, swimming, fishing, and other recreational activities for residents and visitors;
- Maintaining a healthy economy with opportunities for future economic viability;
- Protecting or adapting vulnerable neighborhoods, including the Pier Bowl area of the City;
- Identifying sustainable funding sources to allow the City to improve coastal resiliency; and,
- Improving regional collaboration and coordination with agencies to maintain, enhance, and protect key resources and critical infrastructure.

Many of the strategies are focused on resiliency measures which balance the City's priorities for adaptation and promote the long-term preservation of the public beach, visitor serving facilities, public infrastructure, and private property. To achieve this balance, it is important to weigh considerations and achieve consistency with adopted policies and guidance. Guiding goals, principles, policies, and programs that have been considered in the development of policies for addressing rising seas within the City include those of the state's climate adaptation strategy – the *Safeguarding California Plan Update* (California Natural Resources Agency 2018), *Sea-Level Rise Policy Guidance* (CCC 2018a), the City's Certified LUP (2018), and the California Coastal Act.

With applicable State guidance and local City priorities in mind, the following planning principles can be used to guide resiliency planning efforts:

- Prioritize regional collaboration and coordination in planning for SLR;
- Implement a phased adaptation approach based on tide gauge monitoring and SLR thresholds
- Protect or assist populations vulnerable to coastal hazards;
- Reduce risk of extreme coastal hazards and damage upon critical infrastructure and structures in high-risk areas of the City;
- Maintain flexibility to meet changing conditions;
- Balance approaches to adaptation weighing benefits to costs and ensuring any action selected has a net benefit to cost ratio that is > 1.0;
- Maintain natural defenses (e.g., wide sandy beach, hybrid solutions, living shoreline/sand dunes, native bluff vegetation that are nature based adaptation strategies);
- Consider pilot projects that emphasize and prioritize nature-based solutions designed to minimize maintenance over time;
- Require new development to plan for coastal storm and SLR hazards;
- Develop adaptive measures that are consistent with the LCP; and,
- Conserve, maintain, and, when necessary, restore/enhance beaches and public access for the future.

Chapter 7 Priority Measures for Resources and Assets

This section provides a road map for long-term adaptation planning, including identification of both programmatic measures and projects intended to reduce damage to the City from coastal hazards, timing for initiation or implementation of such measures, areas of future study, financing options, and the next steps for the City to further its adaptation planning efforts. It also assists the City and decision-makers in making informed decisions regarding future land use and development. While the City has a long history of addressing coastal hazards, this is the first focused endeavor by the City to identify possible vulnerabilities to climate-related impacts. Priority adaptation strategies have been integrated into the recently completed LCP Update and will be integrated into the City's in-progress Implementation Plan, and other actions.

The City's resiliency planning approach allows flexibility to choose from an array of adaptation strategies over time. The City may choose to implement a hybrid adaptation approach using soft and nature-based protection measures and accommodation concepts based on potential SLR thresholds and monitoring. Planning for these priority measures is anticipated to require significant regional or multi-jurisdictional coordination and funding. Many adaptation strategies take substantial time to implement. As a result, advanced planning and securing financing is vital.

The SLRVA identified the potential for physical impacts and their effect on coastal resources as a means to begin the process of improving coastal resiliency in the City over the long-term by developing a plan of action and path forward. Resiliency comes from increasing an asset's adaptive capacity by reducing vulnerability to hazards (i.e., protection). Some of the resources identified in this study have reduced vulnerability to hazards such as bluff erosion because of protections that are in place like the LOSSAN railroad revetment.

Existing and Ongoing Coastal Resiliency Programs

This section of the Plan outlines ongoing programs and adaptation strategies that the City has already engaged in and continues to pursue to promote long-term coastal resiliency. San Clemente's approach to adaptation is comprised of many subcomponents all designed to work together. The City's commitment is, for the long term, to maintain a popular public beach heavily used by visitors and the City's residents. There are more than 15 public beach access points in the City, and the beaches offer a wide variety of recreational experiences ranging from surfing and swimming to volleyball, fishing, and other recreational activities.

At this time, the City's favored approach is to pursue a combination of beach nourishment, sand retention/management, and flood management projects to maintain the existing high-quality public beach and public access in San Clemente as the primary means of addressing sea-level rise.

San Clemente's strategy is based on sound scientific and engineering principles, which have been extensively reviewed. The strategy accounts for community input and recognizes that the beach is a public asset of importance beyond San Clemente. The City believes the strategy will be successful, is "feasible" within the meaning of the State law and will best meet both public and private goals for a significant period of time. In accordance with the California Coastal Act section 18.04.010 and Public Resources Code sections 21061.1 and 30108, the term "feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors.

At the center of these ongoing efforts are the City's Winter Storm Berm Program and the U.S. Army Corps of Engineers (USACE) Coastal Storm Damage Reduction Project described in more detail below.

San Clemente Winter Storm Berm Program

The City implements an annual Winter Storm Berm Program to protect the City's shoreline from wave action and related flooding during the winter storm season. The sand berm is typically constructed in late November and remains in place until approximately early March the following year based on storm predictions, tides, and beach conditions. The City has an existing program where sand is pushed from the intertidal zone up onto the back beach. The City monitors tides and selects a very low tide, then moves that sand up to the back of the beach. Generally, the first time this is done each year is late fall before the winter storm season, and then again in late winter. The first event is to pile up sand to help resist storm waves, and the second event attempts to restore beach area for the summer season. The winter storm berm is created in the area that generally runs from Linda Lane to south T-street and is approximately 2,500 feet in length. Funded by the City, this ongoing measure reduces the probability of damage to development and infrastructure.

The City implemented an annual Winter Storm Berm Program to protect the City's shoreline from wave action and related flooding during the winter storm season. A sand berm is erected annually and is in place for approximately three months out of the year during the winter storm season, typically in late November and until approximately early March the following year, based on storm predictions, tides and beach conditions.

Historically, large waves generated by Pacific Ocean storms during the winter have caused damage to local beaches and coastal structures. Existing vulnerable buildings include the City's Marine Safety Headquarters as well as public parking and restroom facilities located on the beach. To protect these structures and public infrastructure, every winter the City constructs a seasonal sand berm.

Table 7-1. Ongoing Resiliency Strategy-Winter Storm Berm Program

Adaptation Strategy	Winter Storm Berm Program		
Implementation Timeline	Ongoing annually	Berm Construction: 1 week annually	Beach Restoration (i.e., Berm Removal): 1 week annually
Year Initiated	On-going since the 1970's		
Resource / Asset Benefits	Protection of roadways and infrastructure Protection of up to existing public structures and the public beach Protection of recreation resources (beach, public parking, and restrooms) Retain the Citywide economic benefits of beach recreation for the period during which the berm program is effective Can refortify in emergency storm situations		
Costs & Impacts	Annual construction, maintenance, and restoration costs Less effective over time with increasing rates of SLR, particularly over 2 feet, at which coastal storms may overtop the berm or result in severe beach erosion		
Permitting & Coordinating Agencies	USACE, Regional Water Quality Control Board, State Lands Commission		
Next Steps	Continue to implement the Winter Storm Berm Program in the near-term until the berm is no longer effective (i.e., continual flooding and overtopping above the typical berm height), or another adaptation measure replaces the need to implement this program (e.g., USACE project or living shoreline)		

The costs of installation, maintenance, and removal of the berm are borne by the City. Depending on environmental conditions, the approximate cost of annual berm construction, maintenance, and removal is $28,000.

This berm is not intended to serve as a substitute for private storm protection improvements or flood insurance but can substantially reduce damage. Additionally, with sufficient preparation the City can rebuild and support the existing temporary berm after it experiences large storm events. However, storms can exceed the protection offered by the berm, and the berm is not impervious to being destroyed itself. Though beach front property damage by winter storms with installation of the berm has not been recorded along the City coastline in the past, the possibility remains present even with installation of the berm due to the variability of storms that can occur and as well as potential flooding, wave-attack, and erosion that could also occur over time when combined with SLR.

USACE Coastal Storm Damage Reduction Project

The Reconnaissance phase of this project was initiated on March 28, 2000 under the authority of Section 208 of the Flood Control Act of 1965. The Reconnaissance study resulted in the finding that there was a Federal interest in continuing into the Feasibility phase. The City of San Clemente, the non-Federal sponsor, and the U.S. Army Corps of Engineers (USACE) initiated the Feasibility phase in September 2001 and completed it in February 2012. The City has recently completed the pre-construction monitoring component of the Preconstruction Engineering Design (PED) phase of the project and is seeking construction funding to implement the project.

The USACE Coastal Storm Damage Reduction project, also known as the San Clemente Shoreline project, is designed to nourish an estimated length of 3,412 feet of shoreline at a 50-foot width. The beach-compatible sand needed for the nourishment will be taken from a designated borrow site located offshore of Oceanside, CA, which that will be hauled 18.6 miles to San Clemente and placed by hopper dredge on the beach. The southern limit of the proposed beach fill is located immediately south of the T-Street overpass and the northern limit immediately north of the Marine Safety Headquarters. A taper would continue an additional 330 feet to the north and south to merge with the existing shoreline. Re-nourishment cycles would be performed approximately every 5-10 years.

The San Clemente Shoreline project initiated as a feasibility study in September 2001 with the purpose to identify a technically feasible and economically beneficial “recommended plan” for reducing damages from storm-induced wave attack, which are expected to increase, in the future, as a result of chronic, long-term shoreline erosion. Of great risk is the Los Angeles to San Diego (LOSSAN) rail line, which runs the entire length of the San Clemente shoreline. This commuter rail corridor is among the busiest in the country and separates the beach from the bluff. In some areas it is only protected by unimproved ballast, therefore, the rail corridor is vulnerable to storm-induced damages.

The study area was divided into ten reaches based on locations of developments and the condition of the revetment that runs along various stretches of the railroad tracks. After analysis of each section, it was determined that Reach 6 had the potential to justify the purpose of the study. Reach 6 extends from Paseo de Cristobal to Linda Lane in the City and contains narrow beaches ranging from 0 to 128 feet in width. In addition to the railroad and high coastal bluffs, Reach 6 contains both the San Clemente Pier and the “T-Street Reef” and its beaches backed by park facilities. The “T-Street” region of the shoreline is a very popular surfing site located immediately south of the San Clemente Pier, and directly offshore of the T-Street overpass. The T-Street surf break is due to a permanent, hard-bottom reef that rises above the seabed.

Since the 1990's, the project area has experienced chronic, mild, and long-term erosion. Shoreline erosion is a result of the decrease of fluvial sand supply resulting from the concreting of creeks and rivers, upstream dams, and urban development. Continued future shoreline erosion is expected to result in storm waves breaking directly upon the railroad ballast, which significantly threatens the operation of the rail corridor. Additionally, continued future shoreline erosion will subject public facilities to storm wave-induced damages. For example, the 1983 El Nino storm season resulted in an estimated damage of $3,277,000. These facilities, maintained by the City of San Clemente, include the Marine Safety Building, public restroom facilities located on the beach, lifeguard stations, parking areas, and paving near the Pier and the Municipal Pier itself. The LOSSAN railroad line has experienced railway traffic service delays as a result of the narrowing shorelines. These delays occur when storm wave run-up exceeds the elevation or the crest of the railroad ballast in absence of revetment protection.

The majority of the damages/costs identified in the study are related to LOSSAN railroad protection/construction and operation & maintainance costs. During plan formulation, the USACE narrowed down a final array of alternatives for economic modeling and environmental analysis under the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). A broad set of project alternatives was initially considered including the following:

- No Action Alternative;
- Managed Retreat;
- Beach Nourishment;
- Revetment;
- Seawall;
- Groins;
- Visible Offshore Breakwater; and,
- Submerged Reef.

Table 7-2. Ongoing Resiliency Strategy – USACE Project

Resiliency Strategy	USACE Coastal Storm Damage Reduction Project (50-Year Project)		
Implementation Timeline (Initiated in 2000. PED is underway. Construction could begin as early as 2022.)	PED Phase Completion: additional 2 years	Permitting and Planning for Identified Project: Complete	Construction/Installation of Identified Project: 2 years then renourishment every 5-10 years for an initial authorization period of 50 years.
Year Initiated	2000; Due to loss of sediment from San Juan Creek, the major source of beach sediments for San Clemente (Oceanside Littoral Cell). Downcoast erosion and loss of sediment supply has occurred.		
Potential Resource / Asset Benefits	State and Federally funded Reconnaissance, Feasibility, and PED Phases that will provide additional information about coastal erosion and potential solutions. In-depth economic, environmental, and logistical analysis of potential erosion mitigation alternatives completed Source of federal funding for 65 percent of identified project cost Potential integration with existing and proposed adaptation measures (e.g., annual winter berm, living shoreline) Provision of benefits to City's shoreline, assets, and infrastructure north and south of the project area		

Resiliency Strategy	USACE Coastal Storm Damage Reduction Project (50-Year Project)
Costs & Impacts	Requires local funding for 35 percent of PED Phase and Initial Beach Sand Placement efforts. Re-nourishment cycle cost share requirements are 50/50 Federal and State/Local. State Parks, Division of Boating and Waterways pays 85% of the local cost share requirement and has done so for the Feasibility Phase and PED Phase. Construction Grant funding has also been awarded from the State Parks, Public Beach Restoration Program Grant Funding. Dependent on continued federal funding availability.
Permitting & Coordinating Agencies	USACE, USFWS, NOAA/NMFS, CCC, CLSC, CDFW, RWQCB
Next Steps	Continue to coordinate with USACE towards completion of the PED Phase, including facilitating data sharing contribution of the City's Sea Level Rise Vulnerability Assessment and Coastal Resiliency Plan findings and recommendations. Identify funding sources for local cost share (15% of the local 35% cost share) including City Work-In Kind contributions of staff time and other resources as delineated in the PED Project Management Plan (PMP).

As noted, the USACE project has been designed to be resilient to SLR through incorporating adaptive management components. The project has been Federally authorized under the Federal Water Resources and Reform Development Act (WRRDA) of 2014. The project is annually budgeted under the annual USACE work plan budgets, however, funds are not guaranteed/appropppriated in every work plan/budget cycle due to competing priorities among other projects.

The total budget of the PED Phase is $1,912,000 and has a 65%/35% Federal/ State & Local cost share requirement. The average annual cost of the plan is $2,140,000. Initial construction will be cost shared 65% Federal and 35% Non-Federal, and continuing construction (i.e., each renourishment and monitoring) will be cost-shared 50%-50%. The current estimated total first cost of the plan is $11,100,000. Continuing construction will consist of 8 renourishments with a total continuing construction cost estimated to be $84,900,000 over the 50-year period. The sum of the first cost and periodic nourishments is estimated to be $96,000,000. The preceding costs are based on estimates by the USACE and may be updated/change as the project moves closer to actual construction. The City has expressed their interest in providing the Non-Federal matching funds to implement and construct the recommended plan as the preferred / primary coastal resiliency building measure.

Additional + Proposed Strategies for Consideration in the City

In addition to the efforts the City has already undertaken, there are additional proposed measures the City may choose to implement to address identified vulnerabilities including protection of the public beach and resources landward. Project-level planning, technical study, and coordination with approving agencies would be required for each strategy to further develop and implement the measure(s). In addition, some of the strategies described below may be implemented through or assisted by the above USACE program. This Plan also acknowledges that SLR science and adaptation practices are dynamic; the City will need to monitor the rate of rising seas and associated coastal hazards and reevaluate adaptation strategies in the future based on evolving science and technology.

Hybrid Living Shoreline / Beach Sand Dune Complex

The City should consider establishing a dune system on the seaward side of coastal resources threatened by SLR to protect vulnerable community assets while creating beach habitat as well. This concept is a

blend of strategies aimed at preserving the variety of resources that depend on natural beach processes. There are remnant sand dunes along the beach in the northern portion of the City, and these are prioritized in the City's LCP for protection and enhancement.

Hybrid shoreline management approaches act as a middle ground between traditional shoreline protection and a living shoreline that relies solely on natural protective functions. Hybrid shoreline management measures use a combination of structural and "soft" techniques such as beach nourishment to allow for additional flexibility in project design. If implemented successfully, such an approach can provide the additional co-benefits of recreation, and habitat enhancement along with the increased protection of structural measures.

A key element in providing sustainable living shoreline elements such as dunes or cobble berms is to maintain a wide enough sandy beach to buffer seasonal beach profile changes and annual storm events. This can be achieved with regional beach nourishment upcoast, or local sediment retention features. Typically the structural elements are designed to remain buried behind/beneath this design beach profile and become exposed/uncovered only in an extreme event. Areas of San Clemente with an existing beach are the best candidates for this type of strategy.

Hybrid dune systems specifically involve a rock revetment or cobble berm that is then overlain with a sand buffer. Vegetation can also be utilized in hybrid dune systems to further stabilize dune structures and reduce erosion. Additional beach width and height provides an initial buffer for coastal erosion while also providing additional recreational area. The buried revetment or berm then acts as a hardened last line of defense to prevent damage to adjacent coastal resources under more severe storm events.

Maintenance is required over time as the sand layer erodes naturally, though the underlying structural element reduces overall sediment requirements as compared to a pure nourishment approach. Hybrid dune and cobble berm structures have been employed at several sites in Southern California due to their potential for multiple benefits. Projects have been fully implemented at Surfers Point in Ventura and Imperial Beach in San Diego, and construction of a hybrid dune at Cardiff State Beach (Encinitas) was completed in 2019.

The cost of a hybrid dune and living shoreline concept can vary significantly based on the source location of materials such as sand, cobble, and armor stone. The estimated cost of the Cardiff State Beach living shoreline project was about $2 million, which equates to a rough unit cost of about $700 per linear foot (lf). If coordinated with maintenance dredging of San Juan Creek, or in combination with the USACE project or a regional beach nourishment project, there is an opportunity to significantly reduce the cost due to savings on mobilization costs and imported material.

A hybrid dune living shoreline could prove to be an effective adaptation with multiple benefits to offset adverse impacts resulting from SLR and beach erosion. The adaptive capacity of such a measure is heavily dependent on the amount of sand fronting the restored dune. If coupled with a regional beach nourishment program to offset the long-term erosion and future SLR, this measure could be very effective for the 3.3-foot SLR scenarios. For higher SLR scenarios (4.9 feet), this strategy would remain effective at reducing coastal hazards if the rates of re-nourishment are sufficient to keep pace with SLR. If the rates of re-nourishment cannot keep pace with SLR, then periodic and eventually permanent erosion of the restored dune system would be expected. Under a high SLR scenario, much of the back-beach development would require some form of adaptation to preserve the existing land uses. For example, beach parking would need to be elevated, protected, or reconfigured to accommodate the significantly higher tide range, wave run up and beach berm. While a hybrid dune living shoreline alone may not be

sufficient to mitigate impacts from higher SLR scenarios, it could be implemented in combination with other measures and over several cycles of adaptation.

Table 7-3. Proposed Strategy-Living Shoreline/Dunes

Resiliency Strategy	Living Shoreline/Dunes		
Implementation Timeline[1]	Planning: 1-2 years	Permitting: 2-3 years	Construction: 1 year
Timing	Near-term, based on storm frequency and intensity, based on comparisons to historic trends. Beach Erosion & Coastal Flooding Hazards 0.8 feet of SLR		
Potential Resource/Asset Benefits	Protection of roadways and infrastructure Protection of shoreline structures and recreational resources Protection of public infrastructure including roadways, public parking, bike facilities, and public restrooms Restoration of coastal habitat (dunes) to the area Retention of economic benefits associated with beach recreation		
Costs & Impacts	Construction costs (depends on length of shoreline protected >$2.5 million per 0.50 miles) Moderate ongoing maintenance costs required (roughly $100,000 per year, though costs increase with time) Less effective over time with increasing rates of SLR, particularly as SLR nears 5 feet, which may result in more frequent overtopping of an installed dune system		
Permitting & Coordinating Agencies	USACE, USFWS, CCC, CSLC, California State Parks, CDFW, RWQCB, Caltrans		
Next Steps	Secure funding sources from grants Modeling and additional study for concept design development Coordinate with agencies to develop concept design Public outreach		

1 Based on 2,900-foot-long Cardiff Beach Living Shoreline in Encinitas, CA. Source: State Coastal Conservancy 2018.

Reestablishment of the natural dune system is an effective SLR adaptation strategy that has been implemented in other jurisdictions facing similar coastal hazard threats within similar Southern California community settings (e.g., at Cardiff Beach in the City of Encinitas and at Surfer's Point in the City of Ventura). Dune systems have been documented to reduce coastal storm damage, buffering the shoreline from wave attack during extreme storm events while also providing coastal habitat benefits.

A living shoreline would serve as a green protection strategy to address vulnerable infrastructure, resources, and assets within the City. This concept may include a cobble core persistent dune system or other engineering alternatives consistent with "living shoreline" principles (Figure 7-1). The City recommends engineering investigations that rely upon local sources of material to the maximum extent feasible. This adaptation strategy would also require a robust monitoring program, including pre-project monitoring to inform the design and to serve as baseline for post-implementation monitoring. A living shoreline/dune system would require periodic maintenance. The need for maintenance and adaptive management efforts would likely increase over time with SLR.

Figure 7-1. Living Shoreline / Dune Concept

Dune concept for the Cardiff State Beach living shoreline project, which utilizes dunes to ensure protection for the adjacent Highway 101 and upland development.

To implement a living shoreline, the City would need to coordinate with federal, state, and local agencies to acquire necessary permits, including State Parks for any action within or immediately adjacent to a State Beach. Policies supporting this approach have been incorporated into the LCP Update and would allow the City to facilitate a living shoreline as an adaptation strategy.

Annual maintenance costs of a dune system is approximately $10,000 (2018) per acre per year, not including the cost of labor for dune maintenance (Natural Resources Agency 2018). As with other adaptation strategies, costs associated with the establishment and maintenance of these systems would likely increase and would be influenced by the rate of SLR.

Sediment Management Program

Sediment is nature's adaptation resource and its delivery to the coastal beaches, dunes, and estuaries is instrumental in habitat maintenance and natural defenses. Regional sediment management can augment existing sand and cobble supply to widen beaches and supplement naturally occurring sediment inventories. Wide beaches provide natural defenses against wave attack by dissipating wave energy and buffering the bluffs, dunes, and land uses from erosion. The maintenance of a wide and sandy beach, which can result from management of sediment transport as has naturally occurred historically, has widespread economic and recreational benefits for nearby communities.

The City has had an opportunistic sediment management program in place since 2004. Recently, due to regulatory constraints and increasing monitoring costs, the City has temporarily put this program on hold. A new local sediment management plan, or one prepared in conjunction with other entities to replenish the City's shoreline with currently exported sediment, would help to re-nourish the beach and improve coastal resiliency. Adaptation strategies that export sediment from the watershed to sandy beaches to mimic historical natural processes would go a long way to improve coastline resiliency within existing funding levels.

Table 7-4. Proposed Strategy-Sediment Management

Resiliency Strategy	Sediment Management		
Implementation Timeline	Planning: 1-2 years	Permitting: 1-2 years	Implementation: Ongoing-20+ years
Timing	Near-term, based on a beach width distance, based on comparisons to historic trends. Beach Erosion & Coastal Flooding Hazards (approximately 0.8-foot SLR)		
Potential Resource/Asset Benefits	Provides a local/native source of beach nourishment Increases and retains the quantity and quality of sand that is on the beach, potentially increasing the width of the beach Complements other adaptation strategies including the Living Shoreline, by maintaining beach nourishment Reduces the rate of beach erosion Enhances recreational value		
Costs & Impacts	High ongoing costs Less effective over time with increasing rates of SLR, particularly as higher waves and larger storms have the potential to result in greater erosion rates Sediment transport via truck trips creates short term noise, restricts recreational access, commercial and residential activities		
Permitting & Coordinating Agencies	USACE, USFWS, CCC, State Parks, CSLC, Caltrans, CDFW		
Next Steps	Secure funding sources from grants		

	Coordination with federal, state, and local agencies Public outreach

Development of a regional opportunistic sediment placement program for sediments and sand with the designation of specific receiver sites is a high priority for the City in coordination with other agencies, including the County. Regional sediment management is currently described in the Coastal Regional Sediment Management Plan (CRSMP) and as noted, updates to the CRSMP to address SLR are currently being pursued. Partnerships with the County Flood Control District would be required to ensure successful regional management, including the need for a consistent sustainable funding source and regulatory permit requirements. Changing the approach to local debris basin cleanout activities and the deposition of these materials within the watershed should be investigated as well as transport to the beach or other adjacent coastlines depending on the extent of sediment transport, sediment quality and quantity, and potential regional benefits.

There are several components to a successful shoreline sediment management program that would benefit the City. This could include the following:

- Work with OCCOG and other cities in the region to update the 2013 OCCRSMP that includes SLR and its anticipated effects.
- Develop a flexible regional opportunistic sediment placement program that identifies and permits specific placement or receiver locations in the City.
- Streamline regulatory approvals with extended permit duration (e.g., 20 years).
- Regulate existing practices that export debris basin sediments out of the watershed.
- Create sustainable local, state, and federal funding programs.

Beach sand nourishment is an important shoreline management practice in much of Southern California. Sand-only nourishment projects (e.g., without a retention component) can require millions of dollars in funding annually with a permit process and regulatory requirements sometimes constituting a substantial portion of project costs. Following the investment of time and resources, large wave events can strip beaches of all past nourishment and can require full replacement of beach nourishment. Additionally, the time at which a storm occurs over the studied span of SLR directly influences the volume of sand needed for replenishment; a storm that occurs at approximately 1 foot of SLR would displace less sand and have a smaller re-nourishment cost than a storm event occurring at approximately 5 feet of SLR. Finally, sediment nourishment becomes less effective with higher rates of SLR due to higher wave action and the potential for higher rates of erosion, particularly during the winter season.

Permit processes can take several years, and the short duration of permits (e.g., 5 years) can require expensive repetitious permit processes for similar projects. Sustainable funding, longer-term permit durations (e.g., 20-year program-level permits), and increased regulatory flexibility should be explored if beach nourishment is to play a major role in SLR adaptation.

Similar to the living shoreline adaptation strategy, the sediment management adaptation strategy would reduce vulnerabilities to the areas within the City currently vulnerable to existing beach erosion and coastal flooding and may partially assist to protect portions of the City projected to be affected by approximately 4.6 feet of SLR.

Sand Retention Structures

Sand retention measures include structures that prevent sand transport away from the beach and encourage sand deposition on the beach. Types of structures include the following alongshore and cross shore systems:

- **Groins**: These structures serve to maintain a wider beach but have the potential to diminish horizontal access along the beach. Constructing groins and other structures on the beach or in the ocean typically requires habitat mitigation (e.g., restoration of comparable habitat in another location) and could alter the character of San Clemente's natural shoreline. New groin designs may become available in the future, so this option should be evaluated over time.
- **Breakwaters**: These structures maximize wave reduction and sand retention but can disrupt and alter wave patterns and interfere with surfing resources, which may negatively impact the City. Current permitting and mitigation requirements, and the degree of potential negative impacts, may restrict use of breakwaters as an adaptation measure. New breakwater designs may become available in the future, so this option should be evaluated over time.
- **Multi-Purpose Artificial Reefs**: These structures create rocky reef habitat and have potential to enhance surfing resources; however, using artificial reefs to retain sand and enhance surfing is still in the conceptual/experimental phase of development. Reefs have been investigated, constructed, and tested in various locations, including Orange County (e.g., Wheeler Reef Phases 1-3). Successful reef installation remains a work in progress to date. New reef designs may become available in the future to ensure that reef implementation will provide the intended benefits, so this option should be evaluated over time.

Additionally, other structures have sand retention value while reducing the physical disturbance/ presence of the structure and associated costs. As described below, these options include a cross-shore structure or headway of rock or cobble that limits sand movement downcoast and an offshore breakwater or reef that retains sand in-place by reducing wave energy before it reaches the beach. Sand retention structure adaptation strategy strategies could reduce vulnerabilities to areas within the City that would otherwise be vulnerable to existing beach erosion and coastal flooding with approximately 3.3 feet or greater of SLR.

Table 7-5. Proposed Strategy-Sand Retention Structures

Resiliency Strategy	Sand Retention Structures		
Implementation Timeline	Planning: 2-5 years	Permitting: 2-5 years	Construction: 2-10 years
Timing	Near-to Mid-term, based on SLR elevation and beach width distance, as indicated by a change from historic trends. Beach Erosion & Coastal Flooding (between 0.8 and 4.9 feet SLR)		
Potential Resource/Asset Benefits	Physically maintain existing land area with associated infrastructure Capture sand drift within retention structures Reduce loss of sand and habitat along shoreline Potentially increase effectiveness of winter berm or living shoreline improvements, depending on placement Potentially provide recreational opportunities		

Resiliency Strategy	Sand Retention Structures
Costs & Impacts	Construction costs High, ongoing maintenance costs required Less effective over time with increasing rates of SLR, unless the installed structures are heightened over time Alteration to wave energy, potential associated loss of coastal access and recreational opportunities
Permitting & Coordinating Agencies	California State Parks, CCC, CSLC, County of Orange, USFWS, CDFW
Next Steps	Coordination with state and adjacent jurisdictions on project feasibility Modeling, engineering, and additional environmental investigations required Public outreach Identify/secure funding from public agencies or grants

Cross-Shore (Shore Perpendicular) Sand Retention Structures

Sediment transport along the shoreline is predominantly from north to south. In areas with dominant along-coast sediment transport, cross-shore sand retention structures tend to trap sand up coast of the retention structure in what is called a "fillet," which are often used to widen beaches and provide more natural defenses to coastal wave hazards. While a stone revetment may provide more suitable habitat for shorebirds and other coastline species, cobble can be utilized to provide a stable base for dune placement and maintain public access to the beach. Both rocks and cobble are appropriate materials to dissipate wave energy, though cobble can be more effective at reducing sand placement loss (Komar & Allan 2010). Though these protection options may be challenging to design consistent with the Coastal Act and local coastal policies, they may be options to consider for sand and sediment retention along the City's shoreline.

Figure 7-2. Cross-Shore Rock Revetment

A cross-shore rock revetment has been implemented to retain sand and protect vulnerable neighborhoods from beach erosion.

Specific design considerations must be examined to avoid downcoast impacts resulting from the interruption of sand transport caused by the cross-shore structure. This typically involves beach nourishment both up and down drift of the retention structure to prevent loss of sand to downcoast beaches, emphasizing the need for regional coordination for such projects. As these types of projects result in potential regional changes to sediment transport, adjacent jurisdictions would need to be involved in the process; extensive outreach to these jurisdictions would be required along with a technical feasibility study to determine cost-benefits, structural design, funding, and processing requirements. The process would also involve agency permitting and environmental review.

Offshore Multi-Purpose Reefs

Erosion and coastal flooding are often caused by large waves running up the beach. If the wave energy can be reduced before it reaches the coast, then less beach erosion and flooding would occur. The offshore natural and man-made reefs already provide some natural defense in reducing wave energy by

causing some waves to break farther offshore. However, as an adaptation strategy, engineered offshore structures could further dissipate wave energy. Offshore structures can reduce wave energy as it reaches the shore to reduce sand movement from the beach and, as a result, slow sand transport along the shoreline, acting as retention structures. The most common form of offshore structure is an offshore breakwater (e.g., Ventura or Channel Islands Harbor), or a multi-purpose reef, which may provide shoreline protection, recreational benefits and habitat benefits (e.g., Natural Shoreline Infrastructure oyster reef projects in San Francisco Bay) (The Nature Conservancy 2017). These structures can be designed to mimic nature-based solutions that are made of natural material (rock) and can replicate natural rocky structures offshore. Regarding offshore artificial reefs, both natural (e.g., recycled shell, gravel) and manmade (e.g., concrete, aggregates) materials can be used to construct artificial reef elements. Prior Natural Shoreline Infrastructure oyster reef projects in San Francisco Bay have used concrete "Reef Ball" installations, which cost approximately $500 to $550 (2018) per linear foot in a direct line, and between $700 to $1,000 (2018) per linear foot when arranged to accommodate a denser installation pattern (California Natural Resources Agency 2018). These options would similarly require initial outreach with adjacent jurisdictions, followed by an extensive feasibility study to determine the permit path and potential regional impacts.

The City of Solana Beach and the USACE worked to develop a conceptual engineering design for an artificial reef located offshore from Fletcher Cove, the City of Solana Beach's main beach. The primary goal of the reef would be to retain sand to create a wider beach and reduce direct wave attack on the City's coastal bluffs. Secondary but important goals of the project are to provide recreational enhancement and biological resource value immediately offshore. The conceptual project is based on the multi-purpose conceptual reef planned for Ventura County (Oil Piers Reef). In April 2010, the USACE and the City of Solana Beach completed the conceptual engineering design study for a submerged reef at Fletcher Cove. Federal, State, and local funding commitments for future phases of the project are being pursued to support the initiation of necessary environmental review, design, and permitting activities. Although the project has been on–hold since 2013 due to lack of funding, this project could be used as an example of information and the need to develop site-specific data and to replicate nature as much as possible when pursuing a structure.

Storm Drain and other Public Utility System Improvements

A major infrastructure challenge associated with SLR is the need for efficient, rapid drainage of storm water. Some segments of the City's existing storm drain system that are lower in elevation and closer to sea level may lack the elevation requirements necessary for a gravity flow system to effectively accommodate current and projected storm events. Some storm drains are located down-gradient from outfall locations, at a lower elevation than necessary for gravity flow, which is a problem that becomes exacerbated during high tide storm events when outfalls can be inundated. Presently, the existing infrastructure is not always able to accommodate all storm water flow, which can flood portions of the City's shoreline including coastal access points that cross beneath the railroad corridor. As sea levels rise, greater portions of the system may not drain during high tides and during more of the tide cycle, which, in turn, may increase storm water flood depths and frequency. Culverts and pipes may also create back flows of ocean water into the neighborhoods. Flood risks within high-hazard areas can be addressed by upgraded infrastructure accomplished through a combination of elevation, relocation, redesign, and retrofitting, as necessary, to preserve recreational and commercial use. Infrastructure upgrades could improve resiliency in San Clemente.

Table 7-6. Proposed Strategy-Storm Drain Improvements

Resiliency Strategy	Storm Drain Improvements		
Implementation Timeline	Planning: 3-4 years	Permitting: 4-5 years	Construction: 2-10 years
Timing	Near-to Mid-term, based on SLR scenario where coastal flooding & tidal inundation after 0.8 feet of SLR has occurred.		
Potential Resource/Asset Benefits	Accommodate stormwater and reduce inundation Remove storm water from low-lying areas during rain events, and from future tidal inundation Reduces the duration of flooding during storm/tidal events Can be relatively adaptable to higher volumes of water during pump replacements		
Costs & Impacts	Construction/replacement costs High ongoing maintenance costs required, and frequent maintenance checks to ensure operational reliability during storm or tidal inundation events Requires reliable energy to operate during events		
Permitting & Coordinating Agencies	CCC, CSLC, Caltrans		
Next Steps	Establish a Citywide Capital Improvement Program (CIP) to incorporate "Green Street" and storm water infrastructure in public right of way improvement projects to support improved drainage/storm water runoff through the City Evaluate the need to replace existing culverts that may contribute to coastal hazards Investigate the use of pumps to move water out of areas affected by future tidal inundation areas Public outreach Secure construction and operational funding sources (e.g., assessment district, public agencies, etc.)		

The City may need to investigate of the use of storm water pumps and/or lift stations (pumps) to move water out of low-lying areas of the City if they experience tidal inundation with areas of ponded flood waters from rainfall event storm water runoff. As tidal inundation increases with SLR, even without heavy rainfall or runoff events, the use of pumps to move water out of the lower-elevation areas may be warranted. The use of pumps is moderately adaptable, as the pumping capacity could be increased or improved over time when the pumps need to be replaced. As the necessary volume of water to be pumped increases, operational and maintenance costs would likely escalate over time. Additional challenges for the operation of storm water pump systems can include accommodating the large amounts of organic / fibrous material and solids that often accompany storm water.

Accommodation for storm drain improvements could be integrated to the City's Capital Improvement Program (CIP). The action item would have the intent of improving storm water runoff, reducing tidal inundation, and accommodating larger volumes of storm or tidal water that have the potential to affect inundate vulnerable areas of the City. The range of options for consideration under the CIP action item should also include preventative measures before storm water or tidal effects can reach the storm drain systems (e.g., inlets, outfalls). At this time, no funding source has been identified for these potential improvements.

Chapter 8 Regional Assets and Multi-Jurisdictional Coordination

Several of the critical facilities and assets within the City that are vulnerable to SLR are managed by other local, state, and federal agencies. These include LOSSAN Corridor, Pacific Coast Highway/U.S. 101, and San Clemente State Beach. Adaptation measures for these important public assets and facilities requires coordination, collaborative regional solutions, and partnerships with adjacent and affected jurisdictions and entities, including the County of Orange, California State Lands Commission (CSLC), CCC, State Parks, USACE, the California Governor's Office of Emergency Services (Cal OES), and FEMA; infrastructure and transportation providers, such as Caltrans and LOSSAN; and special districts including the Santa Margarita Water District (SMWD).

Good adaptation planning is collaborative, considering interconnected ecological, social, political, and economic systems. Partnerships and dialogue between the City and agencies would be essential in developing and implementing sound regional adaptation strategies. Through coordination with other jurisdictions and agencies, the adaptation planning process aims to improve coordination and leverage local resources to minimize vulnerabilities and impacts associated with SLR.

Existing LOSSAN Railroad Corridor

The existing railroad and revetment that traverses through San Clemente is owned and operated by the OCTA. The OCTA was awarded an SB 1 Adaptation Planning Grant in 2019 from Caltrans to fund a study entitled the "*Orange County Rail Infrastructure Defense Against Climate Change Plan*." The study identifies strategies to evaluate the negative effects of storm activity, increased precipitation levels, SLR, temperature increases, and associated climate events on the OCTA-owned rail right-of-way in Orange County and develop strategies to ensure resilience of the transportation services and assets. OCTA completed the study in January 2021 entitled "Orange County Rail Infrastructure Defense Against Climate Change Plan", which identified vulnerable locations, and assessed short-and long-term alternatives to improve resiliency of the transportation system that is utilized by disadvantaged communities and military operations, as well as contributes to a thriving economy. City Staff participated as stakeholders with OCTA as part of their outreach efforts related to the development of this study.

Pacific Coast Highway

El Camino Real (Pacific Coast Highway to the north of the City) traverses the City inland of the railroad and serves as a primary regional access route. The roadway is under the jurisdiction of Caltrans District 12. The City should continue to coordinate with Caltrans to efficiently facilitate any adaptation measures determined by Caltrans to be required to ensure the roadway remains resilient to SLR over the long term.

Wheeler North Reef Phase Three Expansion Project

The Wheeler North Reef Phase 3 project (WNR) area is located adjacent to the existing Phase 1 and 2 reef sites about 1,000 feet offshore of the City of San Clemente, between the San Clemente City Pier to the north and San Mateo Point to the south. The Reef complex is located offshore at a water depth that ranges from 34 feet to 49 feet in the Pacific Ocean. The WNR Phase 3 reef area encompasses approximately 1,200 acres.

Southern California Edison Company (SCE) is expanding the Wheeler North Reef to satisfy California Coastal Commission (CCC) Permit No. 6-81-330-A. Phase 1 (SCE's test modules) and the Phase 2 portion of the reef has been completed. Phase 3 is anticipated to be completed in July 2020. While the reef is

intended as a mitigation project to offset operational impacts associated with the San Onofre Generating Station (SONGS), some nominal indirect/incidental sand retention benefits may be generated by the project due the reef modules effects on reducing wave energy.

Ongoing Resiliency Efforts and Additional Efforts for Consideration

The City may consider continuing existing strategies or pursuing new strategies to help protect valuable public and coastal and infrastructure resources within the City of San Clemente. While these strategies have not been evaluated in detail for their potential effectiveness under various SLR scenarios, we have included some approximate SLR thresholds for each strategy which may be useful for planning purposes and consideration of phasing SLR adaptation options.

WINTER STORM BERM PROGRAM

This is an existing and ongoing program. It is recommended that the City continue to implement the annual winter storm berm program along the beach in the near term while monitoring rates of SLR and storm frequency. This strategy would need to be modified in response to an 0.8 foot SLR scenario as the berm would need to be higher and wider to mitigate storm flooding. When the USACE project is implemented, it is anticipated that the winter berm program will be more effective even with 0.8 feet of SLR.

USACE COASTAL STORM DAMAGE REDUCTION PROJECT

This is an existing and ongoing program. It is recommended that the City pursue remainder PED funding in FY 21/22, and subsequent years as needed, to complete the in-progress PED phase of the project. The City should also continue to seek construction funding support from the Federal government and State government so that the City can implement the program as soon as possible following completion of the PED phase of the project.

The USACE *Feasibility Study* evaluated sea level rise of 0.7 meters (2.3 feet) and concluded one extra nourishment over the 50-year initial period would be required to offset the increase in shoreline erosion due to projected future sea level rise. Based on the recommendations and conclusions of the USACE Feasibility Study the program is anticipated to remain effective up to the 3.3-foot SLR scenario near the project area. Beyond the initial 50-year project life, increases in nourishment volume and frequency may be required depending on SLR trends.

HYBRID LIVING SHORELINE/DUNE SYSTEM

Design and construct a living shoreline pilot project to function as a permanent storm berm that could either supplement or replace the annual winter berm and protect the City's shoreline once the 3.3-foot of SLR scenario appears to be a reality. This strategy would need to be implemented along with a local or regional nourishment program that is able to sustain a wide enough beach (~30-50 feet) to function as a living shoreline.

This could be undertaken in conjunction with the sand retention structure(s) described above or independently. Install hybrid dune structures along the City's northern shoreline. Utilize existing structures as material for the structural component of the hybrid dune. Align hybrid dune design with any planned beach nourishment activities. Develop a monitoring program to evaluate performance and maintenance needs of hybrid dune structures over time. Evaluate the performance of the Cardiff Living Shoreline project that is operational in northern San Diego County (Encinitas) and for lessons learned .

The SLR threshold for this strategy varies depending on the scale of the local or regional beach nourishment program. A significant nourishment program could be sufficient to allow for a living shoreline/dune system to remain functional for SLR of up to 3.3-feet or higher depending on what long-term decisions are made regarding the railroad corridor.

REGIONAL RESILIENCY BUILDING PROJECTS

Once cost-effective regional resiliency building programs or management strategies have been identified, such as those which may be undertaken in Dana Point, Camp Pendleton, and the County of Orange by Caltrans or others, the City will work with regional partners to expeditiously implement these programs. The City could collaborate with Dana Point and the County of Orange on shoreline management projects at the City's northern border including the development of the Master Plan for Capistrano Beach which is currently in the early design/alternatives phase.

SEDIMENT MANAGEMENT PROGRAM

The County of Orange prepared the "Orange County Coastal Regional Sediment Management Plan" (OCCRSMP) in 2013 to develop a coastal regional sediment management plan that provides sufficient information for decision makers to develop policies and/or execute management sub-plans for the future vitality of Orange County beaches and shoreline areas. The OCCRSMP identified the City's beaches as critical erosion hot spots and also noted that 3 million visitors per year come to the City's beaches, generating $87 million in annual spending annually as of 2013. The OCCRSMP outlined coastal maintenance needs through a multi-pronged approach ranging across geographic regions and utilizing many possible methods. The first steps to fully implement the OCCRSMP would be collaborative discussions between local agencies before a JPA could be modified or formed. This JPA would have the task of implementing and updating the OCCRSMP over the next 50 years. The City should continue to coordinate with the County to pursue one or more of the strategies laid out in the OCCRSMP as a supplemental SLR adaptation strategy.

SAND RETENTION STRUCTURES

Assess the potential of sand retention structures, in conjunction with beach replenishment efforts, to increase beach width, as well as the need to pre-fill the beach to avoid creating downcoast effects. Depending on the design, these measures are more appropriate for utilization before approximately 2 feet of SLR has occurred and should be implemented by the time approximately 1 foot of SLR has occurred unless the installed structures are modified or heightened over time. The existing Phase 1 and 2 of the Wheeler North Reef project may provide some sand retention effects for the southern half of the City, and the Phase 3 expansion reef complex will cover the area in the City to its northern border near the Poche public beach access point. However, a nearshore reef which resembles the existing reefs at T-Street or Riviera would be required to have a meaningful effect on sediment retention and such a system would need to be designed to perform well over time for specific SLR thresholds.

STORM DRAIN IMPROVEMENTS

Install water pumps within storm water drains in the City to reduce the threat of flooding from storms and tidal inundation. This is an adaptive measure that could be monitored as necessary over time to address changing conditions. While not currently necessary, planning should begin with approximately 1 foot of SLR, and implementation should occur with approximately 2 feet of SLR.

Chapter 9 Funding Opportunities and Mechanisms

Coastal resiliency building is a complex undertaking and the City will need to secure funding to implement any of the strategies described in this Plan. Anticipated challenges will include acquiring the necessary funding for implementing strategies and gaining commitment and support from federal and state government agencies to address the local realities and challenges. Lack of resources from state and federal agencies will hinder or delay implementation. To support its success, the City will continue the regional dialogue and maintain state and federal partnerships to identify, fund, and implement preferred resiliency solutions. Potential sources of funding that could be explored by the City are described below.

Establishment of a Shoreline Account

The City may consider establishing a "Shoreline Account," which would serve as the primary account where all funds generated pursuant to future resiliency building programs and projects would be held. The City should invest the Shoreline Account funds prudently and expend them for purposes outlined in this Plan including, without limitation:

- Sand replenishment and retention studies and projects;
- Opportunistic beach nourishment programs and development of stockpile locations;
- Updating the mean high tide line survey;
- Preparation of seasonal / annual beach profile surveys and monitoring programs;
- Repair and maintenance of shoreline protection systems (such as the winter storm berm or a living shoreline) subject to reimbursement by the affected and/or non-compliant property owners; and
- Repair and replacement of beach access infrastructure and recreational amenities.
- Storm Drain pumping systems to minimize future flooding
- Improvements to or new access in and around the Municipal Pier

The City may use the funds in the Shoreline Account, subject to the restrictions of any terms of the funding sources, to pay for projects such as beach sand replenishment and retention structures, public recreation and public beach access improvement projects, feasibility and impact studies, operating and maintenance expenses, and to pay to conduct surveys and monitoring programs. Some potential resiliency building programs and funding mechanisms that can be further explored are described below.

California State Parks, Division of Boating and Waterways Grants

State Parks, Division of Boating and Waterways (DBW) administers two coastal protection programs: The Shoreline Erosion Control Program and the Public Beach Restoration Program. The general objectives of these programs are to preserve and protect the California shoreline, minimize the economic losses caused by beach erosion, and maintain urgently needed recreational beach areas. This can be achieved by cosponsoring the construction of beach erosion control projects with local and federal agencies, improving present knowledge of oceanic forces, beach erosion and shoreline conditions, and using this knowledge to prevent future erosion.

Government agencies, such as the City, are eligible to apply for local assistance grants through these programs. The Shoreline Erosion Control Program can assist in the planning and construction of all types of beach erosion control and shoreline stabilization measures, including hard structures like seawalls. This program can fund up to 50 percent of nonfederal project costs. This Program is authorized in statute

by Harbors and Navigation Code sections 65-67.4. The Public Beach Restoration Program can assist in the planning and construction of engineered placement of sand on the beach or in the nearshore environment. This program can fund up to 85 percent of nonfederal project costs at non-State beaches. This Program is authorized in statute by Harbors and Navigation Code sections 69.5-69.9.

Geologic Hazard Abatement District

Assessment districts are common funding mechanisms for utilities, such as water supply and utility providers. Establishment of a Geologic Hazard Abatement Districts (GHAD) may be a useful tool to explore for groups of affected property owners to self-assess and self-fund one or more of the coastal resiliency strategies described in this Plan. Establishment of a local or regional GHAD provides opportunities for beach and bluff front property owners to establish an assessing entity to implement one or more of the priority adaptation strategies described above. A GHAD could provide a potential means for future renovations or improvements to flood control structures, including future alterations that may be necessary because of SLR. By accumulating a funding reserve for future maintenance and rehabilitation, a GHAD can provide the financial resources necessary for potential future expansion, maintenance, or repairs of infrastructure or other structures. Further, because of the relative safety of GHAD revenues (typically financed through the collection of supplemental tax assessments), GHADs can borrow from lenders or issue bonds with very attractive credit terms. A GHAD should be established to better assess hazards and fund improvements for issues that affect a larger regional area, resulting in greater reserves of funding and often improved maintenance or repair services. Given the threat from coastal hazards extends beyond the City, the possibility exists for establishment of a GHAD that includes areas of the City, as well as threatened adjacent communities / neighborhoods to the north.

Infrastructure Financing Districts

As of September 2014, California law allows cities and other entities to create enhanced infrastructure financing districts. This allows incremental property tax revenues to be devoted to a specified purpose such as a fund for cleanup, infrastructure, parks and open space, transportation, or other things that could be applied to a variety of adaptation approaches. With the passage of Assembly Bill 313 and Senate Bill 628, the requirements for establishing these districts have been streamlined. The intent of these bills was to fill the local funding void left by the dissolution of the redevelopment agencies. Basically, the City would establish an Economic Infrastructure Financing District (EIFD), develop a business plan with priority projects (e.g., infrastructure, adaptation, etc.), and then draw funds from changes in local tax revenues occurring as part of a redevelopment or rezone or apply for grant funds.

Dedicated Sales or Transient Occupancy Tax Increase

TOT INCREASE

TOT from hotel stays and short-term vacation rentals provide a source of General Fund revenues for the City. A dedicated increase in this TOT (e.g., 2% for sand) could be reserved specifically for resiliency approaches that maintain the City's beaches and open spaces. Presently the TOT rate is 10%; a potential increase of 2% could yield an additional $530,000 annually. A regionally coordinated increase in TOT to provide regional funding for coastal improvements, maintenance, or repairs could also be coordinated with other jurisdictions in the County.

SALES TAX INCREASE

The City may consider this approach or coordinate on a countywide approach such as a quality of life initiative to generate local revenues to be used to finance long-term coastal resiliency strategies. The City

of Solana Beach (San Diego County) instituted a two percent sales tax increase that is used as a dedicated source of funding for coastal resiliency building.

Local Hazard Mitigation Planning and Pre-Disaster Assistance

There is overlap between LCP planning and the Local Hazard Mitigation Plan (LHMP) as both address a potential range of hazards in a given City. California Governor's Office of Emergency Services' (Cal OES') Hazard Mitigation Planning Division and FEMA's Hazard Mitigation Assistance grant programs provide significant opportunities to adapt by reducing or eliminating potential losses to the City's assets through hazard mitigation planning and project grant funding. An update to the City's LHMP would be required to add SLR and climate change-related hazards and to make adaptation projects eligible for federal funding. Currently, Cal OES and FEMA have three grant programs: Hazard Mitigation Grant Program, Pre-Disaster Mitigation, and Flood Mitigation Assistance. The total value in each of the grants vary annually based on federal funding authorization, but typically each is in the 10s to 100s of million dollars.

Impact Mitigation Fees or In Lieu Fees: Sand Mitigation / Public Recreational Impact Fees

Impact mitigation, or in lieu fees, are another way to generate monies for adaptation measure implementation. Certain structured fees could be established to generate revenues for: 1) covering the necessary planning of, technical studies for, design of, and implementation of adaptation strategies, or 2) developing an emergency cleanup fund to be able to respond quickly and opportunistically following disasters. Disasters, through a different lens, are opportunities to implement changes.

There are currently two structured fees that the CCC uses to address the impacts of shoreline protection – a Sand Mitigation Fee and a Public Recreation fee. The Sand Mitigation Fee is a fee intended to mitigate for the loss of sand supply and loss of recreational beaches in front of structures. The Public Recreation Fee addresses impacts to the loss of public recreation based upon the loss of beach area physically occupied by the coastal structure. An additional fee for ecosystem damages is under consideration by the CCC, which could assess a fee based on the cost of restoration or replacement value of the damaged habitat.

SAND MITIGATION FEE

Such a fee would mitigate for actual loss of beach quality sand, which would otherwise have been deposited on the beach. For all development involving the construction of a bluff retention device, a Sand Mitigation Fee could be collected by the City to be used for sediment management purposes. The fee could be deposited in an interest-bearing account designated by the City in lieu of providing sand directly to replace the sand that would be lost due to the impacts of any protective structure. Consideration of sand volumes lost over time should factor into whether actual sand placement is preferred or whether the volume/$ should be retained until a substantial volume can be contributed. The methodology used to determine the appropriate mitigation fee has been approved by the CCC in past cases. The funds should solely be used to implement projects that provide sand to the City's beaches, not to fund other public operations, maintenance, or planning studies.

PUBLIC RECREATION FEE

Similar to the methodology used by the CCC for the Sand Mitigation Fee, the CCC has used a methodology for calculating a statewide public recreation fee. The City could develop administrative processes consistent with CCC guidance, including development of impact mitigation fees for public access and

recreation, proposing a public recreation/access project in lieu of payment of Public Recreation Fees to provide a direct recreation and/or access benefit to the general public, and project prioritizations.

California Infrastructure and Economic Development Bank

The California Infrastructure and Economic Development Bank (IBank) was created in 1994 to finance public infrastructure and private development that promote a healthy climate for jobs, contribute to a strong economy, and improve the quality of life in California communities. IBank has broad authority to issue tax-exempt and taxable revenue bonds, provide financing to public agencies, provide credit enhancements, acquire or lease facilities, and leverage state and federal funds. IBank's current programs include the Infrastructure State Revolving Fund Loan Program, California Lending for Energy and Environmental Needs Center, Small Business Finance Center, and the Bond Financing Program.

Green Bonds

Bonds are debt instruments that allow governments and other entities to borrow money from investors and repay that investment over a certain time at a certain rate. Government bonds often remain tax exempt, meaning the interest that investors earn is tax exempt. Bonds are a very traditional and familiar platform for financing public infrastructure and government programs, and recently the market has developed "green" bonds to finance green adaptation infrastructure.

Proposition 1 and Proposition 68 Grant Opportunities

The California Department of Fish and Wildlife (CDFW) has available funding opportunities for multi-benefit ecosystem restoration and protection projects under both Proposition 1 (Water Quality, Supply, and Infrastructure Improvement Act of 2014) This grant funding opportunity make available funds for public agencies for planning activities that lead to specific on-the-ground implementation projects, funds for implementation activities (e.g., construction and monitoring) of restoration and enhancement projects, and funds for acquisition or purchases of interests in land or water

Following passage of the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68), $40 million has been appropriated to the California Natural Resources Agency for competitive grant funds that protect, restore, and enhance California's cultural, community, and natural resources to address climate resiliency and adaptation. Funding under this program is available to local agencies and other eligible applicants for projects qualifying under a number of categories including resource protection, enhancement of park, water, and natural resources, and improvement of community and cultural venues or visitor centers.

Chapter 10 Conclusions, Recommendations and Next Steps

This Plan represents the beginning of the City's phased adaptation efforts to begin to build coastal resiliency and adapt to SLR by reducing risks in the City and exposure of assets to coastal hazards. Reviewing current City programs and policies associated with SLR risk reduction, such as those around shoreline protection, is the first step to identify immediate adjustments to alleviate or eliminate risks. Where adjustments to current practices will not sufficiently address the risks, then more substantial actions must be identified and should be implemented within a future LCP Amendment. This effort will be ongoing in the coming years as understanding of the variables involved in climate science continues to improve.

This Plan is intended to establish a process in which new data and information will be assessed, as needed, to inform adaptation decisions and actions. As such, it is anticipated that the Plan will be periodically re-evaluated and updated.

All resiliency strategies have been evaluated for conformance with the relevant City and state policies, plans, and guidelines which include the following:

- San Clemente Local Coastal Program (LUP and IP)
- San Clemente General Plan
- San Clemente Climate Action Plan
- San Clemente Local Hazard Mitigation Plan
- CCC and OPC Sea Level Rise Policy Guidance
- CRA Safeguarding California Plan

Resiliency building measures within this Plan focus on ways to best obtain, utilize, and disseminate current and future SLR information to inform decision-making in coastal areas. Coastal Resiliency and Adaptation Measures include the following:

- Use of best-available science. The City has identified and uses the best-available sea-level and coastal hazard science and requires it for site-specific vulnerability assessments, discretionary permit applications for projects in the Coastal Zone and preparation of required technical reports.
- Shoreline Profile Monitoring. Establishment of an ongoing shoreline profile monitoring program would enable the City to establish baseline conditions now, at various transect locations in the City each spring and fall against which future SLR impacts and shoreline changed could be monitored.
- Identified planning horizons and/or SLR thresholds. Development and/or redevelopment requires the use of appropriate planning horizons, and/or SLR thresholds and incorporation of SLR-related risks, probabilities and uncertainties associated with planning horizons, as well as model projections.
- Sea-level rise hazard maps. Published maps in the SLRVA identify areas exposed to potential future hazards under different SLR scenarios and designate areas that require further monitoring or analysis. The maps may be used in combination with other adaptation measures including site specific geological studies, siting to avoid hazards, and coastal bluff development setbacks, to provide additional analysis of potential hazards.

- Hazard monitoring. The City will conduct ongoing hazard monitoring efforts in an effort to better understand potential SLR impacts and use the data to inform future planning and decision-making.

Financing Strategies

The City is proactively developing coastal resiliency programs, projects and policies (see 2018 LCP), and exploring financing strategies to address potential future SLR impacts. However, implementation of resiliency-building policies, plans, and programs takes substantial time and investment to get to the implementation/construction phase.

Reducing the impacts of SLR and increased coastal erosion and flooding will require extensive and ongoing coordination with federal, state, and regional agency partners, investment in community resiliency, and a financial program to be able to ensure that the City's long-term community vision is maintained now and long well in to the future.

As next steps, the City should identify, evaluate, and pursue all feasible potential sources of revenue for funding-preferred actions identified in this Plan. The costs of priority strategies should be allocated and shared in proportion to the benefits realized by the affected parties, including the public, the City, businesses, and private property owners, respectively. The City's financing strategy could include the following:

- Coordinate with the County of Orange and cities of Dana Point and Oceanside to explore sustainable local funding sources for shoreline management and adaptation measures such as uniform increases in TOT, local bond measures, changes to any assessment districts to include shoreline management, etc.
- Actively continue to seek state and federal funding for expedited implementation of priority adaptation strategies and prioritize the creation of a wider beach and a beach profile that can feasibly be established and maintained on City beaches for shoreline protection and recreation benefits.
- Work with the League of California Cities, Coastal Cities Group, OCCOG, the County of Orange and Camp Pendleton to lobby state and federal legislators to create sustainable long-term funding programs for adaptation planning and capital improvements, including beach nourishment programs.
- Support formation of a GHAD or EIFD to enable self-funding of selected projects.

Future Technical Studies and Analyses

This Plan builds on the findings of the SLRVA regarding potential hazards to the City from SLR. Given the dynamic nature of SLR science and potential vulnerabilities, the following issues merit further investigation.

COST-BENEFIT ANALYSIS

For any/all preferred coastal resiliency measures the City is interested in pursuing, such as a living shoreline, hybrid solution or beach sand dune system, a Cost-Benefit Analysis would show which strategies would be more cost effective and yield greatest benefits relative to an investment of public funds. Importantly, this analysis is required for most competitive grant programs and would be included as part of an application for grant funding in California.

CRITICAL INFRASTRUCTURE MASTER PLANS

This Plan would identify infrastructure that may be vulnerable to coastal hazards, including transportation, water and sewer, and storm water, and enable the City to leverage the unique opportunity of proposed public facility revitalization initiatives to build adaptive capacity into new and redeveloped City/public infrastructure. Future coastal hazards are anticipated to require resiliency measures be implemented as part of the City's Capital Improvement Program (CIP). Critical Infrastructure Master Plans can support the City in an effort to systematically identify vulnerable segments and address potential upgrades, and timing for such capital improvements considering SLR.

DEVELOPMENT OF A CIP FOR COASTAL RESILIENCY

The City should explore the development of Capital Improvement Program (CIP) for ensuring that all necessary public infrastructure in the City that is required for public health and safety are going to be resilient in the future under SLR scenarios described in this Plan and Final SLRVA (2019).

Public Outreach and Community Involvement

The City will continue to solicit input, comments, and feedback from the public, agencies, and interested parties on these proposed adaptation strategies. Successful implementation of any adaptation strategy requires communication of vulnerabilities, potential adaptation tradeoffs, costs, and alternatives. Outreach efforts designed to inform community residents and stakeholders, including disadvantaged communities and vulnerable populations, of potential future coastal hazards will be conducted by the City during the decision-making processes on proposed new adaptation strategies.

Multi-Agency and Regional Coordination

Adaptation planning for priority strategies is anticipated to require significant regional or multi-jurisdictional coordination and funding. The City cannot adapt to the impacts of SLR alone given the regional and global effects of SLR and the commensurate need to have regional or larger-scale adaptation strategies. The City will need to address coastal hazards by establishing collaborative regional solutions and partnerships with adjacent and affected jurisdictions and entities. The City is taking the following actions to work with local, regional, state, and federal agencies.

- Establish and actively coordinate with regional partners on a regular basis to promote essential regional adaptation strategies and pursue cost-sharing agreements. Such agencies should include, but are not limited to, Dana Point, Orange County, and Marine Corps Base Camp Pendleton.
- Lobby state and federal legislators to implement legislation that requires California Public Utilities Commission (CPUC) and OCTA coordination with local jurisdictions on SLR and adaptation planning, protection of coastal habitats, and preservation of public lateral and vertical coastal accesses.
- Continue to coordinate with the OCTA on adaptation planning for critical facilities, including the SCRRA railroad and revetment that traverses the City's shoreline.
- Continue to coordinate with Caltrans on agency-specific vulnerability assessments and future planning/implementation of key infrastructure, such as U.S. Highway 101.

Monitoring Sea Level Rise and Implementation Actions

Sea level is inherently variable in response to predictable astronomical tides and less predictable atmospheric events such as El Niño and individual storms; however, given that extreme flooding occurs

infrequently, sea-level rise may be realized before extreme flooding occurs. Tracking sea level rise may, therefore, allow the City to anticipate and act in advance of the projected effects of sea level rise.

Implementing adaptation measures will require coordination, planning, permitting, engineering, and financing. Each strategy will have a certain lead time from initial concept to implementation, which varies depending on the scale and type of strategy, and the amount of SLR that the strategy can accommodate.

Once the strategies are prioritized, then conservative estimates of lead times before implementation will be developed as part of this program. These lead times can then be used to inform timelines that serve as a catalyst for the resiliency planning process.

Specific, additional near-term actions the City can take to promote local resiliency include:

- Installation of a local tide gauge at the Municipal Pier as part of the City's efforts to conduct SLR monitoring.
- Support a twice yearly (May and October) beach profile / shoreline transect monitoring program to monitor the width of the beach over time. Actively disseminate the results and their implications to local and regional agencies.
- Monitoring the frequency of flooding and storm damage. The City will track and keep records of coastal flooding and storm damage events and information. This could be a collaborative effort between City staff and residents in which reports, pictures, and videos are collected. The date, type, location, and severity of flooding (e.g., depth, duration, wave height), and damages can be collated into a file. The intent will be to track the frequency, extent, and severity of flooding to assess if and how the frequency of flooding is increasing. If significant and/or extreme flood events occur, then storm data (e.g., water levels, wave conditions) can be collected, and storm frequencies can be recalculated to quantify the increase in flood risk for comparison against risk-based thresholds.
- Integrating long-term shoreline and beach profile data into monitoring programs that include measurable policy timelines / events. Given that a guiding principle is to maintain a walkable beach, beach width should be used as a metric for considering when measures would be implemented. Specific beach-width thresholds will need to be further detailed as part of subsequent monitoring, analysis, and planning.
- Leveraging the unique opportunity of proposed public facilities revitalization initiatives to build adaptive capacity into new and redeveloped City/public infrastructure such as the City's existing Marine Safety Division Headquarters.

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Chapter 12 References

Arcadis. 2015. *Urban Water Management Plan*. San Clemente, CA

California Coastal Commission, 2019. *Environmental Justice Policy.* Adopted March 8, 2019.

California Coastal Commission, 2018. *California Coastal Commission Sea Level Rise Policy Guidance.* Adopted August 12, 2015.

California Coastal Commission, 2021. Draft *California Coastal Commission Sea Level Rise Policy Guidance for Critical Infrastructure.* Public Review Draft, August 2021.

California Natural Resources Agency (CNRA). 2014. *Safeguarding California: Reducing Climate Risk.*

City of San Clemente. 2019. *Final Sea Level Rise Vulnerability Assessment*. November.

City of San Clemente. 2018. *Local Coastal Program Land Use Plan*. August.

City of San Clemente. 2016. *Centennial General Plan.* January.

City of San Clemente. 2012. *Climate Action Plan*. April.

Coastal Environments, 2014. Updated Coastal Processes and Hydraulics/Hydrology Studies for Doheny State Beach, Technical Report. September 11, 2014.
CoSMoS. USGS Coastal Storm Modeling System 3.0.
https://walrus.wr.usgs.gov/coastal_processes/cosmos/index.html

Everest International Consultants. 2013. Science Applications International Corporation. King, P. *Orange County Coastal Regional Sediment Management Plan.*

IPCC. 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Kopp, R., Horton, R., Little, C., Mitrovica, J., Oppenheimer, M., Rasmussen, D., Tebaldi, C. 2014. Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites. Earth' s Future, 383-407.

Natural Resources Agency, 2014. *Safeguarding California: Reducing Climate Risk. An update to the 2009 California Climate Adaptation Strategy*. July.

OOCF. 2017. Our Coasts Our Future http://ourcoastourfuture.org/

OPC-SAT., 2018. *State of California – Sea-Level Rise Guidance – 2018 Update*. Prepared by the California Ocean Protection Council Science Advisory Team and California Natural Resources Agency.

Smart Coast California. 2021. https://www.smartcoastca.org/general-info.html.

USACE, 2018. *San Clemente Shoreline Project Preconstruction, Engineering and Design Project Management Plan*. June.

USACE. 2012. *Final Report*. *San Clemente Shoreline Feasibility Study Orange County, California*. United State Army Corps of Engineers, San Clemente, CA. February.