Meeting Date: 08/23/22
Staff: M. Farnum, M. Wells

# Staff Report 46 (Informational)

## PARTY:

California State Lands Commission (Commission)

## BACKGROUND:

Sea level rise affects critically important public trust lands, resources, uses, and values along California's iconic coast. Assembly Bill 691 (AB 691, Chapter 592, Statutes of 2013) was pioneering legislation that sought to address sea level rise vulnerability at some of California's most valuable public trust lands, including major ports, harbors, and beaches. AB 691 required local trustees of granted public trust lands with average annual revenues over $250,000 to develop sea level rise vulnerability assessments that included an inventory of the trust lands and assets at risk and proposed measures to adapt to sea level rise. Thirty-five local trustees were required to submit assessments by July 2019 (links to the full assessments can be found here). Thirty-two trustees submitted 34 assessments to the Commission (three trustees did not submit assessments, and two trustees submitted two assessments each, corresponding to the multiple grants they manage). Commission staff, working with the consultant firm Revell Coastal (now Integral Consulting), reviewed the assessments and developed a report (Exhibit A) to summarize the information and make recommendations to the State, Commission, and trustees for improving the process of assessing sea level rise vulnerability and preparing adaptation plans for coastal resiliency. In addition to the summary report, Commission staff and the consultants created two-page summaries for each assessment to provide a high level snapshot of the trustee's unique public trust lands, assets at risk, financial costs associated with sea level rise vulnerability, and proposed or completed adaptation measures (see Appendix D within Exhibit A).

## AB 691 SUMMARY REPORT:

The AB 691 summary report (Report), developed using funding from the Legislature, includes the following:

1) A synthesis of the submitted assessments to illustrate and understand common risks and adaptation approaches.

2) A summary of common challenges faced by trustees in complying with the AB 691 reporting requirements, including reporting on economic impacts to important coastal assets.
3) Recommendations to the State, Commission, and trustees for effectively supporting strategies to build asset resiliency to rising water levels and extreme weather events and safeguarding at-risk assets from future damage.

The Report contains the following sections: Methods, Summary of Reporting, Assessment Findings, and Recommendations, all of which are described below. The Report also contains appendices that provide more details on the financial reporting and cost estimates, the types of trustees subject to AB 691 (categorized as 'large ports,' 'small harbors/marinas,' 'small harbors/marinas with recreational amenities or natural assets,' and 'jurisdictions with recreational amenities'), and the two page summaries of each assessment. For additional and location-specific details, readers are encouraged to review the two page summaries and the full assessments to learn more about the unique characteristics of each granted lands area; the important public trust lands, resources, uses, and values vulnerable to sea level rise that are managed there; and the opportunities that exist to create more resilient shorelines. Commission staff recognizes that many trustees have continued to take steps to prioritize sea level rise preparedness planning in the years since submitting their AB 691 assessments and that the data included in their assessments, in many cases, have been updated or replaced based on additional work. Nonetheless, Commission staff believes that the information contained in the Report provides a useful platform from which to begin estimating collective risk, check assumptions, identify common challenges, and form the recommendations in the Report.

## METHODS:

This section of the Report briefly details the methods that the trustees' used to develop their assessments. Of particular note was the fact that each trustee used different methods to assess sea level rise vulnerability and create adaptation strategies based on the size, location, and type of public trust uses associated with the granted lands they managed. While some trustees submitted assessments that were created for other sea level rise planning efforts, like those used to prepare Local Coastal Programs[1], most created original assessments specific to the components outlined in the legislation.

The methods section also describes the approaches that the Commission team took in reviewing the assessments and creating the Report. The Commission team

[1] Local Coastal Programs are land use plans authorized by the California Coastal Commission in accordance with the California Coastal Act.

adjusted its approach over time in response to patterns that emerged while reviewing the assessments. The team shifted its focus from a compliance evaluation methodology to a synthesis and summary focused on recommendations for improving AB 691 implementation. Staff sought to identify the common vulnerabilities of public trust lands and resources and the challenges trustees encountered in assessing those vulnerabilities and developing adaptation strategies. The team drafted recommended solutions that respond directly to the results of the review and summary process and that may be applied by state and local partners for future efforts that seek to protect and adapt public trust lands and resources to sea level rise.

## SUMMARY OF REPORTING:

This section summarizes the assessments and the approaches trustees used to address the four required AB 691 components. This components include:

1. An assessment of the impacts and vulnerabilities to granted public trust lands from sea level rise (Identify Vulnerabilities).
2. Maps showing sea level rise projections in 2030, 2050, 2100, and flooding during a 100-year storm event (Map Projected Sea Level Rise Impacts).
3. An estimate of financial costs of sea level rise impacts on granted public trust lands, including revenue impacts due to lost use of land or facilities, cost to repair damage, and cost to prevent or mitigate damage (Estimate Financial Costs).
4. A description of adaptation strategies to protect, preserve, and restore natural and built assets, including how wetland restoration and habitat preservation would mitigate sea level rise impacts (Adaptation Plans).

The content of the assessments varied widely in scope and level of detail. The most prevalent challenges the trustees faced were the lack of available mapping and asset valuation data, financial resources, technical capacity, and clear guidance in the statute. There were multiple ways trustees could prepare their assessments because the criteria in the legislation was drafted in broad terms.

## ASSESSMENT FINDINGS:

*Component 1 Identify Vulnerabilities*

The most frequently identified vulnerable assets were those associated with vessel infrastructure that are critical to support commerce, navigation, and fishing. The large ports, which generate 90 percent of trustee revenues, identified numerous vulnerabilities that will require costly replacements and upgrades to continue supporting port operations into the future. These assets are essential not just to

California's economy and coastal communities, but to the national and global supply chain and economies. Smaller ports and harbors similiarily identified vessel infrastructure as among the most vulnerable assets. These assets are vital to local economies. Many trustees also identified critical infrastructure and linked transportation routes as vulnerable, as well as public access points, recreational spaces, and natural assets like beaches, wetlands, intertidal rocky habitat, and eelgrass beds. Nearly all trustees identified existing shoreline protective structures (typically hard armoring devices like seawalls, rock revetments, rip rap, etc.) as increasingly vulnerable over time as sea levels rise.

*Component 2 Map Projected Sea Level Rise Impacts*

Trustees used available granted lands mapping data to determine the extent of the area under their jurisdiction subject to the Public Trust and identify the public trust assets, resources, and uses within that area. They used sea level rise mapping tools to visualize scenarios for 2030, 2050, and 2100 of the coastal hazards associated with sea level rise, including the potential impacts of storms that result in extreme water levels, elevated wave run up, and coastal erosion. The trustees used various mapping tools, some more comprehensive than others.

*Component 3 Estimate Financial Costs*

The assessments revealed that, collectively, vulnerabilities to sea level rise could result in approximately $19 billion in damages and replacement costs by 2100, roughly ten times larger than the trustees' annual revenues ($1.9 billion). Large ports account for approximately $11 billion of the costs, and smaller marinas and harbors account for most of the remaining $8 billion. Sea level rise and the negative impacts of hard protective structures could also cause granted lands to lose at least $5 billion in value from natural resources by 2100, primarily to beach recreation and wildlife habitats, and the human-benefiting services they provide (sometimes called "ecosystem services"). In total, the potential losses to granted lands could surpass $24 billion in damaged assets and lost natural resources by 2100. When including lost revenues and the downstream impacts from commerce disruptions and other losses of Public Trust uses, the potential costs of sea level rise on granted lands could be orders of magnitude larger than these estimates.

*Component 4 Adaptation Plans*

AB 691 lacked robust requirements or guidance related to the development of adaptation plans. The legislation was enacted before other state sea level rise adaptation planning guidance such as the California Coastal Commission's first comprehensive Sea Level Rise Policy Guidance (first released in 2015, and updated several times since then), and the Ocean Protection Council's 2018 State Sea Level

Rise Policy Guidance. Trustees' generally proposed more short-term adaptation measures than those that could address potential sea level rise scenarios at the end of the century, and the measures often relied on some form of hard armoring that could protect an asset for a period of time while longer-term solutions were being planned.

**RECOMMENDATIONS:**

The intent of AB 691 was to understand the statewide impacts of sea level rise on public trust assets and resources and ensure that granted lands trustees have started long-term adaptation planning. While the submittal of the AB 691 assessments by trustees and preparation of the Report by Commission staff fulfilled those intentions to a degree, more can be done to develop a comprehensive picture of sea level rise vulnerability and chart a path forward for successfully adapting public trust lands to sea level rise. The Report includes recommendations for the State, Commission, and trustees to consider, organized in the following categories: identifying vulnerabilities, improving mapping, estimating costs, adaptation planning, and ensuring equitable adaptation. Newly created or improved guidance, additional resources, and new or revised policies are described that would further advance sea level rise planning and coastal resiliency and address many of the challenges that the trustees and Commission staff identified when developing the assessments and Report.

## OTHER PERTINENT INFORMATION:

1. This report is consistent with the "Leading Climate Activism", "Meeting Evolving Public Trust Needs", "Prioritizing Social, Economic, and Environmental Justice", and "Committing to Collaborative Leadership" Strategic Focus Areas of the Commission's 2021-2025 Strategic Plan.

## EXHIBIT:

A. AB 691 Report

## NEXT STEPS:

Although AB 691 is fundamentally a reporting and documentation statute, it also enshrines sea level rise planning as a management priority for local trustees. Recognizing the enormous implications of sea level rise on the State's economic and social future, AB 691 was also meant to spur trustees to examine the magnitude of the threat to their lands, assets, and operations, and ensure that

trustees take reasonable steps to protect public trust lands from sea level rise. By compiling and evaluating the information provided by trustees in their assessments, Commission staff identified certain trends and challenges common across the submittals and developed recommendations for future action.

The Report also serves as an important feedback mechanism for the various statewide sea level rise policies and guidance. By providing information on common challenges trustees encountered in completing their assessments and economic risk evaluations, the report can assist state agencies and policy makers in refining guidance or developing legislation to fill gaps, provide additional planning direction (e.g., economic valuation best management practices), and help the State prioritize or target funding assistance to the most vulnerable localities.

**Exhibit A**

# AB 691 Synthesis Report

## Proactively Planning for Sea Level Rise Impacts on Granted Public Trust Lands


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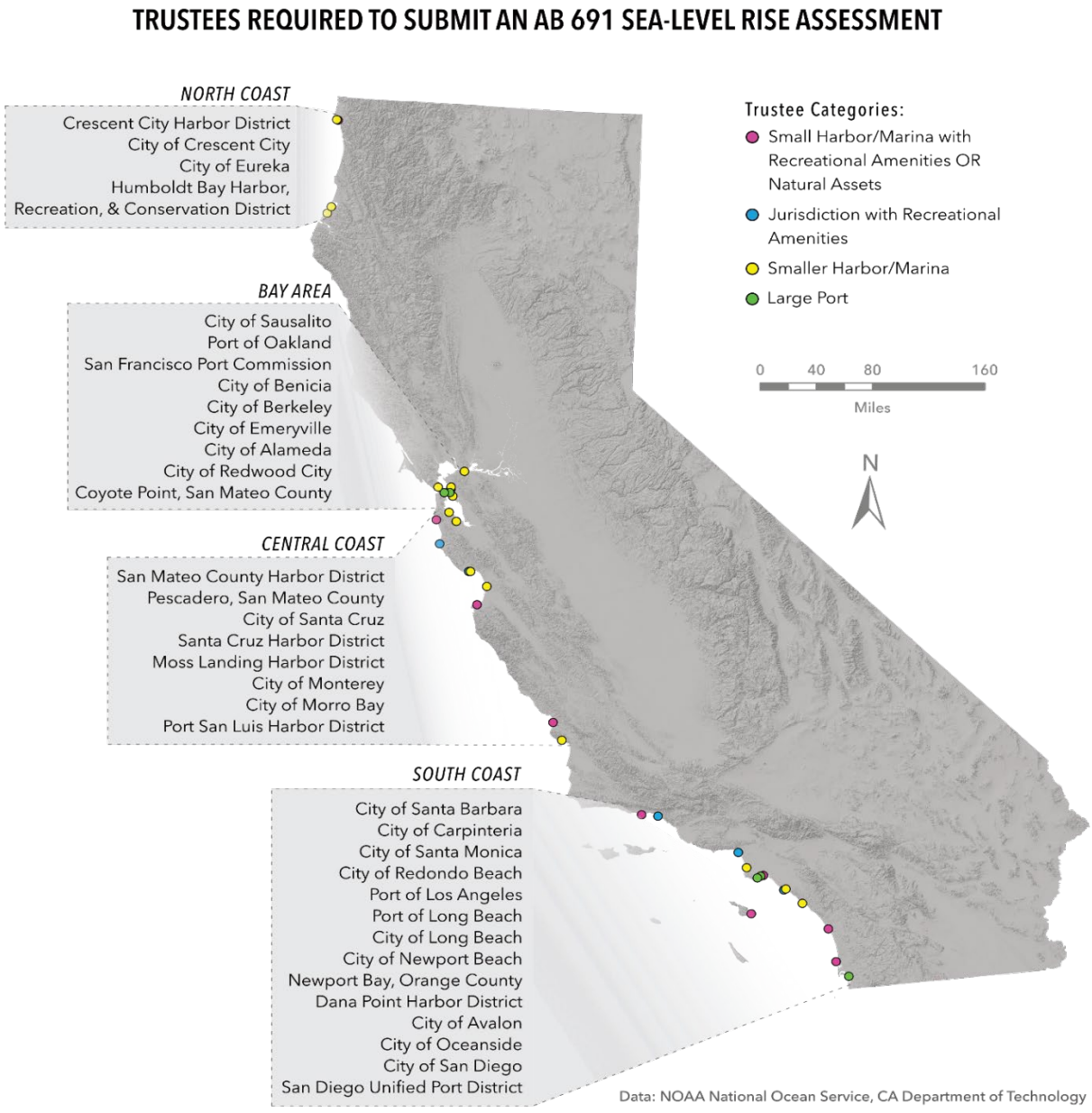
August 2022


CALIFORNIA STATE LANDS COMMISSION

integral consulting inc.




Cover Photo: Wave overtopping a coastal access point in Oceanside (Photo courtesy of the City of Oceanside)

# Executive Summary

California's state lands are at risk from sea level rise and will only exist for future generations to use and enjoy if actions are taken now to adapt. State lands along the coast encompass the tidelands and submerged lands out to the state/federal offshore boundary, approximately three miles from the shore. These lands are public, and in many areas are managed on behalf of the state by local trustees, like ports, harbor districts, cities, and counties. These lands support important and wide-ranging uses and purposes, including public access to the water, beach recreation and tourism, commercial shipping and the global movement of goods and services, and high market value commercial and sport fisheries. They are also home to complex and vital ecosystems, rich biodiversity, and hold deep cultural significance for both indigenous and non-native Californians. To preserve these valuable lands and their uses as sea levels rise, we need to know which assets and resources are in harm's way and begin planning for the changes to come. This report compiles information from local trustees of granted public trust lands, the entities that manage many of the state lands at risk, to learn what is at stake, what strategies and adaptation plans are being contemplated, and recommends ways the state can support the work of local trustees to ensure a collaborative approach is taken to reduce the risks and increase resiliency to the impacts of sea level rise.

This effort began with the passage of Assembly Bill 691 (AB 691; Chapter 592, Statutes of 2013), pioneering legislation that sought to address the risk and exposure to sea level rise at some of California's most valuable public trust lands. The legislation required trustees to make addressing sea level rise a management priority and required local trustees, where average granted land revenues are greater than $250,000 annually, to prepare and submit an assessment to the California State Lands Commission (Commission) on how the local trustee proposes to address sea level rise.

Sea level rise is one of the most consequential issues of our time, and a challenge unlike any we have ever known. Estimates developed for this report show that damages and replacement costs for vulnerable assets could top $19 billion by 2100, and natural resources and recreational amenities could lose over $5 billion in value. The Commission, having stewarded California's public lands and resources for over 80 years, is well positioned to partner with local trustees and others to lead adaptation efforts. It is our hope that this report illuminates what is at stake and what actions and steps are necessary to successfully adapt so that we can preserve essential infrastructure and maintain public access to California's beautiful coastline and many bays and waterways.

Since the passage of AB 691, the Commission has worked closely with the trustees by providing resources and guidance to address challenges they encountered while developing the assessments. After reviewing the completed assessments and reflecting on the course of their development, the Commission recognized opportunities for improvements in the State's and Commission's sea level rise policies and resources. The Commission also identified ways the trustees could improve their assessments and adaptation plans to better protect public trust lands. The Commission's team prepared a set of recommendations for the State, Commission, and trustees, which are summarized in Table 1. At the end of each recommendation, the target entities are identified by the letters corresponding to State **(S)**, Commission **(C)**, and trustee **(T)**.

*Table 1: AB 691 Recommended Actions*

| **Recommendations for Identifying Vulnerabilities** |
|---|
| 6.1.1 Establish standardized sea level rise vulnerability assessment guidance and reporting templates to make sea level rise reporting easier and more consistent. **S, C** |
| 6.1.2 Increase state support for research, resources, and tools for vulnerability assessments and adaptation planning. **S** |
| 6.1.3 Expand guidance and resources for assessing social vulnerabilities and protecting vulnerable frontline communities. **S, C, T** |
| 6.1.4 Use OPC's latest guidance for determining the most appropriate sea level rise projections based on the risk aversion and lifespan of assets. **C, T** |
| 6.1.5 Identify the risk exposure and importance of key assets that support public trust uses. **T** |
| 6.1.6 Assess the interconnected, interrelated vulnerabilities of local communities and critical infrastructures that granted lands and the public trust uses depend on. **S, C, T** |
| 6.1.7 Develop consistent financial accounting practices to gather and report data on public trust land, resource, and asset values so that economic valuation can be more readily integrated into sea level rise planning. **S, C, T** |
| **Recommendations for Mapping of Projected Sea Level Rise Impacts** |
| 6.2.1 Use mapping and modeling tools that assess all potential hazards and the combination of their effects. **C, T** |

| |
|---|
| 6.2.2 Complete mapping for all granted lands and identify areas landward of the current boundary where anticipated impacts from sea level rise will occur. **S, C, T** |
| 6.2.3 Consider the future movement of the boundary between public trust lands and private uplands and evaluate risks to resources and assets that will be exposed to increasing erosion and flooding as sea levels rise. **S, C, T** |
| **Recommendations for Estimates of Financial Costs** |
| 6.3.1 Provide explicit and consistent guidance for assessing financial costs. **S** |
| 6.3.2 Expand guidance and resources for assessing the financial and non-financial values of natural resources and their connection to social and public health sciences. **S, C** |
| **Recommendations for Adaptation Planning** |
| 6.4.1 Work together to align sea level rise planning and policies across the state. **S, C, T** |
| 6.4.2 Create sustained relationships with regional climate collaborative groups to facilitate coordination, share information, and leverage resources. **S, C, T** |
| 6.4.3 Provide funding to Trustees for vulnerability assessments, ongoing monitoring, asset repairs, adaptation planning, and implementation of adaptation projects. **S** |
| 6.4.4 Create a "no net loss" policy for beaches. **S** |
| 6.4.5 Support and encourage local, place-based planning and adaptation policies and projects that address local and regional conditions. **S, C** |
| 6.4.6 Proactively incentivize, support, and subsidize nature-based adaptation strategies, including conservation and restoration. **S, C, T** |
| 6.4.7 Prioritize the adaptation of Public Trust uses, resources, and values. **S, C, T** |
| 6.4.8 Create phased adaptation approaches for short-, mid-, and long-term strategies. **T** |
| 6.4.9 Consider managed retreat options for all vulnerable structures. **T** |
| 6.4.10 Implement monitoring programs and develop thresholds and triggers for the implementation of adaptation measures. **T** |
| 6.4.11 Prioritize nature-based adaptation strategies over hard shoreline armoring where appropriate. **S, C, T** |

| |
|---|
| 6.4.12 Develop strategies to address impacts of hard armoring on public trust lands and explore opportunities to transition to hybrid or nature-based shoreline protection when and where feasible. **S, C, T** |
| 6.4.13 Ensure sediment management practices evaluate beneficial reuse options based on cost-benefit analyses that include ecosystem service valuation, recreational value, and damage reduction benefits. **S, C, T** |
| 6.4.14 Leverage the 'Cutting Green Tape Initiative' to simplify permitting and funding for nature-based adaptation projects. **S, C, T** |
| 6.4.15 Support strategies that protect critical infrastructure, working waterfronts, and ports. Partner with local asset managers to implement the best alternatives to nature-based strategies when nature-based strategies are insufficient or cannot be implemented. Support employing multiple strategies if needed, including phased approaches to managed realignment or retreat, to safeguard assets critical to the public and their safety. **S, C** |
| 6.4.16 Codify periodic updates of revised and improved AB 691-like criteria to evaluate climate impacts to public trust lands. **S** |
| **Recommendations for Equity and Environmental Justice** |
| 6.5.1 Adopt an environmental justice policy that incorporates climate vulnerability. **T** |
| 6.5.2 Integrate and prioritize equity and social justice, including restorative justice for coastal tribes, in all sea level rise adaptation plans and projects. **S, C, T** |

# Table of Contents

## List of Figures and Tables

# 1.0 Purpose and Scope

California acquired all right, title, and interest in tide and submerged lands and beds of navigable waterways within its borders when it became a state in 1850. The California State Lands Commission (Commission), created in 1938, manages these lands and the public uses of them, pursuant to the common law Public Trust Doctrine. In many areas, however, the Legislature has enacted statutes that grant day-to-day management of public trust lands to local municipalities (referred to as trustees); those trustees administer leases and manage their granted public trust lands on behalf of the people of California. The terms and conditions of trust grants, and the permitted uses associated with those grants, vary widely.

The Commission received funding in the 2018 Budget Act (Mitchell; Chapter 29, Statutes of 2018) to work with local trustees to develop financing and implementation strategies for addressing the sea level rise vulnerabilities that the trustees identified in the assessment reports trustees were required to submit pursuant to AB 691. Subsequently, the Commission authorized staff to retain a consultant, Revell Coastal (now Integral Consulting), to, together with Commission staff, review the AB 691 submissions, prepare a statewide analysis, and provide recommendations for assisting trustees in safeguarding the legislatively granted public trust lands and assets under their management (C105, August 23, 2018).

In developing the scope and objectives of this report, Commission staff recognized that the State has an interest in understanding if the existing state guidance is helpful to the trustees tasked with implementing the guidance, and whether the trustees have identified any additional or different challenges or needs that the State should address that are not reflected in current guidance. This report explores these issues with a particular focus on whether existing programs, funding, laws, and State level guidance are effectively aligned with what the trustees say about their challenges and needs (i.e., a top-down and bottom-up analysis).

Organizationally and substantively, this report aims to meet the goals articulated by the Commission at its August 2018 meeting. Those goals include a synthesis of the trustees' AB 691 assessments followed by a set of recommendations to provide local and state decision makers with effective short- and long-term policy goals, strategies, and targeted assistance that is responsive to the trustees' real-world challenges. To meet these goals, this report provides the following:

1) A synthesis of the submitted AB 691 assessments to illustrate and understand common risks and adaptation approaches.
2) A summary of common challenges faced by trustees in responding to the AB 691 reporting requirements, including reporting on economic impacts to important coastal assets and resources.
3) Recommendations to the State, including the Legislature, Governor's Office, and agencies, for effectively supporting strategies to build resource and asset resiliency to rising water levels and extreme weather events and safeguarding at-risk assets from future damage.

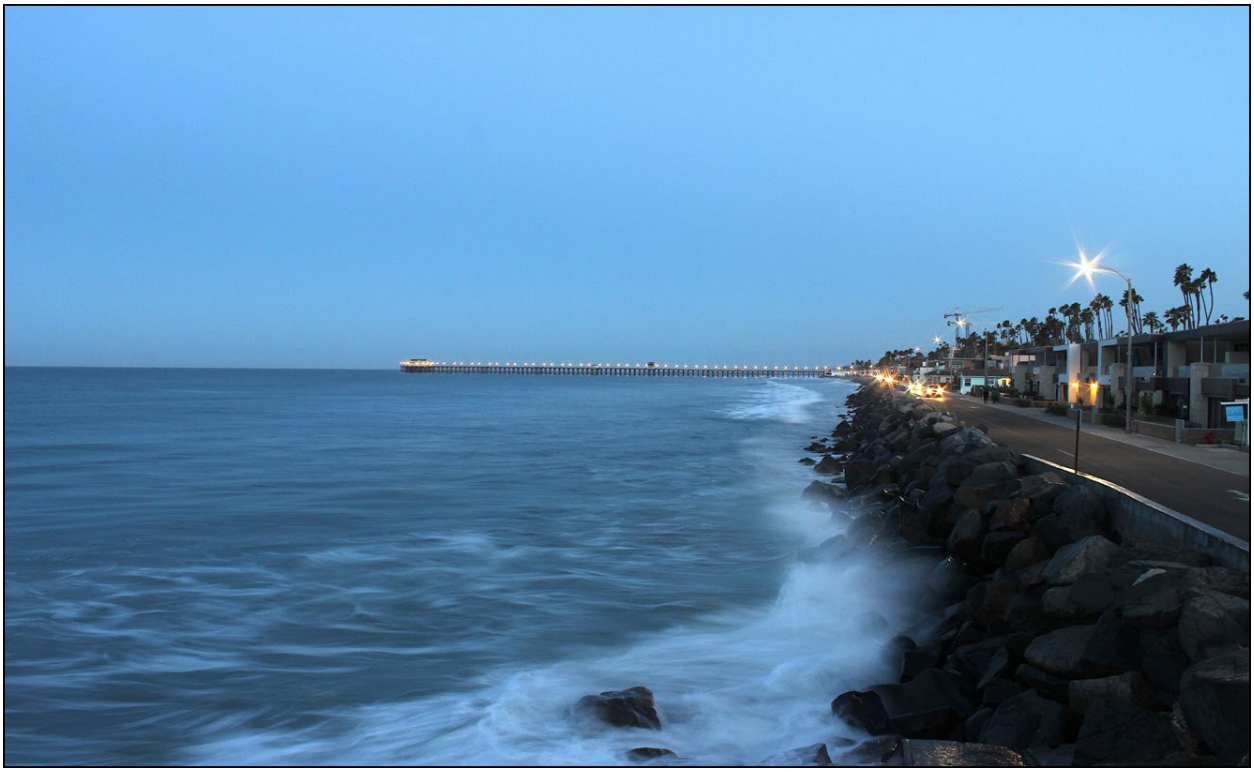


*Figure 1: Oceanside Pier (photo by Integral Consulting)*

## 2.0 Introduction

Sea level rise will be the most consequential impact of the climate change crisis to California's coast. Many of the state's critically important lands, resources, public uses, and assets are concentrated along the coast, specifically within the state lands granted to local trustees. A significant number of jobs and industries are also at risk from sea level rise. The state lands that have been granted to local trustees include the state's five major ports (San Francisco, Oakland,

Los Angeles, Long Beach, and San Diego). These ports account for nearly one million jobs in California, three million jobs nationwide, 40 percent of the nation's imports, and 30 percent of its exports[1]. California's ocean-based recreation and tourism industry, which contributes $26 billion to California's Gross Domestic Product and supports over 440,000 jobs, is also threatened as sea levels rise, causing flooding and erosion of beaches and public access points[2]. The state's invaluable and irreplaceable natural resources, including coastal habitats and wildlife, are also highly vulnerable to sea level rise as ranges shift or are squeezed between rising seas and coastal development. These natural resources provide numerous benefits to the state, including economic, cultural, and health benefits that provide a significant portion of the California identity and must be protected.

Careful planning for adaptation and coastal resiliency can better ensure public trust lands and their functions survive rising sea levels. The Commission and local trustees are working together to assess the vulnerabilities of state lands under the trustees' management and review trustees' action plans to mitigate the identified risks. These efforts are underpinned by state policy and the best available science, which direct planners and communities to consider a range of sea level rise scenarios and adaptation strategies. Statewide guidance is available, but more is needed to assist local trustees and stakeholders with planning, funding, and implementing solutions especially at the local levels with their unique circumstances – a one size fits all approach will not work. Due to the variety of public trust lands and uses managed by trustees and the Commission, different approaches will be needed to achieve resiliency in different areas. Localized strategies are also necessary to ensure the support and engagement of local communities that know these areas best and understand what will be needed to safeguard them.

This Section provides an overview and discussion of the current statewide approach to sea level rise and sources of sea level rise guidance, the role of the Commission in managing the state's public trust lands and coastline, the role of local trustees and their responsibilities under AB 691, a list of the trustees required to comply with AB 691, and finally, a preview of how the Commission, trustees, other agencies, and the Legislature might use this report to develop additional sea level rise guidance, policy, and legislation.

[1] https://californiaports.org/about-capa/
[2] https://coast.noaa.gov/states/fast-facts/tourism-and-recreation.html

## 2.1 Overview of California's Sea Level Rise Policies

Sea level rise policy in California is driven by data and science and relies on a precautionary approach to deal with the uncertainty of sea level rise projections. The building blocks for developing policies and actionable solutions were first described in California's first Climate Adaptation Strategy (CNRA, 2009). They can be summarized as:

- Gather data and invest in scientific analysis
- Use the science to assess vulnerability (to assets, lands, people, communities, wildlife, etc.)
- Create and implement solutions and strategies

The California Ocean Protection Council (OPC) is required to release and update the State of California Sea-Level Rise Guidance (Guidance), which provides recommendations for planning decisions at state and local levels. OPC issued Guidance documents in 2010, 2013, 2018 and will continue to update the Guidance every five years. In 2020, the California Natural Resources Agency (CNRA) led an inter-agency effort to develop a set of Sea Level Rise Principles to ensure state agencies are aligned in their approaches to sea level rise planning and policy setting. Various state agencies have also released similar strategy and guidance reports. These statewide reports do not mandate or regulate planning decisions, nor do they contain specific adaptation plans; however, they provide tools and frameworks that state and local governments should use in their planning processes.[3]

## 2.2 The California State Lands Commission

California became the owner of the State's tide and submerged lands and beds of navigable waterways within its borders when it became a state in 1850; the Commission manages these lands on the State's behalf. These "sovereign" lands have restrictions on their use. More specifically, the California Constitution, California law, and the common law Public Trust Doctrine prohibit the sale or alienation of sovereign lands except in limited circumstances.

The Commission consists of the State Controller, the Lieutenant Governor, and the Governor's Director of Finance, and all decisions are made at public meetings. The Commission protects and enhances these lands and natural resources by issuing leases for use or development, ensuring public access, and

[3] We note that many planning efforts and policies were initiated after the AB 691 assessment submission deadline in 2019. Please refer to the recommendations in Section 6 of this report for additional discussion about sea level rise planning and guidance alignment.

resolving boundaries between public and private lands. Through its actions, the Commission secures and safeguards the public's access rights to natural navigable waterways and the coastline and preserves irreplaceable natural habitats for wildlife, vegetation, and biological communities. While all sovereign lands are held in trust for the benefit of the people of California, the Commission only has direct authority over those sovereign lands that the Legislature has not granted to local jurisdictions. Tide and submerged lands granted by the Legislature to local jurisdictions remain subject to the Public Trust Doctrine and to state oversight through the Commission.

*Figure 2: Aptos Creek living shoreline project (photo by Integral Consulting)*

## 2.3 Legislative Grants of Public Trust Land and Assembly Bill 691

The Legislature has enacted over 300 statutes that grant public trust lands to over 80 local municipalities (referred to as grantees or trustees) to manage on the state's behalf for the people of California. The uses permitted in each granting statute vary. Some grants authorize the construction of ports, harbors,

airports, wharves, docks, piers, and other structures necessary to facilitate commerce and navigation. Other grants allow only visitor-serving recreational uses or open space. Revenues generated by a trustee from the use or operation of their granted lands are state trust assets and must be reinvested back into the granted lands.

While granted lands and their assets are managed locally, the Legislature delegated the state's oversight of the granted lands to the Commission. The Commission represents the statewide public interest to ensure that trustees operate their grants in compliance with their granting statutes, the California Constitution, and the Public Trust Doctrine.

Recognizing the threat that sea level rise poses to granted lands and the related management challenges trustees will face, the California State Legislature passed AB 691 (Muratsuchi; Chapter 592, Statutes of 2013) to plan proactively for sea level rise on granted lands. AB 691 required local trustees with granted lands revenues averaging over $250,000 annually, between 2009 and 2014, to develop and submit assessments to the Commission on how the trustee proposes to address sea level rise. AB 691 required the assessments to be submitted to the Commission by July 1, 2019, and required the Commission to publish the assessments on its website.

The assessments were required to contain the following components:

1) An assessment of the impacts and vulnerabilities to granted public trust lands from sea level rise (Identify Vulnerabilities).
2) Maps showing sea level rise projections in 2030, 2050, 2100, and flooding during a 100-year storm event (Map Projected Sea Level Rise Impacts).
3) An estimate of financial costs of sea level rise impacts on granted public trust lands, including revenue impacts due to lost use of land or facilities, cost to repair damage, and cost to prevent or mitigate damage (Estimate Financial Costs).
4) A description of adaptation strategies to protect, preserve, and restore natural and built assets, including how wetland restoration and habitat preservation would mitigate sea level rise impacts (Adaptation Plans).

## 2.4 AB 691 Trustees

AB 691 applied to 35 local trustees, 32 of which submitted assessments to the Commission. Three trustees subject to AB 691, marked with asterisks (**) in the list below, did not submit assessments due to constrained resources and capacity.

List of trustees required to submit an AB 691 Assessment:

**North Coast**

- Crescent City Harbor District
- City of Crescent City
- City of Eureka
- Humboldt Bay Harbor, Recreation, & Conservation District**

**South Coast**

- City of Santa Barbara
- City of Carpinteria
- City of Santa Monica
- City of Redondo Beach
- Port of Los Angeles
- Port of Long Beach
- City of Long Beach
- City of Newport Beach
- Newport Bay, Orange County
- Dana Point Harbor District
- City of Avalon
- City of Oceanside
- City of San Diego
- San Diego Unified Port District

**Bay Area**

- City of Sausalito**
- Port of Oakland
- San Francisco Port Commission
- City of Benicia
- City of Berkeley
- City of Emeryville
- City of Alameda
- City of Redwood City**

**Central Coast**

- San Mateo County Harbor District
- Pescadero, San Mateo County
- City of Santa Cruz
- Santa Cruz Harbor District
- Moss Landing Harbor District
- City of Monterey
- City of Morro Bay
- Port San Luis Harbor District

Since the trustees vary widely in their size, annual revenues, and uses of granted public trust lands, Commission staff organized the trustees into four categories for comparison purposes in this report. Refer to Appendix A for each category's definition, list of trustees, and trustee revenues.

*Table 2: Summary of Trustee Categories*

| Trustee Category | Number of Trustees | Average Annual Revenue, 2013-2019 |
|---|---|---|
| Small Harbor/Marina with Recreational Amenities or Natural Assets | 18 | $5.9 million |
| Small Harbor/Marina | 7 | $3.8 million |
| Jurisdiction with Recreational Amenities | 5 | $4.0 million |
| Large Port | 5 | $339.3 million |

### 2.5 Next Steps/Using this Report

AB 691 is fundamentally a reporting and documentation statute; but it also enshrines sea level rise planning as a management priority for local trustees. Recognizing the enormous implications of sea level rise on the state's economic, environmental, and social future, AB 691 was also meant to spur trustees to examine the magnitude of the threat to their lands, assets, and operations, and ensure that local trustees take reasonable steps to protect public trust lands from sea level rise. By compiling and evaluating the information provided by trustees in their assessments, Commission staff identified certain trends and challenges common across the submittals and developed the recommendations for future action presented in Section 6 of this report.

This report also serves as an important feedback mechanism for the various statewide sea level rise policies and guidance. By providing information on common challenges trustees encountered in completing their assessments and economic risk evaluations, the report can assist state agencies and policy makers in refining guidance or developing legislation to fill gaps, provide additional planning direction (e.g., economic valuation best management practices), and help the state prioritize or target funding assistance to the most vulnerable localities.

## 3.0 Methods

This section of the report is divided into two parts. First, a brief description of the various approaches taken by trustees to meet the AB 691 requirements is presented. Second, the evolution of the report over several years is described, including the need for adjustments and refinement as staff evaluated the contents of the various trustee assessments and discovered that individual trustees approached their assessments in very different ways.

### 3.1 Assessment Preparation Methodologies (trustees)

The trustees used multiple approaches to prepare their assessments. Most trustees (74 percent) submitted assessments that were prepared specifically for AB 691, either prepared by outside consultants or in-house staff. Of those that submitted AB 691-specific assessments, 75 percent hired outside consultants, and 25 percent used in-house staff.

The legislation also allowed trustees to repurpose reports that were previously prepared for other purposes, such as climate action plans or local coastal program updates if they met AB 691's criteria. Six trustees (17 percent) chose that option.

Three trustees (nine percent) – the City of Redwood City, the City of Sausalito, and the Humboldt Bay Harbor, Recreation, and Conservation District – failed to comply and did not submit an assessment. Commission staff made multiple outreach efforts and offers of assistance, but ultimately the trustees could not overcome the constraints of limited resources and capacity.

## 3.2 Report Development Process (Commission staff)

Before the 2019 assessment due date, Commission staff engaged in outreach with trustees and provided resources and guidance that could assist them with developing their assessments. These efforts included creating a webpage with guidance documents and example assessments, conducting webinars, and hosting a question/answer forum and sharing information.

In 2019, Commission staff and its consultant firm, Revell Coastal (now Integral Consulting), started to review submitted assessments. The initial approach was to develop a report card that identified how well each trustee satisfied the required components and note opportunities for improvement. After reviewing the assessments, however, the team realized that a report card would not be the best evaluation method due to a lack of consistency among the various assessments, making it difficult to directly compare them. Instead, the Commission's team determined that a better course of action would be to focus on the information the trustees could provide and be responsive to the needs and challenges the trustees identified while preparing their assessments. This process allowed Commission staff to more readily develop recommendations for ways the State, Commission, and trustees can contribute to an improved process for assessing sea level rise risks to public trust resources and identifying the best site-specific adaptation strategies.

Commission staff also created two-page summaries of each assessment (Appendix D), making it easier to view a "snapshot" version of a particular assessment and compare their reported risks and adaptation strategies. The summaries are intended to be companions to the assessments and should not be thought of as representative of the more extensive and nuanced information in the full assessments.

Lastly, Commission staff conducted periodic outreach and check-ins with other state agencies and the Legislature to stay informed about efforts that were taking place concurrently with the development of this report. One important state level companion effort was undertaken by the Legislative Analyst's Office (LAO), which was seeking to describe various threats posed by rising seas and the consequences to public and private property, the economy, and the State's natural resources to make the case for state prioritization of, and

immediate action on, sea level rise planning and adaptation. Throughout the fall of 2019, Commission and LAO staffs communicated about the initial trends and challenges Commission staff was encountering and on the specific areas the LAO intended to focus on for its own report. Generally, Commission and LAO staffs agreed that understanding and explaining the dire consequences of sea level rise on both California's economic centers, e.g., ports and business hubs, and its physical coastline, were critical, as was the need for the State to prioritize sea level rise preparedness actions sooner rather than later.

On February 28, 2020, both LAO and Commission staffs briefed the Commission about these complementary projects (Staff Report 58 [video presentation] and Staff Report 59, February 28, 2020). Subsequently, the LAO published a report in August 2020 titled *What Threat Does Sea Level Rise Pose to California?*[4] The LAO report's conclusions are well aligned with this report, and Commission staff believes that the recommendations at the end of this report fit well with and expand on those conclusions, namely: that careful preparation and implementation of adaptation activities can help lessen sea level rise impacts; that many near-term preparation and adaptation activities, including support for regional collaboratives and cross-jurisdictional collaboration, can be effective at reasonable cost-scales; and that the State is a critical partner and convenor, particularly with respect to information sharing, public awareness, funding support, and legislation.

## 4.0 Summary of Reporting

This section summarizes the assessments and the approaches trustees used to address the four required AB 691 components listed in Section 2.3 above. Due to the components being broad in scope with multiple acceptable ways the trustees could prepare their assessments, the content of the assessments varied widely in scope and level of detail. Some trustees only considered threats from coastal flooding, whereas others considered a comprehensive range of hazards driven by sea level rise, such as erosion, higher wave flooding, and higher tides. Some trustees only assessed the impacts to infrastructure assets, while others included social and ecological impacts. The assessments also differed in how they estimated financial costs and damages, especially with respect to the valuations of losses to natural resources.

[4] https://lao.ca.gov/reports/2020/4261/sea-level-rise-081020.pdf

*Figure 3: Monterey Bay (photo by Integral Consulting)*

## 4.1 – Summary of approaches used by trustees

### Component #1: Identifying Vulnerabilities

Component 1 of AB 691 focuses on identifying the vulnerabilities of public trust resources to sea level rise impacts. To satisfy this component, trustees had to identify hazards exacerbated by sea level rise, like flooding and erosion, and identify the built and natural assets within their purview that are vulnerable to those hazards.

All trustees reported their vulnerable built assets, such as port infrastructure, harbor facilities, and restrooms. These assets could suffer structural damage by coastal hazards accelerated by sea level rise and critically impair public trust uses of the granted lands. The vulnerabilities of critical infrastructure, such as water or wastewater treatment facilities and other utility infrastructure, could also negatively affect public safety and interests beyond the geographic boundaries of the granted lands.

Most trustees (78 percent) considered the vulnerability of natural assets to some degree, primarily the vulnerability of beaches. Flooding and erosion of beaches and other coastal habitats can lead to the loss of public beach access, recreational opportunities, and ecosystems. Coastal habitats, like beaches and wetlands, can also protect inland areas from sea level rise impacts, and those protection benefits are also at risk. The negative impacts of sea level rise are often exacerbated by seawalls and other shoreline protective structures that can increase erosion and cause the loss of natural resources as they are squeezed between a fixed shoreline position (e.g., seawall) and rising sea levels. Despite Component 1 specifically requesting the consideration of natural assets, 22 percent of the trustees omitted consideration of natural assets in their assessments.

Component 1 also directed trustees to consider the impacts of sea level rise to public trust values, including but not limited to public access, commerce, and recreation. Public trust values could also include social equity, local jobs, public safety, and other social impacts that could be affected by sea level rise on public trust lands. While the assessment requirement was vague about this last request, 25 percent of the assessments included some social impacts in their vulnerability analyses, recognizing that the communities that use, enjoy, or depend on these lands for their livelihoods will be heavily impacted by sea level rise.

### Component #2: Mapping of Projected Sea Level Rise Impacts

Component 2 of AB 691 asked trustees to visualize the effects of sea level rise on their granted lands in the years 2030, 2050, and 2100, and include the potential impacts of 100-year storm events.

AB 691 permitted the use of online mapping tools if the trustees did not have in-house resources to create original maps. Mapping tools, often referred to as "sea level rise viewers," are available online from various government and research organizations. The mapping tools are often differentiated by the models and data sources they rely upon and can depict a range of impacts from sea level rise. The simplest models only consider the projected sea levels and the elevations below projected sea levels are considered at risk of flooding. Other models incorporate the effects of wave energy, particularly during storms and extreme high tides, and how that energy can allow ocean water to flood areas further inland and at higher elevations than the sea level. The most complex models also factor in potential erosion and shoreline features, in addition to the projected ocean elevations and wave energy. The effects of

sea level rise can be cumulative and threaten locations that a mapping tool might consider safe if only one or two of the effects are considered.

Twenty-five percent of the assessments used tools that considered only flooding from sea level rise, 41 percent considered flooding and storm impacts, and 34 percent used more complex models that considered flooding, erosion, storms, and other hazards, as well as shoreline features.

*Table 3: Comparison of Common Mapping Tools*

| Mapping Tools & Models | Description | Sea Level Rise Impacts & Coastal Hazards Considered |
|---|---|---|
| NOAA Sea Level Rise Viewer | Developed by NOAA, this model depicts water depths after accounting for 1 to 10 feet of sea level rise and the average of the highest high tides. | Rising Sea Levels<br>High Tides |
| Pacific Institute | This model, funded by OPC, depicts areas in Northern California at-risk of flooding and erosion from 1.4 meters of sea level rise and a 100-year storm event. | Rising Sea Levels<br>Storm Flooding<br>Coastal Erosion |
| Adapting to Rising Tides: Bay Shoreline Flood Explorer | Developed for the San Francisco Bay Conservation and Development Commission (BCDC), this tool depicts flood risks within the San Francisco Bay by modelling the combination of sea level rise with high tides or storm surges. The model uses detailed elevation information of the existing shoreline protections and identifies where the | Rising Sea Levels<br>High Tides<br>Wave Run-up<br>Storm Surges |

| Mapping Tools & Models | Description | Sea Level Rise Impacts & Coastal Hazards Considered |
|---|---|---|
| | protections are at-risk of overtopping. | |
| Coastal Resilience | Funded by The Nature Conservancy, this tool depicts the location of flood hazards when accounting for sea level rise and either storm flooding, high tides, or coastal erosion. The tool is part of a suite of tools that can also estimate social, economic, and habitat vulnerabilities, and the effects of potential interventions. | Rising Sea Levels<br>High Tides<br>Wave Run-up<br>Storm Flooding<br>Coastal Erosion<br>Social, Economic, Habitat Vulnerabilities |
| USGS CoSMoS | Created by the US Geological Service (USGS), this model projects storm-induced coastal flooding and erosion for current and future sea levels. It uses state-of-the-art climate modelling data to provide local projections at high resolutions. | Rising Sea Levels<br>High Tides<br>Wave Run-up<br>Storm Flooding<br>Coastal Erosion |

### Component #3: Estimates of Financial Costs

Component 3 of AB 691 asks for an estimate of financial costs that sea level rise could cause. The estimates were to include:

- Repair and replacement costs for damaged assets
- Anticipated costs of adaptation and mitigation measures, and potential financial benefits of such measures
- Valuation of lost use of land and assets (i.e., loss of revenue)

- Non-market valuation of public trust resources, including ecosystem services and recreation
- Anticipated costs of adaptation and mitigation measures, and potential financial benefits of such measures

This financial cost component is where the trustees' methods and scope of analyses varied the most.

*Figure 4: Signs of corrosion and cracking on the Monterey Bay Inn Seawall (City of Monterey)*

### *Repair & Replacement Costs*

The trustees analyzed their potential costs for repairing and replacing damaged assets by inventorying the assets they identified as vulnerable to the impacts of sea level rise. These analyses focused on built assets, like piers, wharves, and other facilities. The inclusion of supporting infrastructure, such as utilities and transportation infrastructure, was sporadic because the trustees might not have direct responsibility for those assets (e.g. water supply, electrical grid), and the legislation lacked clear guidance on whether they should be included.

Most trustees (89 percent) provided information on the potential costs of damages to their existing assets. However, only 34 percent of the trustees estimated the costs associated with maintaining or replacing assets in the future due to rising sea levels.

### *Adaptation Costs*

Component 3 also asked trustees to consider the anticipated costs of adaptation measures and the potential financial benefits of such measures. Unlike costs for repairs, these would include costs for proactive measures that prevent or mitigate damages. Ideally, these costs correspond to the trustees' adaptation plans outlined for Component 4. However, this element of the AB 691 requirements proved challenging, with less than half (43 percent) of the trustees providing estimates of adaptation costs. The reported costs varied significantly in how the trustees reported them and what costs were considered.

Some trustees provided broad ranges, whereas others provided qualitative cost ratings (i.e., low, medium, high cost). A few trustees provided adaptation costs that were calculated for Local Coastal Plans and included adaptation measures for areas outside the geographic boundaries of their granted land. Additionally, some trustees only considered their repair and replacement costs of existing infrastructure to be their costs for future adaptation.

### *Loss of Revenue*

Another potential cost is the loss of revenues from the impacts of sea level rise on revenue-generating operations and assets. These costs could include lost retail lease revenues, parking revenues, slip fees, transient occupancy taxes, and more. Although AB 691 did not explicitly require trustees to estimate their potential revenue loss, four of the trustees did report their potential revenue losses. This includes the City of Monterey, which derives substantial revenues from tourism. Monterey's estimates included lost revenues from hotel accommodations and retail sales at Fisherman's Wharf. Any closure of Monterey's Fisherman's Wharf would have consequences not only to the trustee's jurisdiction but to the entire City of Monterey through loss of commerce, sales tax revenues, and transient occupancy taxes from overnight visitors.

### *Non-Market Valuation of Natural Resources*

It can be difficult to quantify the value of State-owned natural resources on granted lands, such as beaches, that are used heavily by the public for recreation and enjoyment. One approach is to estimate non-market valuations, which represent the financial value of the ways natural resources are enjoyed, consumed, or benefit human well-being.

Non-market valuations can include the value humans derive from directly using or interacting with natural resources, such as through recreational activities, the consumption of water, and health benefits from breathing clean air. Non-market valuations can also include the valuable benefits natural resources provide by simply existing, including erosion control, flood protection, carbon sequestration, and air and water purification.

Monetary values can be assigned to these services by considering their contribution to local economies, the societal costs that are avoided (i.e., avoided flood damages), or the cost consumers are willing to pay for the use of the natural resources. Despite this being a difficult task, almost half of the trustees attempted to estimate non-market values of natural resources at risk. The most common natural resources to be valued were beaches, which provide enormous value to California's economy and culture.

The loss in non-market value provided by natural resources will be a significant consequence of sea level rise. The trustees that reported non-market valuations estimated a loss of $184 million by 2030, $531 million by 2050, and $1.3 billion by 2100. Considering over half of the trustees did not report non-market valuations, these reported losses are significantly underreported.

Refer to Appendix B for a complete list of each trustee's reported losses in non-market value.

*Figure 5: Kelp forest providing recreational diving opportunities offshore of the City of Avalon. (City of Avalon)*

### Component #4: Adaptation Plans

Component 4 of AB 691 required trustees to describe tangible adaptation approaches to address identified vulnerabilities to public trust resources. The trustees' submissions included multiple factors for their approaches, including adaptation strategies, the timing of impacts and action, specific locations, and the types of coastal hazards to prepare for.

### *Adaptation Strategies*

Many trustees acknowledged the four main categories of sea level rise adaptation strategies: no action, accommodation, protection, and retreat.

Within the 'protection' category, recent statewide policies have recommended prioritizing nature-based solutions[5] over hard armoring (e.g., seawalls, revetments, bulkheads, groins). Nature-based solutions include construction of living shorelines (e.g., oyster reefs), restoration of wetlands, marshes, and dunes, and other coastal projects that create or mimic more natural systems while also providing a protective benefit against wave action and flooding. However, only 22 percent of the trustees considered nature-based solutions, and 100 percent discussed plans for hard armoring. While hard armoring is not usually the best long-term practice, many granted lands are located in dense, highly built areas where relocation is not possible due to due to the types of services provided by the trustees as well as a lack of open space to move to. These areas are already heavily engineered with hard armoring intended to protect important public trust consistent uses, including port and other maritime commerce infrastructure, boating and fishing facilities, visitor-serving and tourism amenities. Trustees plan to continue to depend on these solutions to maintain commerce, navigation, and other public trust uses. Trustees that are less reliant on built assets and more on natural resources, such as beaches, can and should prioritize nature-based solutions.

Nearly all small ports and marinas with floating docks identified 'accommodation' strategies, such as raising guide piles, as necessary to prepare for future increases in sea levels.

[5] For more information on Governor Newsom's Executive Order N-82-20 and the California Natural Resources Agency's efforts to promote nature-based solutions, visit: https://resources.ca.gov/Initiatives/Expanding-Nature-Based-Solutions

**Natural**

Conservation, restoration, or creation of natural habitats

(Photo of dune restoration, Ventura. Credit: Paul Jenkin)

**Hybrid**

Combination of natural habitats and hard armoring materials

(Photo of a "living" levee, Hamilton Bay. Credit: Damien Kunz)

**Hard Armoring**

Construction of hard, engineered structures

(Photo of riprap along Hwy 101, Ventura. Credit: David Powdrell)

*Figure 6: Shoreline Protection Strategies*

More than half of the trustees (56 percent) ultimately recognized that a managed retreat strategy is inevitable. Many of the plans for retreat were hybrid strategies that would use nature-based solutions to mitigate the short-term risks and buy time until managed retreat strategies could be implemented to address the long-term risks.

### *Timing*

Some trustees took the next step and estimated implementation timeframes, as requested by the criteria. The timelines, however, were often based on the years listed in sea level rise projections. This approach can be risky since sea level rise projections are uncertain and can change. Timelines for action should be based on on-site monitoring programs and specific thresholds that trigger proactive measures, allowing for ample time for implementation.

### *Location and Hazard Type*

Lastly, some trustees focused their planning on site-specific hazards and chose different strategies based on the types of hazards each location faces. This approach rightfully recognizes that the impacts of sea level rise are wide-

ranging and using multiple strategies is key to preparing for multiple hazards. However, this approach must be paired with a broader strategy to ensure some consistency among locations, so vulnerabilities do not exist at the borders of the individual locations.

Figure 6 provides a visual summary of the types of approaches and considerations the trustees used when meeting the requirements of Component #4.

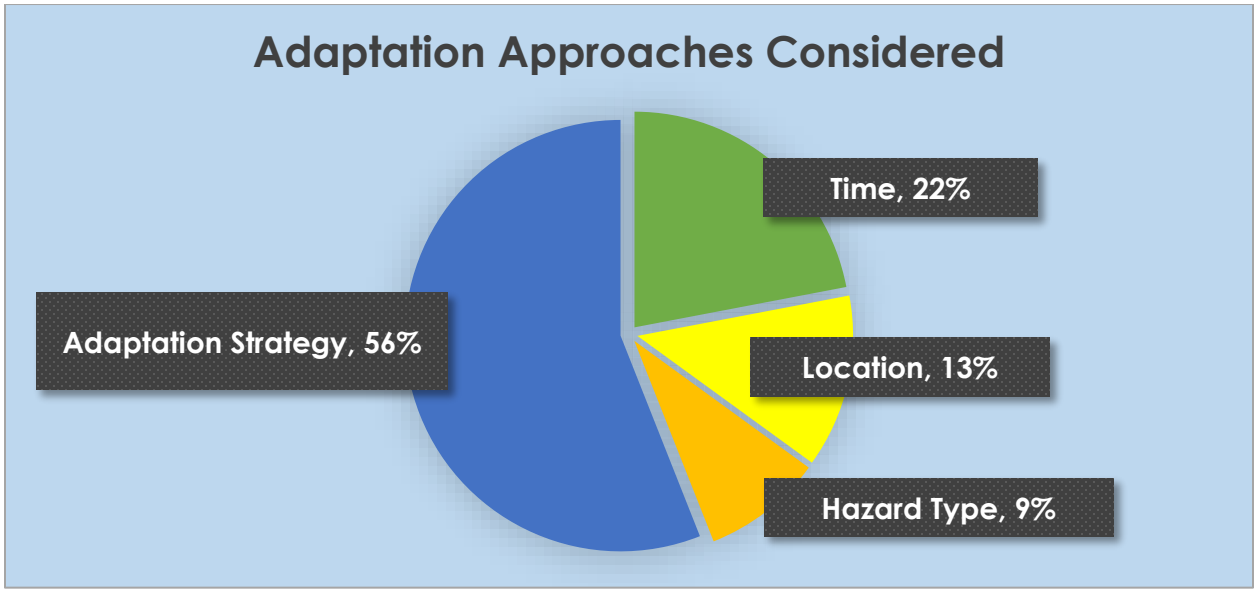



*Figure 7: Adaptation approaches considered by adaptation strategy, time, location, or hazard type*

## 4.2 – Challenges identified during Commission staff review of trustee assessments

After its initial review, Commission staff and the consultant team recognized that the disparities in the assessments reflected challenges faced by the trustees while attempting to fulfill AB 691's requirements. Many trustees struggled to address the requirements due to a lack of available data, financial resources, technical capacity, and clear guidance in the statute. As a result, Commission staff also faced challenges while reviewing the assessments due to their inconsistencies, misunderstandings of AB 691 requirements, and, in some cases, omissions of critical details. This section elaborates on the challenges trustees experienced during their assessment preparation and by the Commission's team while summarizing the individual assessments into a statewide report.

### Component #1: Identifying Vulnerabilities

This component asked the trustees to inventory their assets that are vulnerable to the sea level rise impacts. However, many trustees struggled with determining which assets are located within the boundaries of their grant and should be included in their assessments. Determining the location of future boundaries, which are changing due to sea level rise, makes this task even more difficult. Sea level rise is causing boundaries to shift landward, subjecting new land, natural resources, and assets to the Public Trust. As this occurs, trustees must be prepared to manage and protect these new areas from the effects of sea level rise, and ensure the assets and their uses are consistent with the Public Trust.

Because of the difficulties in determining present-day and future boundaries, the trustees excluded many vulnerable assets that should have been evaluated in their assessments. These omissions from their vulnerability assessment can significantly affect how risks are prioritized and what adaptation or protection strategies should be employed.

Another challenge related to Component 1 was the lack of spatial data and other resources to help trustees identify their natural resources. These resources are not well documented in state or public data sets. As a result, natural resources were the most common public trust assets to be excluded from the assessments. Knowing the natural resources' location, composition, and health is vital to protecting them and leveraging their multitude of benefits.

Both challenges, and associated omissions in the submitted assessments, constrained Commission staff's ability to accurately assess the statewide vulnerabilities of granted lands. Because of these challenges, trustees need more precise and comprehensive guidance on what assets, resources, and boundaries to include in their assessments and resources to accurately inventory all natural and built assets within current and future boundaries.

### Component #2: Mapping of Projected Sea Level Rise Impacts

The biggest challenge to mapping the impacts of sea level rise on public trust lands was delineating or estimating the future location of granted lands boundaries, which are changing due to sea level rise.[6] If the trustees are unsure of their future boundaries, they cannot adequately identify all risks or prepare comprehensive adaptation plans. The AB 691 legislation failed to anticipate the challenges associated with changes to public trust boundaries. As a result, there is no clear guidance on how to account for changing boundaries. Less than half

[6] For more information about the concept of the "ambulatory boundary" please visit: https://www.slc.ca.gov/water-boundaries/

of the trustees anticipated future boundary changes in their mapping of sea level rise impacts.

The trustees and Commission staff also faced challenges related to the mapping tools that were used and the lack of pertinent guidance in AB 691. The trustees used a wide variety of publicly available tools, but the tools varied in detail, complexity, and accuracy. Many of the maps submitted to the Commission were insufficient to properly understand the potential impacts of sea level rise. To ensure consistency between the trustee's maps, guidance should be provided on preferred tools, scales, hazards, and details that the maps must include.

### Component #3: Estimates of Financial Costs

Trustees experienced multiple challenges in estimating the financial costs of sea level rise impacts. As with components 1 and 2, expected future changes in public trust boundaries have significant financial implications. An accurate assessment of the financial costs must consider future boundaries and the assets that will be contained within those boundaries. However, most trustees did not attempt to account for future boundaries in their financial cost estimates. Similarly, some trustees had difficulty allocating costs for assets located on top of boundaries and partially on private property.

Without clear directions about what should and should not be included in their assessments, the trustees were unsure if supporting infrastructure that they rely on, like utilities and transportation infrastructure, should be included. Damages to supporting infrastructure could financially impact the trustees even if the infrastructure is mostly located outside of granted lands boundaries or if the trustees are not responsible for managing it.

Concerns about reporting proprietary financial data were another challenge that impaired the accuracy of the trustee's cost estimates. Many trustees and private owners of assets within granted lands refused to disclose asset valuations and revenues. This issue was common for the large ports, which contain some of the most valuable assets and highest revenue-generating operations on or near the coast. The underreporting of these assets and revenues (potentially off by billions of dollars) has resulted in an incomplete understanding of sea level rise's future costs.

Figuring out how to estimate the non-market valuation of natural resources was also very difficult for trustees. Most trustees lacked specific guidance on the valuation methods they should use and the scope of natural resources, ecosystem services, and human benefits they should include in the analysis. As a

result, few trustees attempted to perform non-market valuations, and those that did often omitted many valuable resources and public health benefits.

Overall, the trustees used many different approaches and methodologies in their financial cost estimates, making it difficult to compare their individual estimates and sum the estimated statewide costs of sea level rise impacts to granted lands. No standard template or guidance was issued with this component, resulting in incongruent data and the Commission's inability to thoroughly assess the statewide cost impacts to granted lands.

*Figure 8: Oceanside Pier (photo by Integral Consulting)*

### Component #4: Adaptation Plans

Most of the trustees' submissions did not include detailed proposals for their adaptation plans, likely due to a lack of resources, guidance, and actual physical space to accommodate the necessary future actions (e.g., retreat strategies).

The trustees often described their existing efforts for maintaining and repairing their aging protective infrastructure and then broadly described other alternative strategies. Most statewide guidance focuses on shifting away from protective structures toward nature-based solutions because that is the best long-term strategy for most locations. However, many trustees are already

heavily invested in protective infrastructure, and their public trust uses (i.e., international commerce) can seem incompatible with the nature-based solutions that are often recommended. Heavily engineered locations, like ports, could benefit from more guidance on implementing and financing nature-based solutions, and how to integrate them with the hard protective infrastructure that will still be required.

Most trustees will need more inland space to implement their adaptation plans, including relocating facilities and other assets further inland to protect them against sea level rise. Many nature-based solutions, such as horizontal levees and dune restorations, will also require inland space. However, many of the inland areas surrounding granted lands are currently privately owned. The legal and financial uncertainties of the trustees' use of inland areas must be addressed for the trustees to begin planning accordingly.

# 5.0 Assessment Findings

Despite the challenges faced by the trustees during their assessment preparation and by the Commission's team during its review process, the Commission's team was able to grasp the critical vulnerabilities and magnitude of financial impacts from sea level rise to granted lands, as well as identify gaps in the trustees' adaptation plans. However, the Commission's findings should not be viewed as a complete understanding of sea level rise impacts to granted public trust lands due to the discrepancies and deficiencies in the assessments.

## 5.1 – Component #1: Vulnerabilities

The most identified vulnerable assets are those associated with vessel infrastructure that are critical to support commerce, navigation, and fishing. The large ports, which generate 90 percent of the trustee revenues, identified numerous vulnerabilities that will require costly replacements and upgrades to continue supporting port operations into the future. With the economic importance of California's large ports, their sea level rise vulnerabilities can also endanger state and national supply chains and lead to crippling economic consequences if port operations are constricted or shut down.

Smaller harbors, such as those in Crescent City and Eureka, also share similar vulnerabilities to their vessel infrastructure. While these locations play a minor role in the state and national economy, the potential economic consequences will be felt acutely in their local regions. Small harbors serve a vital role in their local economies, yet they lack the financial resources to maintain their current infrastructure, and funding adaptation strategies in the future will be even more challenging.

The second most identified vulnerable assets were the miles of engineered protective structures, including seawalls, bulkheads, and breakwaters. Some of these protective structures are essential for protecting the trustees' public trust uses, assets, and supporting infrastructure. Unfortunately, these structures will provide less protection as sea levels rise and they degrade from exposure to wave energy and corrosive salt water. The costs of perpetual maintenance and upgrades raise questions about the long-term feasibility of the structures. The trustees should assess each structure to determine if they are vital to protect public trust interests or if other adaptation measures are more appropriate.

Among natural resources, beaches were the most frequently identified as vulnerable to sea level rise. This is likely skewed by the insufficient assessment of other natural resources, such as kelp forests, rocky intertidal zones, and surf breaks. From other state reports [7,8] and the scientific literature [9,10], it is well known that these natural resources are also highly vulnerable to sea level rise. The future of beaches and other coastal resources will depend on the trustee's adaptation approaches. The current approaches, largely dependent on hard armoring, are already harming many coastal and marine resources. Maintaining the status quo can cause these resources to diminish further or disappear entirely. Using nature-based adaptation approaches can mitigate and potentially reverse those damages while helping protect surrounding areas from the impacts of sea level rise.

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[7] *2009 California Climate Adaptation Strategy*. (2009) California Natural Resources Agency. https://resources.ca.gov/CNRALegacyFiles/docs/climate/Statewide_Adaptation_Strategy.pdf

[8] Petek, Gabriel. *What Threat Does Sea-Level Rise Pose to California?*. (2020). California Legislative Analyst's Office. https://lao.ca.gov/reports/2020/4261/sea-level-rise-081020.pdf

[9] Cayan, D.B., P.D. Bromirski, K. Hayhoe, M. Tyree, M.D. Dettinger, R.E. Flick. (2008). Climate change projections of sea level extremes along the California coast. Climatic Change 87(Suppl. 1): 57-74

[10] Barnard, P.L., Dugan, J.E., Page, H.M. *et al.* Multiple climate change-driven tipping points for coastal systems. *Sci Rep* **11,** 15560 (2021). https://doi.org/10.1038/s41598-021-94942-7

*Figure 9: Wave overtopping a breakwater at Dana Point Harbor, April 2007. (Dana Point Harbor)*

## 5.2 – Component #2: Mapping

To the extent they were able, given the challenges described in the preceding section, trustees used available granted lands mapping data to determine the extent of the area under their jurisdiction subject to the Public Trust and identify the public trust assets, resources, and uses within that area. They used sea level rise mapping tools to visualize the coastal hazards associated with sea level rise, including the potential impacts of storms that result in extreme water levels, elevated wave run up, and coastal erosion. The sea level rise mapping tools were used to look at future sea level rise scenarios at specific time intervals – 2030, 2050, and 2100 – per the legislation. These changes affect the location of the mean high water ambulatory boundary between public trust lands and upland property and put infrastructure and public trust uses at risk. The mapping that the trustees conducted was essential to understanding the existing and potential future vulnerabilities from coastal hazards and preparing for sea level rise.

## 5.3 – Component #3: Financial Costs

Although the financial cost estimates were often incomplete in the trustee's assessments, the Consultant's team made adjustments to the reported data including using data from comparable trustees to estimate some of the missing costs, revenue reports, and aggregated costs for all trustees. These revised aggregate cost estimates were calculated for both the damages and replacement costs of built assets and the losses of natural resources. These estimates are broad approximations and should only be used to understand the magnitude of potential financial implications due to sea level rise.

According to the Consultant's estimates, the trustees' cumulative vulnerabilities to sea level rise could result in approximately $19 billion in damages and replacement costs by 2100, roughly ten times larger than the trustees' annual revenues ($1.9 billion). Large ports account for approximately $11 billion of the costs, and smaller marinas and harbors account for most of the remaining $8 billion. The costs burdens are not proportional to trustees' annual revenues, which will make it more challenging for some trustees to repair damaged assets and fund adaptation measures. Large ports face costs that are roughly seven times their annual revenues, whereas smaller harbors and marinas (with and without recreational amenities) face costs that are over 71 times larger than their annual revenues.

Sea level rise and the negative impacts of hard protective structures could also cause granted lands to lose at least $5 billion in value from natural resources by 2100, primarily to beach recreation and wildlife habitats, and the human-benefiting services they provide (sometimes called "ecosystem services"). Jurisdictions with recreational amenities, which rely heavily on their natural resources, are at-risk of losing approximately $3 billion in non-market value. Those jurisdictions only generate $20 million in annual revenue, which will not be enough to fund the necessary adaptation measures to protect their natural resources. These estimates do not fully capture the broader costs to local communities, social equality, human health, and businesses that depend on the natural resources within granted lands.

In total, the potential losses to granted lands could surpass $24 billion in damaged assets and lost natural resources by 2100. When including lost revenues and the downstream impacts from commerce disruptions and other losses of public trust uses, the potential costs of sea level rise on granted lands could be orders of magnitude larger than these estimates.

Refer to Appendix C for cost estimates for each trustee category.

## 5.4 – Component #4: Adaptation Plans

Many of the trustees' assessments did not propose specific adaptation plans but instead described how the general adaptation strategies (e.g., protect, accommodate, retreat) could apply to them. The trustees primarily focused on short-term strategies to maintain their current levels of protection and repair or replace damaged assets as needed. Some trustees did express a desire to use nature-based solutions, like living shorelines, or explore policies to facilitate managed retreat.

The short-term strategies described by the trustees primarily included:

- Repairing and replacing damaged assets as damages occur
- Maintaining and elevating seawalls, bulkheads, and levees
- Elevating docks and wharves


*Figure 10: Port of Long Beach's proposed seawall retrofit (indicated by the red line) to protect chemical storage tanks. (Port of Long Beach)*

Some ports and marinas identified the need to improve navigation armoring, such as breakwaters, which could provide additional protection for mid-term periods.

For long-term strategies, many trustees acknowledged that their adaptation plans would eventually need some form of managed retreat or realignment. The Moss Landing Harbor District, for example, described plans to relocate their harbor further inland and will coordinate with all necessary agencies and adjacent jurisdictions. Moss Landing Harbor District is fortunate that there is undeveloped land for them to relocate to, but that is not the case for many trustees.

Long-term strategies should also include policies that provide frameworks for prioritizing and implementing various adaptation strategies. The City of Santa Monica, as part of their Local Coastal Program update/AB691 submittal, created policies to guide implementation of accommodation strategies, like elevating and flood-proofing buildings. But if they must use protection strategies, nature-based protection measures will be prioritized. Santa Monica also established managed retreat policies to prepare for mid- to long-term risks. Those policies include:

- Requiring the removal of existing structures once they are flooded on a regular basis at high tide, cause the erosion of public lands, or interfere with public access or biological productivity.
- Demolishing and relocating public buildings and critical infrastructure that are vulnerable to long-term erosion or inundation.
- Developing a program that would facilitate the purchase of vulnerable or continuously damaged private properties and convert them to public uses.

Planning for the short-, mid-, and long-term risks of sea level rise should be based on measurable thresholds that trigger specific actions. The thresholds could be based on sea level rise elevations, levels of erosion, or the frequency of damages or flooding. Monitoring programs also need to be implemented to identify when thresholds are met. The Port of San Diego and County of San Mateo – Coyote Point provided good examples of monitoring programs and thresholds that trigger specific adaptive actions. The Port of San Diego's thresholds include:

- Physical indicators (water levels, frequency of storms)
- Biological indicators (habitat extent and health)
- Operational indicators (performance of flood defense structures, cost of damage)

Many of the best practices for sea level rise planning are inhibited by the challenges described in Section 4.2. These include insufficient resources, guidance, and space to facilitate inland retreat or nature-based solutions. Until those challenges are addressed, most trustees will likely continue relying on short-term strategies. Unfortunately, those strategies, particularly maintaining their existing protective structures, will become financially unsustainable and less effective long-term.

# 6.0 Recommendations

The intent of AB 691 was to understand the statewide impacts of sea level rise on public trust resources and assets and ensure that trustees have started long-term adaptation planning. While some of those objectives were achieved, more can be done to develop a comprehensive picture of sea level rise vulnerability and path forward for successfully adapting public trust lands to sea level rise. The State, Commission, and trustees can address many of the AB 691 challenges (see Section 4.2) with newly created or improved guidance, additional resources, and new or revised policies.

The Commission's team has prepared a set of recommendations for the State, the Commission, and trustees. Recommendations for the State include actions that could be taken by the legislature, Governor's Office and administration, and partner agencies. The agencies can guide and implement the State's policies for coastal development, environmental protection, and public access to public trust resources. The State can continue to demonstrate its commitment to climate leadership by establishing new laws and policies or refining existing policies that prioritize effective and adaptive management. The State can leverage partnerships and programs to coordinate sea level rise resilience and adaptation. The Commission is an integral part of this apparatus and can collaborate with trustees on advancing solutions on-the-ground, as well as connecting back to state policymakers to inform policy and funding actions that affect local plans and projects. Recommendations aimed at the trustees directly respond to the needs identified in their individual assessments, this synthesis report, and many points of contact and communication between trustee staff and the Commission team throughout the AB 691 process. The trustees can use lessons learned from this first assessment in future iterations of sea level rise planning for their granted public trust lands. Importantly, all of the recommendations will have the greatest chance of being carried out if actions are undertaken collaboratively and the ties between local trustees and the State are continuously strengthened, with all parties working together towards the aligned goal of safeguarding public trust lands.

The Commission's team organized the recommendations by the AB 691 requirements they address, and the challenges trustees faced in preparing their assessments for those requirements; at the end of each recommendation the target entities are identified by the letters corresponding to State **(S)**, Commission **(C)**, and trustee **(T)**. Since AB 691 does not require any additional reporting, these recommendations should be viewed as necessary actions to address challenges that are ubiquitous to sea level rise planning in California and will hopefully be used to improve future sea level rise planning initiatives by the State and trustees.

The recommendations also include additional considerations that go beyond AB 691's specific challenges. Implementation will require substantial investments in long-term capital improvement programs to achieve successful adaptation outcomes. The trustees must also have fiscal and policy support from the State to build resilience and adaptive capacity and for conserving public trust lands and resources.


*Figure 11: Port of Oakland (photo by Integral Consulting)*

## 6.1 Recommendations for Identifying Vulnerabilities

The following are recommendations to help trustees assess their vulnerabilities through a comprehensive evaluation of risks to public trust uses and resources.

### 6.1.1 Establish standardized sea level rise vulnerability assessment guidance and reporting templates to make sea level rise reporting easier and more consistent.

The State must ensure any guidance on sea level rise analyses is consistent across all state agencies. OPC and the California Coastal Commission (CCC) have aligned their guidance on sea level rise projections and instructions for their use[11]. However, this guidance has not been applied consistently by all state agencies. The recently adopted State Sea Level Rise Principles and draft Action Plan aim to improve consistency and alignment, but the State could go further and pass legislation to set mandatory standards for the use of projections and risk aversion scenarios. The standards need to be easily understood and simple

[11] In 2018, The California Coastal Commission adopted a Science Update to its Sea Level Rise Policy Guidance to reflect the 2018 OPC State SLR Guidance.

for local jurisdictions and regional planning bodies to apply. Along with mandatory standards, legislation should include a periodic reporting requirement to monitor sea level rise vulnerability as it changes over time and progress on implementing adaptation solutions. Templates and instructions for reporting sea level rise vulnerabilities should be provided by the State to local jurisdictions. The reports should require assessments of physical, financial, and social impacts. The instructions should clearly describe the assessment scope, methodologies, tools, and data sources that should be used. **S, C**

### 6.1.2 Increase state support for research, resources, and tools for vulnerability assessments and adaptation planning.

Partnerships are critical to advancing research that informs state policy and planning initiatives. A great example is the Resources Agency Sea Grant Advisory Panel (RASGAP), which OPC leads and funds research for ocean and coastal management. Similar partnerships are needed to support sea level rise vulnerability assessments and adaptation planning with better data, tools, and other resources. As referenced in Section 4.2 – Component #1, there are critical needs for additional data on the natural resources on public trust lands, as well as understanding how impacts to public trust resources affect local communities and economies. Partnerships with academic research institutions and local stakeholders, and additional State funding to support research to fill data gaps, can help the State and trustees gather that information and incorporate it into their vulnerability assessments and adaptation plans. **S**

### 6.1.3 Expand guidance and resources for assessing social vulnerabilities and protecting vulnerable frontline communities.

The State needs to develop guidance and resources to ensure vulnerability assessments and adaptation plans address vulnerable frontline groups (i.e., lower-income households, renters, elderly, communities of color, and other vulnerable groups).[12] The vulnerabilities of frontline communities should be

[12] The Governor's Office of Planning and Research developed a resource guide in 2018, Defining Vulnerable Communities in the Context of Climate Adaptation, through the Integrated Climate Adaptation and Resiliency Program (ICARP). In the guide, 'vulnerable communities' are defined as those that, "*experience heightened risk and increased sensitivity to climate change and have less capacity and fewer resources to cope with, adapt to, or recover from climate impacts. These disproportionate effects are caused by physical (built and environmental), social, political, and/ or economic factor(s), which are exacerbated by climate impacts. These factors include, but are not limited to,*

assessed distinctly from the total impacts to a region. Vulnerability assessments that only summarize the total impacts to a region can mask the unequal distribution of impacts among socioeconomic groups. Assessments of social vulnerabilities should include, but are not limited to, impacts to public safety, public health, socioeconomic status, housing, and transportation. State guidance is needed to inform how trustees' adaptation plans should prioritize addressing the vulnerabilities of frontline communities and avoid displacement that can exacerbate existing stressors. Ultimately, protecting frontline communities will require more state and local resources to increase the resilience and availability of affordable housing, utilities, local jobs, public access, and transportation. **S, C, T**

### 6.1.4 Use OPC's latest guidance for determining the most appropriate sea level rise projections based on the risk aversion and lifespan of assets.

OPC's Sea Level Rise Guidance uses the best available science to update its sea level rise projections and guidance every five years. The next update will be released in 2023. The guidance provides a step-by-step approach to help decision-makers identify the most appropriate projections based on an asset's risk aversion and lifespan. Commission staff strongly recommends using only the projections associated with "high emissions" scenarios. Risk aversions should be determined based on an asset's exposure, adaptive capacity, and the potential severity of consequences. Low risk aversion should only be used for highly adaptive assets with low consequences if damaged, such as unpaved trails. Medium-high risk aversion should be used for less adaptive and more vulnerable assets with medium to high consequences if damaged, such as marinas, harbors, and tourism facilities. Extreme risk aversion should be used for assets with little to no adaptive capacity that would have significant impacts on public safety, the environment, or the economy if impaired. This includes major ports, coastal power plants, desalination facilities, and contaminated/toxic sites. **C, T**

### 6.1.5 Identify the risk exposure and importance of key assets that support public trust uses.

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*race, class, sexual orientation and identification, national origin, and income inequality*." This guide is a good starting place for trustees, the Commission, and other state resource managers to learn more about incorporating vulnerable communities into climate vulnerability assessments, but more guidance and tools are needed that address the specific needs and characteristics of coastal areas dealing with sea level rise.

Trustees should carefully map the locations, elevations, and footprints of assets that are critical to public trust uses to determine their risk exposure. The assets should also be categorized based on their importance for supporting each granted land's public trust uses. This exercise will inform the prioritization of assets that must be protected or adapted to uphold public uses and operations. The trustees should not overlook the critical importance of natural assets for health, cultural, recreational, and tourism-related uses. Understanding risk exposure and importance of assets will directly inform the prioritization of adaptation solutions.

Vulnerable assets that are vital for primary uses should be considered for immediate protection and maintenance while also planning for longer-term solutions. Vulnerable assets that support secondary uses, such as parking lots, offices, and bathroom facilities, should be relocated away from hazardous areas without compromising public benefit or public access. **T**

### 6.1.6 Assess the interconnected, interrelated vulnerabilities of local communities and critical infrastructures that granted lands and the public trust uses depend on.

Sea level rise impacts that occur outside of granted lands could profoundly impact public trust uses and resources. For example, the flooding of nearby roads could limit access to granted lands and impair the use and operations of the granted lands. Conversely, impacts within granted lands could adversely affect the local communities that depend on the granted lands for tourism, recreation, or commerce. Trustees' vulnerability assessments should evaluate the interconnectivity of granted lands and surrounding communities, including infrastructure, utilities, economies, housing, public health and safety, culture, and other shared interests. Collaboration with neighboring jurisdictions is necessary to adequately assess and prepare for the interconnected vulnerabilities. **S, C, T**

### 6.1.7 Develop consistent financial accounting practices to gather and report data on public trust land, resource, and asset values so that economic valuation can be more readily integrated into sea level rise planning.

Accurate information on the value of public trust lands, resources, and assets is needed to sufficiently plan for their protection and adaptation to sea level rise; such information must be collected and calculated based on a consistently applied set of assumptions and metrics across the various localities. Concurrently with the development of economic valuation guidance by the state, the Commission should develop and provide a detailed template for trustees that solicits value information in addition to revenue generation. This will help trustees

plan for repair and replacement costs and prioritize the implementation of different adaptation measures. **S, C, T**

*Figure 12: Santa Cruz Wharf (photo by Integral Consulting)*

## 6.2 Recommendations for Mapping of Projected Sea Level Rise Impacts

The AB 691 assessments and the synthesis process behind this report revealed gaps and inconsistencies in mapping of granted lands boundaries and the identification of where projected sea level rise impacts would occur. The following are recommendations for addressing the gaps and improving consistency in mapping data and information.

### 6.2.1 Use mapping and modeling tools that assess all potential hazards and the combination of their effects.

To fully understand the vulnerabilities of natural and built assets, all potential hazards and the combination of their effects must be spatially mapped. Mapping tools that only evaluate flood risks based on projected elevations of still-water can overlook other hazards and underestimate risks. Erosion, wave runup, king tides, storm surges, and groundwater inundation are additional hazards that can expose assets to risks that maps of still-water elevations would not depict. Each hazard must be identified and mapped based on site-specific conditions and coastal processes. The Commission and trustees may need to use a combination of models to map each hazard and sum their effects on public trust lands. **C, T**

### 6.2.2 Complete mapping for all granted lands and identify areas landward of the current boundary where anticipated impacts from sea level rise will occur.

The lack of complete mapping of the legislatively granted areas represents a major data gap that affects the accuracy of assessing vulnerabilities to public trust lands and adaptation planning. The Commission and trustees should work

together to gather the necessary information, including mean high tide line surveys, to fully map the current extent of each grant.[13] This consideration is crucial to accurately establish baseline conditions, evaluate risks, estimate costs, and ensure no hazards are overlooked as areas shift between jurisdictions. **S, C, T**

### 6.2.3 Consider the future movement of the boundary between public trust lands and private uplands and evaluate risks to resources and assets that will be exposed to increasing erosion and flooding as sea levels rise.[14]

Trustees should use the best available science to identify natural resources and built assets in their vicinity, including the areas that are landward of their granted public trust lands, to understand what might be impacted by sea level rise and related hazards. Trustees and other jurisdictions should assess the vulnerabilities of all assets that are necessary to support public trust uses as sea levels rise. Adaptation planning should occur, in partnership with upland property owners, to prepare for impacts as well as the space needed to relocate or realign assets out of the way of hazards. The state should support the communication and relationship building efforts of trustees and local communities that will be critical to creating effective partnerships to tackle this challenge. **S, C, T**

## 6.3 Recommendations for Estimates of Financial Costs

The following are recommendations that can improve the process of estimating financial costs and accurately accounting for the economic values that should inform sea level rise planning and decision making.

### 6.3.1 Provide explicit and consistent guidance for assessing financial costs.

The State should provide clear guidance on the types of costs, assets, and valuation methods that need to be included in financial cost assessments.[15]

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[13] OPC has been working with NASA's Jet Propulsion Laboratory and the San Francisco Estuary Institute to map coastal areas and assess sea level rise vulnerabilities. These resources will be available to the Commission and trustees to assist with the identification of granted lands boundaries and vulnerabilities to public trust lands.

[14] This recommendation is aligned with key actions that are included in OPC's draft State Agency Sea Level Rise Action Plan and CCC's draft Public Trust Guiding Principles & Action Plan. Both drafts were released in 2022 for public comment.

[15] SB 1078 (Allen), currently being considered in the 2021-2022 legislative session, would establish a Sea Level Rise Revolving Loan Program, administered by the Ocean Protection Council and State Coastal Conservancy. The proposed program will issue low-interest loans to local jurisdictions to buy coastal properties vulnerable to sea level rise in order to lease them out until they can

Without consistency, cost estimates cannot be accurately compared or summed for statewide totals. Incomplete or inaccurate cost estimates can impair the trustee's and State's budgeting and planning efforts to address the largest costs risks. The types of costs should include damages, repairs/replacements, lost revenue, lost ecosystem services, and costs associated with adaptation planning. **S**

### 6.3.2 Expand guidance and resources for assessing the financial and non-financial values of natural resources and their connection to social and public health sciences.

The State should require all sea level rise reports to contain vulnerability assessments of natural resources. Natural resources to include, at a minimum, would be beaches, wetlands, rocky intertidal, kelp forests, eelgrass beds, surf breaks, and open and adjacent spaces. Sea level rise guidance should provide instructions for performing non-market valuations that include ecosystem services spanning environmental, climate, social, economic, and public health benefits. Trustees should monitor habitat area, biodiversity, beach widths, coastal access, water quality, scenic quality, recreation attendance, and other uses of their granted lands. If the valuations of the State's natural resources are not documented, the natural resources may not be adequately prioritized and protected in planning decisions.[16] **S, C**

## 6.4 Recommendations for Adaptation Planning

The following are recommendations to help trustees create thorough adaptation plans that respond to their identified vulnerabilities. These recommendations generally fall under categories related to collaboration, phased planning, nature-based projects, and prioritizing adaptation methods.

### 6.4.1 Work together to align sea level rise planning and policies across the state[17].

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no longer be safely used or operated. This bill highlights just one example of a type of adaptation strategy that necessitates better information related to financial costs, including asset valuation. Detailed information is also foundational to setting priorities for the allocation of limited resources.

[16] See CNRA's 30x30 initiative for more information on strategies and existing programs that can be used to protect natural resources.

[17] This recommendation reinforces the purpose of the recently adopted State Sea Level Rise Principles, developed by the state's Sea Level Rise Leadership Team, of which the Commission is a member. One example of the State's efforts to align sea level rise planning is the Coastal Plan Alignment Compass.

Federal, state, and local governments must align their sea level rise planning and policy decisions to ensure consistency across regions and jurisdictions. Conflicting and incompatible policies and plans can impede effectiveness and cause confusion among governments and stakeholders who are trying to implement guidance at local levels.

Adjacent jurisdictions need to collaborate on vulnerability assessments and sea level rise planning to ensure areas and structures that span multiple jurisdictions, like utility and transportation infrastructure, are not overlooked and there is transparency on management responsibilities, policies, and planning decisions. Adjacent jurisdictions also need to work closely to address the challenges that arise from shifting boundaries caused by sea level rise. **S, C, T**

### 6.4.2 Create sustained relationships with regional climate collaborative groups to facilitate coordination, share information, and leverage resources.

The State, Commission, and trustees should strengthen coordination with regional groups such as the Central Coast Climate Collaborative and the San Diego Regional Climate Collaborative[18]. There is an existing forum, the Alliance of Regional Collaboratives for Climate Adaptation, that can be utilized more extensively to build relationships between state decision makers, agencies, and local and regional partners. The State should support and invest in these groups focused on implementing sea level rise policies, planning, and projects at a regional scale. These groups can play an essential role in connecting important stakeholders, Tribes, all levels of government, and community members. They can also facilitate information sharing, agency updates, and discussions on members' challenges or concerns. **S, C, T**

### 6.4.3 Provide funding to Trustees for vulnerability assessments, ongoing monitoring, asset repairs, adaptation planning, and implementation of adaptation projects.

The State must provide funding assistance to trustees and smaller jurisdictions that lack resources for sea level rise planning and adaptation measures. From 2020 to 2100, the trustees categorized as "jurisdictions with recreational amenities" and "small harbors/marinas" are projected to have sea level rise costs that are 166 and 77 times larger than their current annual revenues, respectively. These smaller trustees cannot cover their costs from revenues alone

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Alignment will take time, but it is critical to achieving resiliency outcomes that will protect public trust lands and assets from sea level rise impacts.

[18] Other venues for increased coordination with trustees and local jurisdictions include the Integrated Climate Adaptation and Resiliency Program, the California State Association of Counties, and the League of California Cities.

and need funding assistance to protect their public trust uses and resources. The State should ensure that trustees with limited financial resources, especially those that serve low-income communities or have high visitation from frontline community members, receive dedicated funds to support adaptation and protection measures[19]. The State should also help smaller trustees develop creative funding solutions that can maximize limited resources, such as regional partnership that can pool resources and increase efficiencies for sharing information and tools. **S**

### 6.4.4 Create a "no net loss" policy for beaches.

Similar to California's "no net loss" policy for wetlands (Executive Order W-59-93), California must establish a policy that ensures no overall net loss and a long-term net gain in the quantity and quality of beach acreage. According to California's Fourth Climate Change Assessment, Southern California could lose up to 67 percent of its beaches by 2100 without large-scale interventions. A "no net loss" policy could include:

- A Statewide beach inventory, accounting, and monitoring program[20]
- Support for and inventory of local implementation of nature-based solutions that preserve and restore beach acreage.
- Development of beach mitigation banking programs that fund beach nourishment projects.
- Support for policies, like rolling easements, that ensure landward migrations of beaches are prioritized over the protection of private properties. **S**

### 6.4.5 Support and encourage local, place-based planning and adaptation policies and projects that address local and regional conditions.

The state should provide guidance, resources, and mapping tools that support the selection of a variety of sea level rise adaptation strategies, and facilitate their implementation, based on the location-specific setting and needs. The unique characteristics, functions, and features of each trustee's granted lands

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[19] SB 1 (Atkins, 2021), passed in September 2021, will provide up to $100 million annually for local and regional sea level rise planning and project implementation, and at least $500,000 for community groups to address sea level rise impacts in disadvantaged communities.

[20] OPC is developing an action plan to address beach habitat loss (3.1.3 in the OPC Strategic Plan). The action items include developing a Beach Resiliency Plan and completing a statewide inventory and projection of beach habitats at a 2-meter resolution by 2022.

should substantially inform the vulnerability assessments and adaptation plans developed for that location. Each trustee should have the ability to choose the best strategies that will protect and adapt their respective public trust lands, resources, uses, values, and assets. **S, C**

### 6.4.6 Proactively incentivize, support, and subsidize nature-based adaptation strategies, including conservation and restoration.

The State should utilize existing and new streams of funding to leverage nature's resilience and adaptive capacities. The State should use its grant and loan programs to incentivize and reduce implementation costs for nature-based adaptation projects. State funding is also needed to support regional sediment management practices that protect inland areas and preserve public trust uses and resources. Additionally, acquiring land adjacent to public trust lands may be necessary to facilitate conservation, nature-based protection, and relocation strategies that require more space.[21] **S, C, T**

### 6.4.7 Prioritize the adaptation of public trust uses, resources, and values.

Each trustee should assess the most important public trust uses, resources, and values of their granted lands, and then prioritize the adaptation of assets that are critical for those uses, resources, and values. Select adaptation strategies that are the most applicable for the assets and provide the most support for their public trust uses, resources, and values. For instance, trustees that rely heavily on recreational activities should prioritize protection of natural resources and avoid hard armoring that can accelerate erosion and degradation of those natural resources. **S, C, T**

[21] SB 1078 (Allen), a bill to create a sea level rise revolving loan pilot program that is currently pending in the 2021-2022 legislative session, and CNRA's 30x30 initiative (Pathways #2 and #8), are examples of State legislation and policies that can provide funding for conservation, nature-based solutions, and executing strategic land acquisitions. The State also commissioned a report, titled "Toward Natural Shoreline Infrastructure to Manage Coastal Change in California" as part of the Fourth Climate Change Assessment (2018), intended to enable planners to adopt nature-based solutions by describing detailed case studies. Still, many local jurisdictions face hurdles to implementing these solutions and more support, guidance, and tools are needed.

### 6.4.8 Create phased adaptation approaches for short-, mid-, and long-term strategies[22].

Trustees' adaptation plans for each asset should include short, mid-, and long-term strategies. Use short-term strategies to allow for continued use of essential functions or operations while planning, permitting, and implementing mid- and long-term strategies. Hard armoring should only be used short-term, and its decommissioning should be pre-planned. The timelines for transitions between phases should be based on triggers and thresholds, not on future dates. **T**

### 6.4.9 Consider managed retreat options for all vulnerable structures.

When evaluating long-term adaptation strategies, trustees should consider managed retreat for all vulnerable structures that can be relocated. Identify potential relocation sites and conduct a needs assessment for the engineering, financial, or jurisdictional challenges that would need to be addressed. Additionally, identify sea level rise thresholds that would trigger proactive relocation projects, allowing adequate time for implementation before the structures are at risk. **T**

### 6.4.10 Implement monitoring programs and develop thresholds and triggers for the implementation of adaptation measures.

Trustees should begin monitoring and documenting local water levels, hazards, salinity levels, and frequency and extent of damages associated with high tides and storm events, including the timing, location, and extent of flooding or damages. The documentation should include photo or video documentation from before, during, and after high tides and storm events (e.g. CoastSNAP). The data can be used to identify trends and vulnerabilities and ground truth projections from sea level rise and flooding models.

The monitoring plan should inform a set of measurable thresholds that trigger specific adaptation measures once the thresholds are met. Thresholds can be based on water levels or the frequency or extent of hazards and damages. **T**

[22] This recommendation is aligned with the State Sea Level Rise Guidance, which recommends that design and planning efforts include a trigger-based adaptation pathway approach, especially for assets and infrastructure with longer lifespans.

### 6.4.11 Prioritize nature-based adaptation strategies over hard shoreline armoring where appropriate.[23]

Trustees should consider nature-based adaptation strategies, like living shorelines and horizontal levees, and prioritize their use over hard armoring whenever feasible. These strategies should also include protecting and restoring natural resources, such as beaches, dunes, and wetlands, that increase coastal resilience and protect inland areas. Trustees and/or the State should monitor the performance of nature-based adaptation strategies and develop case studies, guidance, and best practices to share lessons learned and encourage wider use of nature-based adaptation strategies. When hard armoring must be used, it should only be considered a short-term solution except where armoring is vital to protect and maintain critical public trust uses (e.g., commerce and navigation at ports). **S, C, T**

### 6.4.12 Develop strategies to address impacts of hard armoring on public trust lands and explore opportunities to transition to hybrid or nature-based shoreline protection when and where feasible.

Hard armoring, such as conventional seawalls, rock revetments, bulkheads, and rip rap, is the most common method of shoreline protection employed by trustees to shield assets and resources from rising seas. Armoring can have adverse impacts, like exacerbating erosion, that will actually accelerate the damage to public trust lands and resources from sea level rise. However, as discussed in Section 4.1, in some areas, particularly the large ports and harbors that are located in heavily urbanized and congested areas, armoring may be the only feasible option. Even in these cases, however, advancements in materials and innovative designs are starting to show how armoring strategies can be less harmful. The State and trustees should work together to develop strategies that will reduce and mitigate the effects of existing hard armoring where it is necessary for those structures to remain in place – these could include implementation of beach nourishment and width management plans as well as phased conversion to construction materials like bio-concrete that are porous and could provide additional habitat space for rocky intertidal species.

Nature-based strategies for shoreline protection should be employed wherever possible, as a cost-saving, long-term investment, and where armoring is the only feasible solution, innovative designs and materials that are more environmentally friendly should be explored. These strategies should be

[23] This recommendation is aligned with Governor Newsom's Executive Order N-82-20 and an overarching goal of OPC's draft State Agency Sea Level Rise Action Plan.

incentivized by the State and trustees through favorable financing and lease terms. The State should also update and expand the technical guidance for nature-based shoreline protection strategies and increase investment in pilot projects that demonstrate the variety and effectiveness of nature-based strategies that can be available to trustees and their partners. **S, C, T**

### 6.4.13 Ensure sediment management practices evaluate beneficial reuse options based on cost-benefit analyses that include ecosystem service valuation, recreational value, and damage reduction benefits.

The State and Commission should support policies that promote the beneficial reuse of dredged sediment that can improve the resilience of tidelands, enhance their protection benefits, and support their ecosystem services. Sediment management projects should employ cost-benefit analyses to consider the value of the ecosystem services, recreational benefits, and damage reduction benefits. In addition to dredging navigational channels, beach sediment management practices must be used to alleviate sediment constraints and address erosion hotspots. Inventories of sediment resources and sediment management programs will be critical to effectively adapt to sea level rise. This should also include careful evaluation of more innovative structures such as nearshore artificial reefs or low profile groins to maintain sand resources. **S, C, T**

### 6.4.14 Leverage the 'Cutting Green Tape Initiative'[24] to simplify permitting and funding for nature-based adaptation projects.

To facilitate the use of nature-based adaptation strategies over hard armoring, the State should simplify and expedite processes for permitting and state-funding of nature-based projects. Nature-based adaptation projects should be considered as conservation and restoration projects for which the "Cutting Green Tape Initiative" outlines methods for improving regulatory efficiency. For example, the California Environmental Quality Act (CEQA) Class 33 categorical exemption could apply to many nature-based shoreline stabilization projects that use native vegetation and other bioengineering techniques to reduce or prevent erosion. In addition, the recently enacted statutory exemption for restoration projects provides that projects undertaken to conserve, restore, or enhance wildlife or their habitats, under specified conditions, could be considered (Pub. Resources Code §21080.56). State agencies should ensure broader awareness of such methods and use them where applicable for nature-based adaptation projects. **S, C, T**

[24] https://resources.ca.gov/Initiatives/Cutting-Green-Tape

**6.4.15 Support strategies that protect critical infrastructure, working waterfronts, and ports. Partner with local asset managers to implement the best alternatives to nature-based strategies when nature-based strategies are insufficient or cannot be implemented. Support employing multiple strategies if needed, including phased approaches to managed realignment or retreat, to safeguard assets critical to the public and their safety.**

The State and Commission should support local decisions to use alternative shoreline protection strategies to nature-based solutions when necessary to protect in-place existing critical infrastructure and maritime industrial, commercial, and navigation facilities. Working and urban waterfronts often do not have the space required to implement nature-based strategies for shoreline or asset protection. In lieu of other options, continued use of conventional or hybrid structures may be necessary in these specific locations. To mitigate the harmful impacts structures like seawalls can have on public trust lands, the State should increase resources and support for research and application of alternative materials and designs that avoid damages to coastal ecosystems and provide habitat for rocky intertidal species while also protecting critical and maritime infrastructure. The State should also support early risk assessment and planning for realignment and relocation of major assets that will need to be moved out of hazardous areas. **S, C**

**6.4.16 Codify periodic updates of revised and improved AB 691-like criteria to evaluate climate impacts to public trust lands.**

The State should consider legislation to require periodic sea level rise vulnerability assessments and the development/update of adaptation plans for granted public trust lands, with updated and improved requirements. AB 691, although a one-time reporting requirement, was a successful catalyst for many trustees to consider the potential impacts of sea level rise as part of their public trust responsibilities. AB 691 also made planning for sea level rise a management priority for trustees. Trustees will continue preparing for sea level rise throughout their jurisdiction,[25] but additional legislation is needed to focus support and resources specifically on public trust lands and address the challenges encountered by trustees and the Commission. Many of the recommendations in

[25] SB 867 (Laird), currently being considered in the 2021-2022 legislative session, would require local governments within the coastal zone, or the jurisdiction of the BCDC, to develop and update sea level rise adaptation plans every 10 years, and technical adjustments every five years.

this report that are directed towards the State can be used to pursue future legislation. In particular, these include:

- Establish standardized sea level rise guidance and reporting templates to make sea level rise reporting easier and more consistent.
- Expand guidance and resources for assessing the financial and non-financial values of natural resources and their connection to social and public health sciences.
- Expand guidance and resources for assessing social vulnerabilities and protecting vulnerable frontline communities.
- Provide explicit and consistent guidance for assessing financial costs. **S**

## 6.5 Recommendations for Equity and Environmental Justice

### 6.5.1 Adopt an environmental justice policy that incorporates climate vulnerability.

Equity and environmental justice should be foundational to planning for sea level rise impacts to public trust lands. Trustees of state lands should adopt environmental justice policies that incorporate climate change if they have not already done so, or incorporate principles and practices adopted from existing policies. Both the Commission and the California Coastal Commission, for example, have environmental justice policies[26] that could be adapted for use by trustees. The policy should promote equity and the advancement of environmental justice through inclusive decision-making that considers the disproportionate burdens on disadvantaged communities and Native Nations. It should describe how the policy will be applied to the trustee's operations, programs, and policies, including sea level rise vulnerability assessments and adaptation plans. Analyses of vulnerability for frontline communities could include factors related to hazards (flooding, etc.), loss of public access, displacement, and economic burdens (potential disruptions to employment, rising costs passed on to ratepayers, rising housing costs, etc.). **T**

### 6.5.2 Integrate and prioritize equity and social justice, including restorative justice for coastal tribes, in all sea level rise adaptation plans and projects.

Integrating equity and social justice in adaptation means first conducting meaningful outreach with vulnerable frontline communities and ensure equitable public participation throughout the entire planning process, including assessing vulnerability. This participation must extend beyond just the local frontline communities to include visitors seeking respite from other climate

[26] Coastal Commission: https://www.coastal.ca.gov/env-justice/
State Lands Commission: https://www.slc.ca.gov/environmental-justice/

related impacts such as extended heat waves and drought. Plans should analyze alternative adaptation options and evaluate them based on their ability to avoid adverse impacts and increase benefits for vulnerable frontline communities. Trustees should consider financial equity when selecting adaptation strategies and their funding, and avoid distributing the costs of protecting or adapting the wealthiest coastal communities to citywide or countywide ratepayers. **S, C, T**

*Figure 13: Santa Cruz (photo by Integral Consulting)*

## 7.0 Report Preparation and Acknowledgements

This report was prepared by a team from the Commission and the consulting firm Integral Consulting (with staff formerly of Revell Coastal). The report concludes a multi-year effort taken on by many contributors. The team that prepared this report would like to thank and acknowledge the hard work of the trustees and consultants that created and submitted AB 691 assessments. The team would also like to thank and acknowledge the Commission's California Sea Grant Fellows that worked on this effort from 2016-2022: Patrick Mulcahy, Jaimie Huynh, Esther Essoudry, Abby Newman, Sam Blakesley, Katie Robinson-Filipp, Kristina Kunkel, Margarita (Marge) McInnis, and Michael Wells.

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# Appendix A – Trustee Categories

**Small Harbor/Marina with Recreational Amenities or Natural Assets:**
This category includes small harbors or marinas with recreational amenities or natural assets located within the grant. Recreational amenities could include retail shops, restaurants, and a wharf or pier that supports recreational fishing. Natural assets can be beaches, intertidal rocky habitats, or eel grass beds. The 18 trustees in this category generated an average annual revenue of $5.9 million dollars, with a range of $324,000 - $45,000,000.

*Table 4: Small Harbor/Marina with Recreational Amenities or Natural Assets trustees and average revenue. Listed in descending order by location, from north to south.*

| Small Harbor/Marina with Recreational Amenities or Natural Assets | Average Annual Revenue, 2013-2019 |
|---|---|
| Crescent City Harbor District | $1,214,896 |
| City of Eureka | $1,015,712 |
| Humboldt Bay Harbor and Recreation District | $1,870,748 |
| City of Benicia | $324,133 |
| City of Alameda | $830,768 |
| County of San Mateo - Coyote Point | $1,179,714 |
| San Mateo County Harbor District | $2,621,883 |
| Moss Landing Harbor District | $1,874,400 |
| City of Monterey | $2,547,150 |
| City of Morro Bay | $2,138,942 |
| City of Santa Barbara | $14,442,524 |
| City of Redondo Beach - Kings Harbor | $6,718,255 |
| City of Long Beach | $619,036 |
| City of Newport Beach | $11,568,720 |
| County of Orange - Newport Bay | $4,626,931 |
| City of Avalon | $6,689,672 |
| City of Oceanside | $389,643 |
| City of San Diego | $45,318,318 |
| **Total** | **$105,991,445** |
| **Average** | **$5,888,414** |
| **Range** | **$324,000 - $45,000,000** |

**Small Harbor/Marina:**

This category includes trustees with small harbors or marinas with breakwaters and jetties along their perimeters and do not have significant additional recreational amenities or natural assets within the boundary of the grant. These trustees often support fishing, public access, and public-serving commercial assets. The seven trustees in this category generated an average annual revenue of nearly $6.8 million dollars, with a range of $645,000 - $24,500,000.

*Table 5: Small Harbor/Marina trustees and average revenue. Listed in descending order by location, from north to south.*

| Small Harbor/Marina | Average Annual Revenue, 2013-2019 |
|---|---|
| City of Sausalito | $797,502 |
| City of Berkeley | $6,131,657 |
| City of Emeryville | $646,271 |
| City of Redwood City | $3,251,000 |
| Santa Cruz Port District | $8,347,776 |
| Port San Luis Harbor District | $3,861,292 |
| Dana Point Harbor District | $24,518,192 |
| **Total** | **$23,035,498** |
| **Average** | **$3,839,250** |
| **Range** | **$645,000 - $24,500,000** |

**Jurisdiction with Recreational Amenities:**

These granted public trust lands do not include a port, harbor, or marina facility and generally serve the purpose of recreation and public access through open coastline or beaches and may also have visitor-serving facilities like wharves, piers, and restrooms. The five trustees in this category generated an average annual revenue of nearly $4 million dollars, with a range of $0 - $16,000,000.

*Table 6: Jurisdiction with Recreational Amenities trustees and average revenue. Listed in descending order by location, from north to south.*

| Jurisdictions with Recreational Amenities | Average Annual Revenue, 2013-2019 |
|---|---|
| City of Crescent City | $537,394 |
| County of San Mateo – Pescadero | $0 |
| City of Santa Cruz | $3,078,991 |
| City of Carpinteria | $312,525 |
| City of Santa Monica | $15,999,164 |
| **Total** | **$19,928,074** |
| **Average** | **$3,985,615** |
| **Range** | **$0 - $16,000,000** |

**Large Ports:**

Large Ports are by far the highest revenue generating granted public trust lands and primarily support commerce, navigation, and national defense. The five trustees in this category generated an average annual revenue of nearly $340 million dollars, ranging from roughly $104 million to more than $622 million in average annual revenue over the reporting timeframe.

*Table 7: Large Ports trustees and average revenue. Listed in descending order by location, from north to south.*

| Large Ports | Average Annual Revenue, 2013-2019 |
|---|---|
| Port of Oakland | $342,316,667 |
| San Francisco Port Commission | $103,826,286 |
| Port of Los Angeles | $464,302,333 |
| Port of Long Beach | $622,132,333 |
| San Diego Unified Port District | $163,785,802 |
| **Total** | **$1,696,363,421** |
| **Average** | **$339,272,684** |
| **Range** | **$104,000,000 - $622,000,000** |

# Appendix B – Estimated Losses in Non-Market Valuations

*Table 8: Estimated losses in non-market value that were reported by the trustees. Blank rows indicate that non-market values were not reported. Positive values represent losses.*

| Trustee | 2030 | 2050 | 2100 |
|---|---|---|---|
| **Small Harbors with Recreational Amenities or Natural Assets** | | | |
| Crescent City Harbor District | $1,058,000 | $11,248,000 | $32,732,000 |
| City of Eureka | | | |
| Humboldt Bay Harbor and Recreation District | | | |
| City of Benicia | | | |
| City of Alameda | | | |
| Coyote Point | $37,000 | $377,500 | $5,350,000 |
| San Mateo County Harbor District | $424,636 | $1,584,129 | $3,990,211 |
| Moss Landing Harbor District | $3,450,000 | $13,800,000 | $0 |
| City of Monterey | $185,000 | $1,021,000 | $1,588,000 |
| City of Morro Bay | | | |
| City of Santa Barbara | | | |
| City of Redondo Beach – Kings Harbor | | | |
| City of Long Beach | $12,000,000 | $48,900,000 | $74,100,000 |
| City of Newport Beach | $22,710,589 | $39,960,077 | $104,840,747 |
| County of Orange – Newport Bay | $136,000 | $213,800 | $668,900 |
| City of Avalon | $2,700,000 | $4,900,000 | $10,200,000 |
| City of Oceanside | $16,800,000 | $80,900,000 | $187,100,000 |
| City of San Diego | $0 | $0 | $14,461,800 |
| **Subtotal** | **$59,501,225** | **$202,904,506** | **$435,031,658** |
| **Small Harbors/Marinas:** | | | |

| | | | |
|---|---|---|---|
| City of Sausalito | | | |
| City of Berkeley | | | |
| City of Emeryville | $0 | $0 | $730,000 |
| Redwood City | | | |
| Santa Cruz Port District | | | |
| Port San Luis Harbor District | | | |
| Dana Point Harbor District | $9,600,000 | $24,000,000 | $43,200,000 |
| **Subtotal** | **$9,600,000** | **$24,000,000** | **$43,930,000** |
| **Jurisdictions with Recreational Amenities:** | | | |
| City of Crescent City | $300,000 | $3,300,000 | $4,900,000 |
| County of San Mateo – Pescadero | | | |
| City of Santa Cruz | | | |
| City of Carpinteria | | | |
| City of Santa Monica | $74,103,850 | $260,773,150 | $816,388,850 |
| **Subtotal** | **$74,403,850** | **$26,073,150** | **$821,288,850** |
| **Large Ports:** | | | |
| Port of Oakland | | | |
| San Francisco Port Commission | | | |
| Port of Los Angeles | | | |
| Port of Long Beach | | | |
| San Diego Unified Port District | $40,435,825 | $40,439,757 | $28,057,568 |
| **Subtotal** | **$40,435,825** | **$40,439,757** | **$28,057,568** |
| **TOTAL** | **$183,940,900** | **$531,417,413** | **$1,328,308,076** |

# Appendix C – Summary of Financial Cost Estimates

The financial cost estimates below are broad approximations and should only be used to understand the magnitude of sea level rise's potential financial implications on granted lands. Many of the cost estimates provided by the trustees were incomplete and underreported the breadth of financial implications. The Revell Coastal team was able to use data from comparable trustees to estimate some of the missing costs in order to aggregate cost estimates for all trustees. The aggregate cost estimates were only calculated for the damages and replacement costs of built assets and the losses of natural resources. The cost estimates are mostly confined to costs that would be incurred within the granted lands boundaries. They do not include:

- Broader costs to local communities, social equality, human health, and local businesses that depend on natural resources within granted lands.
- Downstream economic effects from disruptions to commerce, tourism, or other losses of public trust uses and resources.
- Lost revenues from lower demand or impacts to revenue generating operations.

*Table 9: Damages and Replacement Costs, by Trustee Category ($ millions)*

| Trustee Category | 2020-2030 | 2030-2050 | 2050-2100 | Total, 2020-2100 |
|---|---|---|---|---|
| Small Harbor/Marina with Recreation or Natural Assets | $853 | $1,338 | $4,361 | $6,552 |
| Jurisdiction with Recreational Amenities | $8 | $16 | $144 | $168 |
| Small Harbor/Marina | $184 | $177 | $1,249 | $1,610 |
| Large Port | $781 | $802 | $9,144 | $10,727 |
| **Total** | **$1,826** | **$2,333** | **$14,898** | **$19,057** |

*Table 10: Loss in Non-Market Value, by Trustee Category ($ millions)*

| Trustee Category | 2020-2030 | 2030-2050 | 2050-2100 | Total, 2020-2100 |
|---|---|---|---|---|
| Small Harbor/Marina with Recreation or Natural Assets | $80 | $280 | $573 | $934 |
| Jurisdiction with Recreational Amenities | $220 | $715 | $2,203 | $3,138 |
| Small Harbor/Marina | $21 | $59 | $90 | $169 |
| Large Port | $419 | $419 | $291 | $1,128 |
| **Total** | **$740** | **$1,473** | **$3,157** | **$5,369** |

*Table 11: Total Public Trust Losses, by Trustee Category ($ millions)*

| Trustee Category | 2020-2030 | 2030-2050 | 2050-2100 | Total, 2020-2100 |
|---|---|---|---|---|
| Small Harbor/Marina with Recreation or Natural Assets | $933 | $1,618 | $4,934 | $7,486 |
| Jurisdiction with Recreational Amenities | $228 | $731 | $2,347 | $3,306 |
| Small Harbor/Marina | $205 | $236 | $1,339 | $1,779 |
| Large Port | $1,200 | $1,220 | $9,435 | $11,855 |
| **Total** | **$2,566** | **$3,806** | **$18,055** | **$24,426** |

# Appendix D – Two Page Summaries of the Trustees' Assessments

Commission staff created two-page summaries of the trustees' assessments to provide overviews of the trustees' vulnerabilities, adaptation plans, and financial cost estimates. A standardized template was used for each two-page summary to allow for more accessible takeaways and comparisons of the information reported in the assessments. Since trustees took widely varied approaches to their assessments, Commission staff and the Consultant's team conformed the information where possible to fit into the template format. Blank fields in the two-page summaries indicate insufficient information. The summaries are intended to be companions to the assessments and should not be thought of as representative of the more extensive and nuanced information in the full assessments.

While the AB 691 legislation required the trustees to submit assessments of assets located only within their granted lands boundaries, the scope of some trustee assessments extended beyond those boundaries. As noted in Sections 4.2 and 6.2, precise mapping of the trustees' legislative grants is challenging and, in some cases, exact boundaries remain uncertain. Commission staff received and compiled the information reported by the trustees; they did not independently verify that the asset categories or financial estimates provided by trustees in their assessments were limited to those falling within the boundaries of the grants. Thus, some two-page summaries may list assets and vulnerabilities that exist outside of granted lands boundaries.

One of AB 691's intentions was to encourage the trustees to continue planning for sea level rise after submitting their AB 691 assessments. Accordingly, many trustees have continued the planning efforts and released more up-to-date vulnerability assessments and adaptation plans since submitting their AB 691 assessments. Note that the two-page summaries that follow are a snapshot in time that are no more recent than 2019; while the trustees may have more current information, this report was focused on the assessments submitted to comply with AB 691 and the information and financial estimates as they stood *at the time of submittal*. Please refer to the trustees' respective websites to find their latest reports.

## Small Harbor/Marina with Recreational Amenities or Natural Assets:

These trustees' summary documents are arranged in the same order as the trustees appear in the report. Listed from North-South within their granted land type category, beginning with Small Harbor/Marina with Recreational Amenities or Natural Assets:

- Crescent City Harbor District
- City of Eureka
- Humboldt Bay Harbor and Recreation District[1]
- City of Benicia
- City of Alameda
- County of San Mateo - Coyote Point
- San Mateo County Harbor District
- Moss Landing Harbor District
- City of Monterey
- City of Morro Bay
- City of Santa Barbara
- City of Redondo Beach - Kings Harbor City of Long Beach
- City of Newport Beach
- County of Orange - Newport Bay City of Avalon
- City of Oceanside
- City of San Diego

[1] The Humboldt Bay Harbor and Recreation District did not submit an AB 691 assessment and does not have a two-page summary document.

# Crescent City Harbor District

*Del Norte County*

**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Site Description

Crescent City Harbor District (CCHD) is situated on a low-lying portion of the Pacific coast in northern California. In 1931, CCHD was formed in accordance with Statutes of 704 and originally consisted of tide and submerged lands measuring 400 acres. The CCHD owns and controls land and tideland properties seaward of the 1948 ordinary high-water mark bounded by Crescent City to the west, Crescent Beach to the east, a U.S. Highway 101 corridor to the north, and Lighthouse Way Breakwater to the south. CCHD's property is bounded by a series of breakwaters, except to the north where the boundary becomes less linear. These sovereign lands were granted in 1963, and CCHD now consists of approximately 4,052 acres of land and water area.

Like much of California, CCHD and the surrounding areas are vulnerable to extreme coastal events combined with rising seas. Extreme events such as storm surges and tsunamis can and have caused widespread adverse impacts to coastal resources and infrastructure without the addition of higher sea levels.

## Public Trust Uses

*Primary Uses:* Commerce, Navigation
*Secondary Uses:* Environmental Stewardship, Fisheries, Recreation


**Coastal Hazards considered:**
tidal inundation, storms/tsunamis, earthquakes, saltwater intrusion, shoreline change

**Modeling system used for mapping:**
NOAA

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Pump-out station, boat ramps, docks, dredge ponds, breakwaters, maintenance/storage buildings, office/retail buildings, restrooms, roads/parking areas, seafood processing plants, shipyard building, solar array, seawall, synchro-lift, travel-lift, utilities, and groin |
| Natural Assets | Beaches |

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## Proposed Adaptation and Mitigation Measures

### *Protect*

Repair areas of seawall where armor-stone has slipped into harbor, compromising the integrity of the wall; replace and elevate steel seawall that supports Citizens Dock, CCHD Office, public hoist, and seafood freezers; elevate concrete seawall along the Anchor Way breakwater; repair and elevate Whaler Island groin seawall.

### *Accommodate*

Develop sea level rise mitigation plans and structure elevation program; establish damage pile replacement program; evaluate littoral drift and beach nourishment options to maintain beaches; develop a debris management plan; replace and elevate synchro-lift and travel-lift docks.

### *Retreat*

Limit new development in mapped hazard area; where appropriate, support retrofitting, purchase or relocate structures located in high hazard areas, prioritizing those structures that have experienced repetitive losses and/or are in high or medium ranked hazards.

**Partnerships**

In light of the 2011 tsunami triggered by the Tohoku earthquake, the CCHD focuses much of its efforts towards disaster preparedness and post-disaster recovery plans. Given the existing partnerships that have been developed for disaster preparedness, the discussion of sea level rise can be incorporated into regional planning and coordination. In addition, the CCHD currently relies on its Board of Harbor Commissioners, the City of Crescent City, Del Norte County, the Redwood Coast Tsunami Work Group, the NOAA tidal gauge, its vast network of businesses, technical consultants, academic institutions, and public agencies to monitor and address other climate resilience goals.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (12 in.) | 2050 (24 in.) | 2100 (72 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **$2.8** | **$56** | **$141** |
| **Losses in Non-Market Value** | | **$1.1** | **$11** | **$32.7** |
| **Cost of Adaptation** | | | | **$98.5** |

* Assets at Risk from Table 6, p. 17; Non-market Value from Table 5, p. 17; Adaptation Costs combine Totals from Table 7 and 8, pp. 19 and 20.

# City of Eureka

*Humboldt County*

**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Habitat

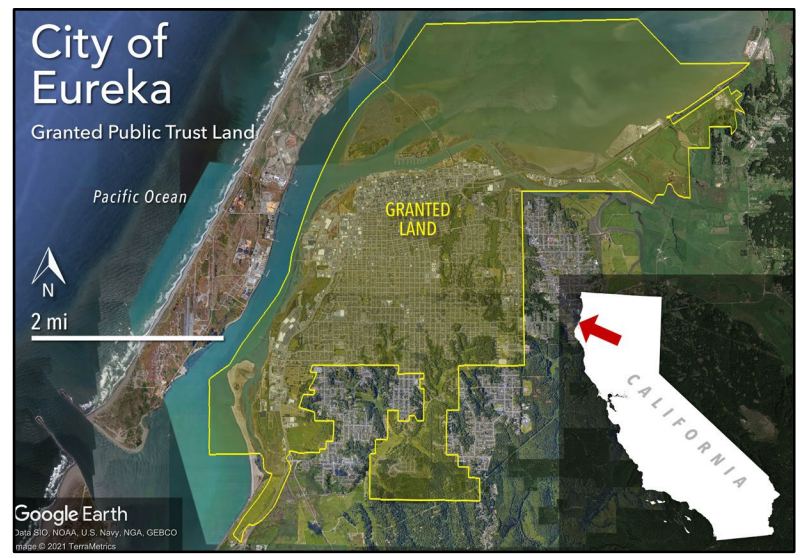
## Public Trust Uses

*Primary Uses:* Safety & Navigation, Fisheries, Commerce
*Secondary Uses:* Recreation, Environmental Stewardship

## Site Description

The City of Eureka was originally granted sovereign waterfront lands in trust in 1857. The City's tidelands include approximately 2,890 acres of submerged lands, and approximately 1,000 acres of adjacent shoreline/upland. Uses on the granted tidelands include mariculture, commercial fishing, and recreational boating docks, piers, and marinas, as well as natural resource areas.

Without the ability to maintain and/or reinforce/expand existing dikes, levees, and other natural and artificial shorelines, much of the tideland area will likely be completely inundated by 2050. In many areas, this also means that onshore/upland supportive services will no longer be viable, and those operations that provide and support commercial fishing, visitor-serving uses, and economic resources will cease. In the interim, the city is also working to define areas where shorelines could be expanded, and additional public trust lands could be provided. The majority of information about sea level rise impacts to public trust resources and adaptation strategies comes from studies and plans developed for other purposes such as the Local Coastal Program and General Plan update.




**Coastal Hazards considered:**
tidal inundation, 100-year storm

**Modeling system used for mapping:**
Northern Hydrology and Engineering (based on North Spit tidal gauge)

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Utilities (wastewater, drinking water, storm water, energy, communications, solid waste), docks, commercial and industrial buildings, public parks, trails, open un-treated contaminated sites |
| Natural Assets | ESHAs—Marine wetlands (378 acres inundated by 2100), Dunes (47 acres inundated by 2100) |

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# Economic Vulnerabilities

The anticipated costs of sea level rise were not provided in this assessment. However, the City of Eureka and County of Humboldt have conducted economic analyses of coastal dependent industrial land use needs, and other needs for the city's tideland areas. These analyses, as well as an economic development policy paper, informed the city's General Plan 2040, adopted in 2018. The City of Eureka used sea level rise projections of 10.8, 22.8, and 64.8 inches for 2030, 2050, and 2100, respectively.

*Figure 1 from City of Eureka Sea Level Rise Assets Vulnerability and Risk Assessment. Vulnerable diked shoreline. Photo: A. Laird.*

## Proposed Adaptation and Mitigation Measures

### *Protect*

Build, enlarge, or maintain a dike/levee along the existing shoreline. Create a wide multipurpose levee along the existing shoreline that provides opportunities for integrated development and elevate land surface behind levee with fill material. Implement tidal barriers. Create a living shoreline using new salt marsh fortified with logs and artificial reef. Create new landmass in the Bay for habitat, recreation, development, and recreation.

### *Accommodate*

Maintain Eureka's boardwalk and working waterfront piers and docks by retrofitting piers to accommodate periodic flooding; modifying structures to dampen tidal impacts; rebuilding and raising above projected sea level rise elevation; maintaining the piers and docks for as long as practical and safe, and then removing structure. Elevate street behind shoreline by integrating structural and non-structural adaptation measures along the line of defense (a street, trail, or other topographic feature).

### *Retreat*

There are several studies under way to analyze the potential for managed retreat along discreet portions of its waterfront.

The above strategies are introduced in Addendum #1 of the *City of Eureka Sea Level Rise Adaptation Planning Report and Final Adaptation Plan*.

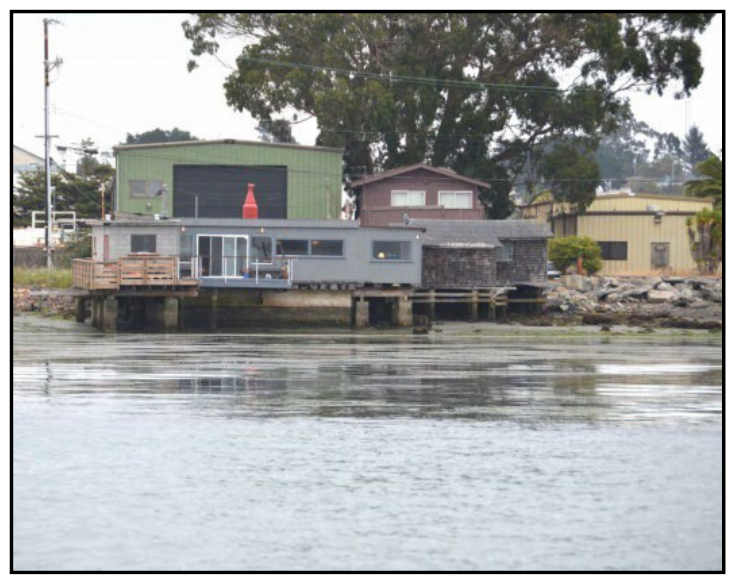


*Figure 2 from Humboldt Bay Shoreline Inventory, Mapping and Sea Level Rise Vulnerability Assessment. Building on Eureka Bay. Photo: A. Laird.*

**Partnerships**

The city has a number of partnerships with other local, regional, state, and federal agencies to study sea level rise and plan for adaptation. For example, the city partnered with CalTrans and Humboldt State University on the recent 2019 study Caltrans Eureka-Arcata Corridor: Sea Level Rise Vulnerabilities and Adaptation Solutions. This study informs adaptation planning currently under way by identifying a range of adaptation options to improve unsafe portions of the corridor.

# City of Benicia

*Solano County*

**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Fishing, Recreation
*Secondary Uses:* Safety & Navigation

## Site Description

The City of Benicia is a waterfront community in the San Francisco Bay Area, located on the north bank of the Carquinez Strait and the north side of Suisun Bay. The granted state lands are along the city's shoreline, extending from the Benicia State Park in the west to the city's eastern extent, just past the east end of the Benicia Industrial Park. The city was originally granted the state lands within the original city boundaries in 1855. Today, the granted area is a patchwork because some lands were privately sold (before the practice was outlawed in the early 1900s), and in some areas, the Public Trust has been terminated through quitclaims and title actions (mostly within the marina). The shoreline is relatively flat and encompasses a variety of land uses, including natural areas (e.g., marshes, wetlands, parks, beaches), park areas (some of which contain natural habitats), industrial/ commercial developments, critical infrastructure including stormwater system and the wastewater treatment plant, the Union Pacific Railroad, and a privately operated port. Benicia will have to prepare for new conditions, by implementing proactive strategies to lessen the impacts of climate change and reduce risk to key areas and assets throughout the city.


**Coastal Hazards considered:**
tidal inundation, 100-year storm, earthquakes

**Modeling system used for mapping:**
NOAA

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Waterfront properties in city's commercial district, Turnbull Park (0.5 acres), parts of the Benicia Industrial Park (4,000 acres), Benicia Marina Harbor, East 2nd Street, East 5th Street, Bayshore Road, East B Street, Industrial Way, the Port of Benicia (645 acres), the Benicia Wastewater Treatment Plant, stormwater outfalls at East 2nd Street and East 5th Street, parts of Union Pacific railroad, waterfront bike and pedestrian trails |
| Natural Assets | Benicia State Recreation Area (469 acres, marsh and 2.5 miles of trails) |

# Other Site Vulnerabilities

The costs below represent Benicia's plans to prepare a downtown sea level strategy that includes near-term redevelopment and a Master Plan, and a long-term process to study, develop, and implement a flood control system for the downtown and waterfront area. The Port of Benicia and private property along the shore owned by the oil company Valero are also highly vulnerable to sea level rise, but no cost estimates of their protection and adaptation strategies were specified. It is difficult to determine costs directly associated with Public Trust assets because this assessment was not developed for AB 691. However, because many costs were listed as unknown, it is likely that the total value of sea level rise impacts will be much higher than what is recorded below.


## Proposed Adaptation and Mitigation Measures

### *Policy Adaptation Strategies*

Prepare a downtown sea level rise adaptation strategy. Incorporate consideration of sea-level rise into the city's Capital Improvement Program, and into the design and funding of future infrastructure projects. Incorporate additional climate change considerations into city plans and codes. Incorporate sea level rise and coastal flooding potential into existing and future recover plans. Track extreme weather costs.

### *Natural or Nature-Based Adaptation Strategies*

Invest in green infrastructure. Coordinate flood planning along Sulphur Springs Creek.

### *Building and Infrastructure Strategies*

Limit new development in mapped hazard area. Develop a "Maintain-A-Drain" program and increase emergency preparedness for the wastewater collection system. Train public works department employees in flood response. Increase pre-event stormwater infrastructure maintenance. Monitor the need to expand the wastewater treatment plant's flood protection measures. Coordinate with the Port of Benicia on sea level rise and flood planning.

**New Sea Level Rise Adaptation Strategy in Development**

The city is developing a strategy to reduce temporary and permanent flooding in the downtown and waterfront area, between East 5th Street on the east and I Street (includes the ballfields used for stormwater retention, Rancho Benicia, where flooding already occurs during a storm event and where older, more vulnerable individuals live, and most of the historical salt marsh footprint) First Street and the Marina. These areas include granted state land and Public Trust assets. It will help avoid near-term disruption and long-term loss of recreational amenities, residential buildings, and economic activity in the downtown area.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (12 in.) | 2050 (24 in.) | 2100 (60 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **n/a** | **$9.525** | | |
| **Cost of Adaptation** | **n/a** | | **$12.78** | |

* Costs are from Chapter 5, pp. 45-80, and represent the sum of estimated costs of adaptation strategies relevant to sea-level rise. Very few specific costs were available.

# City of Alameda

*Alameda County*

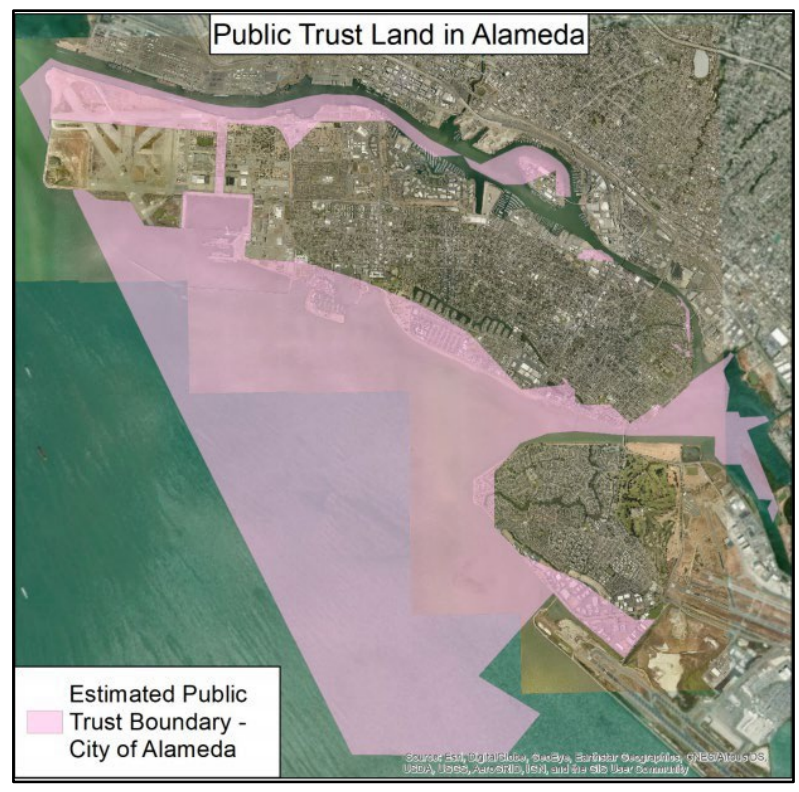
**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Commerce, Recreation
*Secondary Uses:* Safety & Navigation

## Site Description

The City of Alameda on the east side of San Francisco Bay comprises Alameda Island, a peninsula (called Bay Farm Island), and a small island owned by the U.S. Coast Guard. Nearly half of the city is built on filled and/or reclaimed historical tidelands and submerged lands, making it difficult to identify the exact location of the original state lands. This assessment looks at flood impacts to Public Trust resources along 11 key shoreline segments, including critical recreation areas, transportation corridors, and large areas of the Alameda Point Naval Air Station, which is planning an extensive redevelopment. As Bay water levels rise to mean higher high water + 52 inches (and higher), additional impacts to the Public Trust will occur to parcels at the western and southern ends of Bay Farm Island.




**Coastal Hazards considered:**
**tidal inundation, 100-year storm**

**Modeling system used for mapping:**
COAST

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Marinas (12), Parks (7), Hornet Field, Multipurpose Field, Main Street Dog Park, Lincoln Middle School Field, Public boardwalk, Encinal boat ramp, San Francisco Bay Trail, San Francisco Water Trail, USS Hornet Museum, Ferry Terminals (2), Commercial buildings (52), Shoreline Drive, Main sewer pipes and stormwater drainage system |
| Natural Assets | Crown Beach, Crab Cove, Elsie Roemer Bird Sanctuary (7-acre salt marsh and offshore eelgrass beds), Alameda Beach, mudflats |

# Other Site Vulnerabilities

The City of Alameda found that it will face significant losses from damage to buildings, infrastructure, and property exposed to flood hazards, using a model that overlays the value of parcels with flooding data. In addition, access to the ferry terminal on Alameda Island would be lost with 48 inches of sea level rise, and at Bay Farm Island at 52–66 inches. This would cut off a critical commuter transportation route to San Francisco, and a service that brings visitors to support the local tourism and recreation economy. Finally, non-market losses of recreation and habitat values are concentrated at Crown Beach, one of the few and most popular beaches in San Francisco Bay.

## Proposed Adaptation and Mitigation Measures

### *Protect*

Build new levees and seawalls and/or replace existing levees and seawalls with horizontal levees and living shorelines that combine oyster reefs offshore with expanded beaches, cobble berms. Beach nourishment, expand dunes at Crown Beach. Restore aquatic vegetation.

### *Accommodate*

Elevate existing levees and seawalls along Eastshore Drive, shoreline near Webster and Posey Tubes, Bay Island. Upgrade pump and sewage infrastructure. Elevate roads. Expand flood protection barriers, flood-proof facilities, explore other flood control options like installing pump stations. Augment salt marsh and mudflats along Crown Beach, Eastshore Drive, shoreline near Western and Posey Tubes. Coordinate with East Bay Regional Park District on Crown Beach Master Plan. Develop long-term strategies through local ordinances and replacements and repairs. Assess bridge vulnerability.

### *Retreat*

Allow beach to retreat inland. Develop tidal neighborhoods. Install different bike/pedestrian pathways. Consider land acquisition along Northern Waterfront to create a buffer between private upland property and water.

The City of Alameda uses a Social Vulnerability Index to understand which communities are the most vulnerable to rising seas and flood risks. The impacted populations most vulnerable to flood exposure in Alameda include renters, those who are severely housing-cost burdened, low income, seniors living alone, and communities of color. The area of highest overlapping sea level rise risk and social vulnerability is in western Alameda, at and near Alameda Point. This information will influence how the city prioritizes implementing adaptation strategies to protect the most vulnerable residents.

## Anticipated Costs of Sea Level Rise (millions)*

| | Current | 2030 (10 in.) | 2050 (23 in.) | 2100 (83 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **n/a** | **$40.6** | **$48.7** | **$188.1** |
| **Losses in Non-Market Value** | **n/a** | **$78/year, decreasing through time** | | |
| **Cost of Adaptation** | **n/a** | **$11** | **$34** | **$493** |

* Repair and Replacement Costs from Table L-4, p. L-19; Losses in Non-market Value from p. L-20; Adaptation Costs from Table L-8.

# Coyote Point

*San Mateo County*

**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Site Description

The Coyote Point Recreation Area is managed by the San Mateo County Parks Department and is a popular destination within the San Francisco Bay, with more than 500,000 visitors annually. The recreation area is located on 691.65 acres of sovereign land, tidelands, and submerged lands granted to the County of San Mateo by the State of California in 1965. Currently, the primary uses are recreational with a marina, beach access, park, picnic and playground amenities, and an environmental museum (CuriOdyssey). Additionally, this site includes a Sheriff's Office Training Center. The park features spectacular panoramic views of San Francisco Bay along the shoreline and from bluff trails and elevated viewpoints up on the Knoll, and access to natural habitat and marshlands.

## Public Trust Uses

*Primary Uses:* Recreation, Public Access
*Secondary Uses:* Commerce

**Coastal Hazards considered:**
tidal inundation, king tides,100-year storm, overtopping shoreline

**Modeling system used for mapping:**
In-house

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Bay and Promenade Trail, Magic Mountain Playground and other playground areas, picnic and parking areas, public amenities, marina and associated facilities and infrastructure, Peninsula Humane Society & SPCA, Boardsports Kite and Windsurfing Center & School, Sheriff's Office Training Center, PG&E power lines |
| Natural Assets | Freshwater marsh and seasonal wetland, beach area, salt marsh, mudflat areas |

# Other Economic Vulnerabilities

Impacts by 2030 would be centered on the Yacht Club. Impacts thereafter would be broader and involve the general parking, picnic, and other park recreational areas. It is estimated that losses in park revenue due to impacts to parking areas could be on the order of $10,000/day by 2050 and $20,000/day by 2100. Cost estimates reflect present value of future cost with price escalation based on the U.S. Average Consumer Price Index and index base period (1982-84 = 100) (BLS 2019).

**Proposed Partnerships**
Association of Bay Area Governments, Bay Conservation and Development Commission, California Department of Boating and Waterways, California Department of Transportation, City of Burlingame, City of San Mateo, Police Department, Harbormaster, Sam Trans, PG&E, CuriOdyssey, Coyote Point Rod and Gun Club, Coyote Point Yacht Club, Peninsula Humane Society, Point of View, San Mateo County Sheriff's Office

## Proposed Adaptation and Mitigation Measures

### *Protect*

**By 2030**, the Capital Improvement Project, which includes the Coyote Point Recreation Area Shoreline Promenade Improvement Project, the North Shoreview Flood Hazard Mitigation Project, the Living Shoreline and Tidal Elevation Project, and the Burlingame Point Project (project completed in May 2022).
**By 2050**, construct Eastern Promenade project (project completed in May 2022).
**By 2100**, install flood gates/barriers if necessary.
**By 2100**, raise grades and seawall at crest, and raise elevation of marina breakwater to at least +19 feet.

### *Accommodate*

**By 2050**, raise Bay Trail, Levee, and/or facilities or reconfigure the marina
**By 2050**, incorporate backflow prevention devices
**By 2100**, raise southern portion of Airport Blvd *or* raise trail/levee to +21 feet or use dredged material from marina to expand the existing tidal marsh.
**By 2100**, raise the shoreline trails, moles between basins, and parking lots at least +18 feet.

**Anticipated Costs of Sea Level Rise (millions)[*]**

| | Current | 2030 (9.6 in.) | 2050 (22.8 in.) | 2100 (82.8 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **$35.8[†]** | | | |
| **Losses in Non-Market Value** | **n/a** | **$0.037** | **$0.38** | **$5.4** |
| **Cost of Adaptation** | | | **$79** | **$270** |

[*] Repair and Replacement Costs Nonmarket Value from Tables 4-1 and 4-2.
[†] Cost of anticipated Capital Improvement Project

# County of San Mateo Harbor District

*San Mateo County*

## Site Description

San Mateo Harbor District was granted Public Trust lands at Pillar Point Harbor in 1960. Pillar Point Harbor, located approximately 25 miles south of San Francisco in the northern part of Half Moon Bay, was created by riprap breakwaters built by the U.S. Army Corps of Engineers between 1959 and 1961. Pillar Point Harbor remains a major commercial and sport fishing harbor, with 369 berths, on California's central coast, and is host to many public events including the annual Mavericks surfing competition, and the Christmas boat decorating contest. The area also includes several public beaches, coastal trails, bike routes, and pedestrian pathways. Before the construction of the harbor, the area was made up of wide sandy beaches with minimal erosion. While the construction of the outer breakwaters stabilized the shorelines within the harbor, it increased cliff retreat and beach erosion south of the eastern breakwater. The impacts of sea-level rise, which include increased shoreline erosion rates, will only exacerbate these issues and further threaten the Public Trust uses provided by the harbor's coastal resources. Pillar Point Harbor has developed several adaptation strategies to address the vulnerabilities of the area to sea-level rise, some of which include shoreline armoring to protect Highway 1, beach nourishment, and managed retreat.

**Granted Land Type:** Small Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Navigation
*Secondary Uses:* Commerce, Fisheries


**Coastal Hazards considered:**
tidal inundation, 100-year storm, shoreline change/ erosion, cliff retreat, tsunamis

**Modeling system used for mapping:**
NOAA

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Visitor facility, berthing slips, commercial fish-buying center, ice-making facilities, docks, piers, restrooms, launch ramps |
| Natural Assets | Coastal wetlands, beaches |

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# Other Economic Vulnerabilities

Values presented below are in 2017 dollars. Adaptation costs include beach nourishment only, calculated at $40 to $70 per cubic yard. The other option would be to install a seawall or revetment, which costs between $100,000 to $300,000 and is considered to be long-term; however, it will not restore the recreational and ecosystem value due to beach loss. Revenues from granted land were approximately $6.5 million for 2017/2018.


*Figure 3 Loss of beach access due to revetments*

## Proposed Adaptation and Mitigation Measures

### *Protect*

Monitor shoreline conditions regularly to ensure future trail sustainability; monitor the inner breakwater and pier conditions to ensure the harbor's functionality in the future; monitor sand accumulation to avoid a navigational hazard due to sedimentation in the future and keep the boat launch facility functional; monitor vegetation status; employ beach nourishment; install a seawall; repair and improve current revetments along the shoreline of Princeton (this will result in loss of beach and public access, see photo).

### *Retreat*

Execute managed retreat due to probable bluff retreat at Reach 7; monitor revetment conditions at Reach 8.

**Managed Retreat**

Reach 7 will experience significant bluff retreat in the future. However, because there is room for retreat, the beach in front of the bluff will survive and rebuild itself. The coastal trail though will fall inside the erosion zone by the end of the century and will require adjustment. For this reach, it is recommended to execute managed retreat, while monitoring the retreat pattern regularly to ensure the functionality of the coastal trail and beach access.

**Anticipated Costs of Sea Level Rise (millions)f***

| | Current | 2030 (9.8 in.) | 2050 (19.7 in.) | 2100 (29–39 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **$0.15–$0.2** | **$0.21** | **$1.60** |
| **Losses in Non-Market Value** | | **$0.26–$0.59** | **$0.98–$2.18** | **$2.49–$5.50** |
| **Cost of Adaptation** | **$0.11–$0.19** | **$0.14–$0.24** | **$0.16–$0.28** | **$0.22–$0.37** |

* Repair/Replacement Costs from Table 4, p. 5; Losses in NMV from Table 3, p.4; Beach Nourishment Costs from Table 5.1, p. 77.

# Moss Landing Harbor District

*Monterey County*

**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Fishing, Recreation
*Secondary Uses:* Navigation

## Site Description

In 1947, the State of California granted the Moss Landing Harbor District the submerged and tide lands of the Old Salinas River channel below the Potrero and Moss Landing tide gates, including the main channel of Elkhorn and Bennet sloughs and the coastal tide lands to the north and south of the Moss Landing Harbor entrance.

The Moss Landing Harbor is the number one commercial fishing harbor in Monterey Bay with 600+ slips for recreational boaters and commercial vessels. Partnering with marine research and education institutions, the Moss Landing Harbor District provides full public access to the marine environment. Designated as a year-round port of safe refuge, Moss Landing Harbor provides safe, reliable marine refuge and services to members of the boating public. Moss Landing Harbor supports the research and educational endeavors of the Monterey Bay Aquarium Research Institute and Moss Landing Marine Laboratories. Proximity to the Monterey Bay National Marine Sanctuary and the open ocean makes Moss Landing Harbor a valuable maritime resource that is also vulnerable to periodic impacts from ocean storms that will be exacerbated by sea level rise.


**Coastal Hazards considered:**
tidal inundation, 100-year storm shoreline change erosion, river flooding

**Modeling system used for mapping:**
in-house model

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Harbor buildings, docks and entryways to docks, electric meters, storm drains, trash enclosures, lift stations, bathrooms, roads and parking, coastal armoring, harbor jetties, culverts, and tide gates |
| Natural Assets | Wetlands, eelgrass beds, marine mammal haul-out areas, beaches and dunes, parks, coastal access points |

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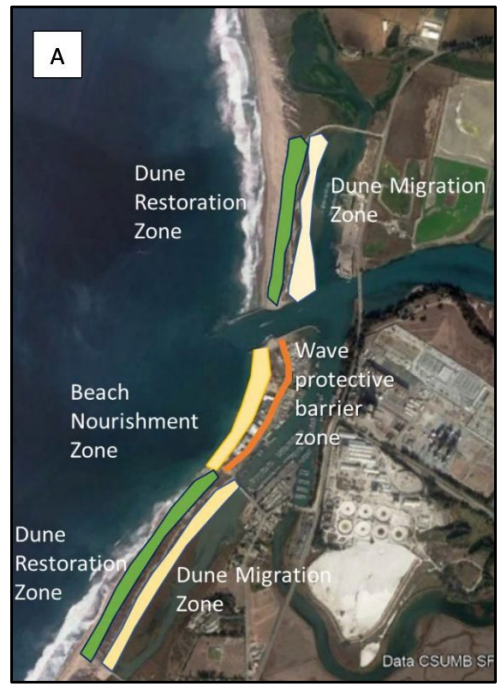
# Other Site Vulnerabilities

Because Moss Landing Harbor will likely no longer function under predicted 2100 sea levels of 6.9 feet (due to the loss of the barrier beach), estimating impacts from higher rates of sea level rise (10 feet—i.e., H++ sea level rise scenario) are not necessary or useful for planning purposes. Also, most adaptation measures identified within the document support the incremental resiliency of in-place harbor infrastructure rather than the development of new coastal amenities and therefore may not be classified as high stakes or long term.





## Proposed Adaptation and Mitigation Measures

### *Policy Adaptation Strategies*

Do not build new infrastructure within projected hazard zones that will not be resilient (for the expected life of the infrastructure) to the predicted impacts of that hazard; work with Monterey County and Moss Landing Community to ensure road access to harbor infrastructure and docks.

### *Natural or Nature-Based Adaptation Strategies*

Design and build low relief berms (with drainage infrastructure) along harbor waterfront and restore coastal beach and dunes to help reduce winter storm flooding to Harbor District property and adjacent roads and infrastructure.

### *Building and Infrastructure Strategies*

Upgrade harbor infrastructure within and adjacent to tidelands to be resilient to 2060 predicted tidal range (>2.6−3.8 feet); raise public parking and access areas of Harbor District property to above the predicted 2060 tidal range; draft long-range plan in partnership with Monterey County to relocate the harbor infrastructure (in tandem with the Moss Landing community, local roads and highway alignment) inland to serve 2100 community needs. Negotiate modified tidal lands lease agreement with State Lands Commission.

**Strategic Relocation**
Moss Landing Harbor District recognizes the impending threat posed by sea level rise and proposes to completely relocate its operations before the year 2100, as the harbor in its current state will be effectively nonfunctional after 2060 under a medium high sea level rise scenario

### Anticipated Costs of Sea Level Rise (millions)*

| | Current | 2030 (4 in.) | 2050 (28 in.) | 2100 (63 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **$30** | **$3.5** | **$13.8** | **n/a** |
| **Losses in Non-Market Value** | **$107** | **$0.2** | **$53.6** | **n/a** |
| **Cost of Adaptation** | | | | **n/a** |

* NMV from Table 9, p. 38, Nature based recreation, beach visitation, recreational boating; Lost Revenue from Table 9, p. 38, commercial fishing, commercial passenger fishing, recreational boating fees, research and conservation budget.

# City of Monterey

*Monterey County*

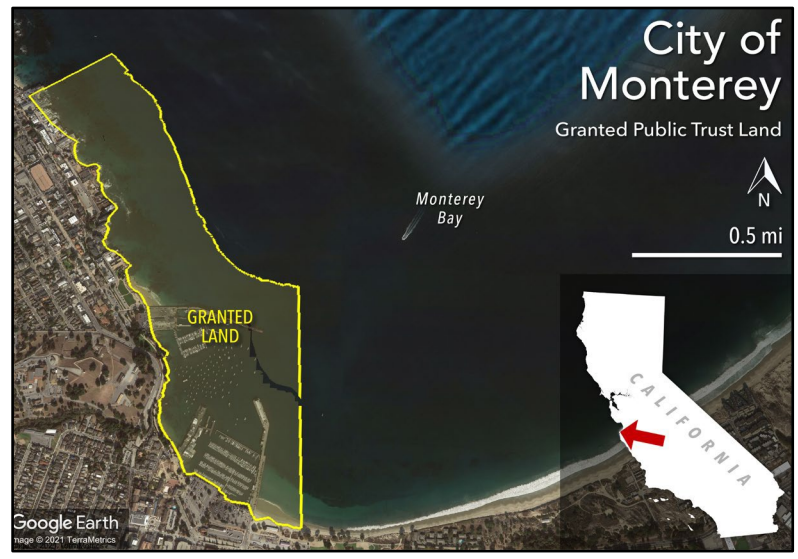
**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Commerce, Fishing
*Secondary Uses:* Recreation

## Site Description

The City of Monterey is located at the south end of Monterey Bay. The city was first granted the state tidelands within its city boundaries in 1868. The original grant was repealed and replaced in 1919 and amended in 1984 to specify that the city's granted lands included submerged lands to a depth of 60 feet at low tide water. The scope of this assessment was developed to complement previous studies with a focus on the tidelands of Monterey, which are generally located between Wharf 2 and the Monterey Bay Aquarium. Monterey took a transect approach to their assessment and divided their granted land into characteristic areas, including the fisherman wharves, marinas and moorings, natural coastal habitat and access points, and the cannery row waterfront. The city operates and maintains the Monterey Harbor and as well as many visitor serving commercial parcels with recreation, retail, and restaurant uses.




**Coastal Hazards considered:**
tidal inundation, wave run-up, shoreline change/ erosion

**Modeling system used for mapping:**
In-house model

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Monterey Bay Aquarium, Cannery Row, lodging, restaurants, retail shops. Pile-supported structures. Remnant historical structures. Seawalls. Roadway/sidewalk. Public restrooms. Sewer lift stations. Coast Guard Pier and Breakwater. Monterey Harbor recreation trail. Old Fisherman's Wharf (total loss at 60 in. of sea level rise). Municipal Wharf 2 (total loss at 60 in. of sea level rise). Municipal Marina (floating docks and moorings). Breakwater Cove. |
| Natural Assets | Sandy pocket beaches bound by rocky headlands/bluffs and reef (total loss at 60 in. of sea level rise). San Carlos Beach. Cobble bluffs. Rocky and sandy intertidal habitat. Public access points at McAbee Beach, Monterey Plaza Hotel Beach, San Carlos Beach, and Monterey Harbor Beach. |

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# Other Economic Vulnerabilities

Impacts from the 2030 and 2050 sea level rise scenarios are largely due to loss of revenue streams from Wharf 1 and 2 in addition to citywide loss of transient occupancy taxes and sales tax from loss of these attractions. The impacts from a 5-foot sea level rise scenario (2100) reflect the direct and indirect economic output and job losses due to the loss of visitor-days and sales caused by closure of one or both major attractions in Monterey—the aquarium and the wharves—from damage associated with the 2100 sea level rise scenario.

## Proposed Adaptation and Mitigation Measures

See section 8 for detailed descriptions of Monterey's adaptation strategies.

### *Natural or Nature-Based Adaptation Strategies*

**Present day–2050**: Opportunistic beach nourishment
**2050–2100**: Living shorelines and artificial reefs.

### *Building and Infrastructure Strategies*

**Present day–2050:** Cannery Row Waterfront—regular inspection and repair; dry flood proofing. Old Fisherman's Wharf & Municipal Wharf II—repair. Coast Guard Breakwater—reinforcement. Access and parking for boating infrastructure—flood storage or conveyance infrastructure, barriers to prevent flooding, elevating parking areas.

**2050–2100:** Cannery Row Waterfront—design for future wave impacts; secondary flood protection measures (i.e., wave return wall pictured at top right). Old Fisherman's Wharf & Municipal Wharf II—replacement. San Carlos Beach Park—reconfigure revetment and bluff-top amenities (potential to utilize a managed retreat approach). Marina upgrades for floating docks, piles, and utilities.

**Extended Closure**
It is assumed that after a major storm event coupled with the 2100 sea level rise scenario, there would be an extended closure period (assumed to be 5 years) during which the damaged facilities are repaired or replaced.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (8.8 in.) | 2050 (23.8 in.) | 2100 (62.6 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | n/a | $1.0075 | $2.06 | $34.0837 |
| **Losses in Non-Market Value** | n/a | $0.185 | $1.021 | $1.558 |
| **Cost of Adaptation** | n/a | n/a | n/a | n/a |

* Lost Revenue from Table 7.1; Non-market Value Estimates from Tables 7.18 to 7.20.

# City of Morro Bay

*San Luis Obispo County*

**Granted Land Type: Small Harbor/Marina with Recreational amenities OR natural assets.**

## Public Trust Uses

*Primary Uses:* Recreation, Fishing
*Secondary Uses:* Conservation

## Site Description

The City of Morro Bay's Public Trust grant spans the coastline from Morro Dunes in the north to the eastern edge of Morro State Park in the south, and extends 3 miles offshore. The coastline here is characterized by a mix of coastal wetlands and mudflats, sandy beaches and dunes, and some coastal bluffs. This area includes the prominent Morro Rock and the northern region of Morro Bay, home to a large population of sea otters. Other land uses supported by the City's grant include beach and dune recreation areas, critical infrastructure (transportation, communication, and wastewater facilities), and The Embarcadero Waterfront, which is a tourism hub for the city.

The city of Morro Bay is susceptible to coastal hazards such as inundation, flooding, and bluff/dune erosion associated with extreme waves and water levels, resulting in adverse impacts on many of Public Trust uses outlined above. With a thoughtful and effective approach to adaptation, beginning with the planning process, impacts from sea level rise can be reduced, resulting in a more resilient coastal community.


**Coastal Hazards considered:**
tidal inundation, 100-year storm, wave run-up, river flooding, bluff/dune erosion

**Modeling system used for mapping:**
In-house model

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | The Embarcadero Waterfront, transportation infrastructure (Highway 1), wastewater and storm drainage facilities, desalination plant, telecommunications infrastructure, Fire Stations 53 and 54, education facilities, fishing industry infrastructure (docks, piers, offloading hoists) |
| Natural Assets | Morro Rock and Morro Rock Beach, Morro Sand Dunes, Heron Rookery Natural Preserve, Eelgrass habitat, Morro Bay Sandspit and Salt Marsh |

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# Other Economic Vulnerabilities

The losses in non-market value are estimated from previous studies of the value spent per beachgoer per day at California beaches, applied to the estimated 250,000 beach visitors that Morro Bay receives annually. In the city's 2018 Sea Level Rise Adaptation Strategy Report, Table 3-3 includes adaptation costs of construction and maintenance are estimated for a variety of options, such as revetments and dunes, but there is not enough detail given to include overall costs in this summary.

## Proposed Adaptation and Mitigation Measures

### *Protect*

Improve existing Highway 1 revetment or build sand dunes atop existing Highway 1 revetment; extend existing sand dunes southward to include protection of Morro Rock parking lot.

### *Accommodate*

Elevate Highway 1 on a bridge; improve and reconfigure underdeck utilities on fixed docks along The Embarcadero Waterfront to be more resilient to sea level rise; improve floating dock design along The Embarcadero Waterfront; improve or elevate storm drains.

Raise entire Embarcadero Waterfront.

### *Retreat*

Shift alignment of Highway 1 eastward, retreat Morro Rock parking lot.

The Embarcadero Waterfront supports various commercial uses, including Morro Bay's commercial fishing industry, a small but vital part o the city's economy. Commercial fishing was a priority for Morro Bay beginning with the building of the harbor during World War II by the Department of the Navy. While much of the waterfront and supporting facilities have significant elevation, extreme sea level rise estimates (i.e., 10 feet) would result in a host of vulnerabilities. Improvements to underdeck utilities, floating docks, and storm drains, or complete elevation of waterfront land, piers, and associated facilities, would ensure protection under future sea level rise conditions.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (12 in.) | 2050 (24 in.) | 2100 (66 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | | | |
| **Losses in Non-Market Value** | **$6.125–$12.5 per year** | | | |
| **Cost of Adaptation** | | | | |

* Replacement cost from Table 4, p.14; non-market value Table 5, p.15; value of exposed assets Table 6, p.15.

# City of Santa Barbara*

*Santa Barbara County*

**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Fishing, Recreation
*Secondary Uses:* Navigation, Conservation

## Site Description

The City of Santa Barbara's Public Trust grant spans the coastline from Hendry's Beach on the west to the Andree Clark Bird Refuge on the east. The Santa Barbara coastline is characterized by a mix of coastal bluffs and low-lying sandy beaches and backshores and serves a variety of land uses. This includes natural areas, recreational beaches and parks, critical infrastructure (transportation, wastewater, and communication infrastructure), the Harbor and all associated facilities, and numerous commercial and industrial developments. Rising sea levels will present increased physical risks to the area, including shoreline erosion and degradation, decreased beach widths, amplified storm surges, and inundation of coastal flood waters. The City has significantly advanced sea level rise planning and adaptation projects since submitting its AB 691 assessment, including the adoption of a phased approach Adaptation Plan with over forty high-priority actions slated to begin in the next 5 years.


**Coastal Hazards considered:**
tidal inundation, 100-year storm, storm wave run-up, shoreline erosion/bluff erosion

**Modeling system used for mapping:**
CoSMoS 3.0 (USGS) and Coastal Resilience Santa Barbara (ESA)
**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Transportation infrastructure, recreation facilities, stormwater infrastructure, Stearns Wharf, harbor services and associated facilities, public property, communication infrastructure, water supply and wastewater infrastructure, Laguna Channel and Tide Gate/Pump System |
| Natural Assets | Recreational areas, beaches, trails, parks, bluffs, Mission Creek, Arroyo Burro County Beach Park |

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* This was a city-wide assessment and therefore the resources, economic information, and proposed adaptation measures may include areas of analysis outside the city's granted lands.

# Other Economic Vulnerabilities

The assets affected are currently worth the amounts below. These amounts (or costs) assume replacement-in-place (no relocation) and as currentlydesigned and represent a rough order of magnitude cost in 2018 dollars for planning purposes only. The costs do not reflect losses and other costs associated with taking no action. The assets include the Braemar Lift Station, Laguna Tide Gates, Laguna Stormwater Pump Station, Harbor, Stearns Wharf, El Estero Wastewater Treatment Plant, and the Charles E. Meyer Desalination Plant. The actual replacement costs for these facilities in the future could likely be much higher. The Santa Barbara Harborworks (breakwater, marinas, etc.) was estimated to be valued around $50 million−$60 million, based on review of damages documented at Crescent City and Santa Cruz harbors during earthquakes in 2006 and 2011 (damages converted to 2018 dollars and scaled to size of Santa Barbara Harbor).

The Santa Barbara Harbor and Stearns Wharf are valuable and important assets in the city. The harbor includes the marina, commercial uses, parking, industrial areas, and the City Pier, which supports the Coast Guard and houses a fuel dock. Under existing conditions, storm events and especially high tides (king tides) can dislocate pile caps at the floating docks, and waves can overtop the harbor breakwater and reduce public access. More than 2 feet of sea level rise (e.g., the 2060 case) is expected to regularly impede normal harbor functions, and the harbor in its current configuration would be unusable by 2100, with more than 6 feet of sea level rise.

## Proposed Adaptation and Mitigation Measures

### *Policy Adaptation Strategies*

Create shoreline monitoring program and identify action thresholds.

### *Natural or Nature-Based Adaptation Strategies*

Study and implement sand bypassing and beach berm construction programs; study and implement additional beach nourishment and seasonal berms.

### *Building and Infrastructure Strategies*

Manage bluff drainage to reduce erosion from runoff and irrigation; require bluff setbacks for new development/ redevelopment and limit use of revetments to protection of essential public services, access points, and major roads; relocate or remove non-critical assets; comprehensively study impacts to wastewater, water, recycled water, and stormwater systems; raise or modify Harbor breakwater, rock groin, sandspit, and the walkway and wall from breakwater to Harbor commercial area; renovate marina facilities and the City Pier in phases, raise piles by the time 0.5−1 feet ofsea level rise occurs; study appropriate triggers for temporarily closing Stearns Wharf during major storms; redesign and reconstruct the Laguna tide gate and pump system.

Proposed adaptation and mitigation measures are from the City of Santa Barbara's Sea-Level Rise Adaptation Plan that was adopted in 2021. The AB 691 Assessment referred to this plan, which was developed after the AB 691 submission due date (2019)

## Anticipated Costs of Sea Level Rise (millions)*

| | Current | 2030 (9.6 in.) | 2050 (30 in.) | 2100 (79.2 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **$397–$459** | | | |
| **Losses in Non-Market Value** | | | | |
| **Average Annual Public Trust Revenues at Risk** | **$14.4** | | | |

.

* These costs are from (p. 45) Table 6: Approximate 2018 Replacement Costs for Public Works Assets in Place as Currently Designed. These cost evaluations have been updated in the most recent Adaptation Plan and the values are more the 2 orders of magnitude greater than what is presented in this table

# City of Redondo Beach (King Harbor)

*Los Angeles County*

**Granted Land Type:** Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

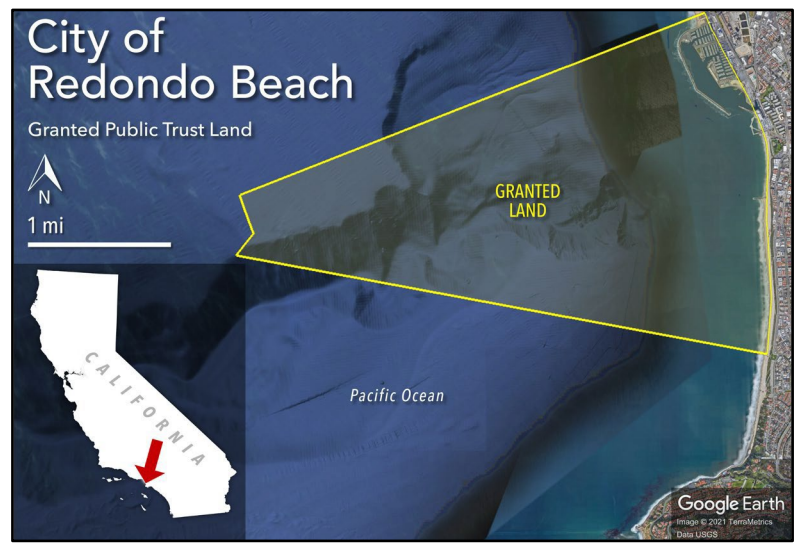
*Primary Uses:* Recreation
*Secondary Uses:* Commerce, Safety & Navigation, Environmental Stewardship

## Site Description

Located at the south end of the densely populated Santa Monica Bay area, the City of Redondo Beach's King Harbor is a man-made facility and a unique urban harbor complex that is one of the most valuable assets of the city. The mixture of sheltered mooring basins, commercial businesses, park and open space, and direct water access supports a variety of recreational opportunities that provide enjoyment for millions of residents and non-local visitors annually. As such, the harbor is an important source of income to the local economy.

King Harbor today is approximately 175 acres. Of that area, the total water footprint is about 99 acres and consists of three mooring basins for wet storage of small craft, an outer harbor navigation channel and transient mooring area, and a turning basin that is offset from the main channel near the harbor entrance. Approximately 40 acres of the development is inland of the 1935 mean high water line.

The public trust grant for the offshore area was given to the city from the state in 1915 to yield the right, title, and interest in all state lands within the city limits seaward of the mean high tide line. At that time, the dedicated lands were intended to be repurposed for harbor development. The grant was later amended in 1971 to release four small parcels areas totaling about 8 acres from future navigation, commerce, or fisheries purposes.




**Coastal Hazards considered:**
tidal inundation, wave run-up, storms (1-, 10-, 25-, 50-, and 100-year)

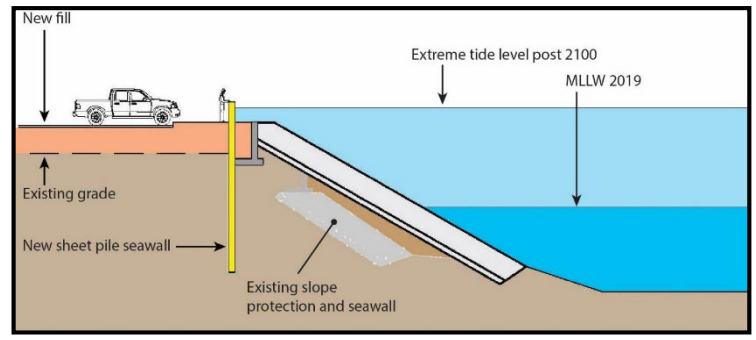
**Modeling system used for mapping:**
CoSMoS

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Marinas, recreational facilities, hotels, restaurants, harbor businesses, roads, South Breakwater, North Breakwater, pier, Moles A-D, stormwater catch basins (57 by 2100) pump stations (4 by 2100), sewer gravity main lines (55 lines, 9,051 ft by 2100), sewer pressurized mains (3 lines, 948 ft by 2100), sewer service lines (129 lines, 2,991 ft), traffic signals (7 by 2100), street lights (143 by 2100), signs (95 by 2100), curb gutters (12,818 ft by 2100), impervious surfaces (73,274 sq ft by 2100), pavement (321,122 sq ft by 2100) |
| Natural Assets | Trees (48 by 2100), tidelands around King Harbor |

# Other Economic Vulnerabilities

Economic costs for non-market values were not provided. Sea level rise adaptation is an estimated order of magnitude cost in 2019 dollars. These estimates do not include various improvements that may be required within existing leaseholds nor any costs that may be incurred by other agencies to improve the outer break wall. Cost of adaptation for 2030, 2050, and 2100 correspond directly to the strategies described below. The costs for 2100 include those for "long-term" protection and beyond 2100. The City of Redondo Beach assessed projected upland impacts.




## Proposed Adaptation and Mitigation Measures

### *Protect*

**Short-Term to 2030 (sea level rise less than 1.0 foot):** Raise the seawall crest around Basins 1 and 2, the low-lying portion of Basin 3 perimeter, along east and south ends, and portions of Mole A adjacent to the North Breakwater. Consider addition of a short parapet wall to prevent flooding of the accessways during extreme high tides.

**Mid-Term 2030 to 2050 (sea level rise between 1 and 2 feet):** Add a perimeter retaining wall to protect existing development and infrastructure from flooding.

**Long Term Period 2050 to 2100 (sea level rise of 5.5 feet):** Extend the crest elevation of the landward retaining wall and increase perimeter protection via construction of extended basin slope protection that would extend into Basins 1 and 2.

**Post-2100:** Build a perimeter sheet pile seawall to reinforce inundation protection supplemented with adjustment of landward finished grades by fill placement.

### *Accommodate*

**Post-2100:** Raise base floor elevations to protect entire harbor footprint.

Develop a debris management plan.

### *Retreat*

**Post-2100:** Relocate utilities.

### Storm Wave Effects

The western portions of Mole A, B, C, and D will be further affected by an increased exposure to storm wave run-up by 2100. Residual sea and swell that propagates into King Harbor will impact those sections of shoreline immediately adjacent to the outer Harbor. The problem will be exacerbated by the fact that the 5.5 foot increase in sea level by 2100 will effectively lower the outer breakwaters by that elevation rendering them similar in crest height to conditions that existed during the destructive January 1988 storm. The wave energy that propagated into the outer Harbor during that benchmark storm event, destroyed much of the shoreline development at Moles C and D.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (9.6 in.) | 2050 (22.8 in.) | 2100 (66 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | | | **$46** |
| **Losses in Non-Market Value** | | | **$3** | **$21** |
| **Cost of Adaptation** | | **$5** | **$6** | **$280** |

* Costs are from Tables 4, 5, and 6 on pgs. 13-15.

# City of Long Beach

*Los Angeles County*

**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Fishing, Recreation
*Secondary Uses:* Safety & Navigation

## Site Description

The City of Long Beach is located within San Pedro Bay on the Pacific coast of California. The city was first granted state lands in 1911. A portion of the city's grant is the Long Beach Harbor District, which is the site of the Port of Long Beach. The port, through the Harbor District, is managed distinctly from the remainder of the granted lands, by an independent city department called the Long Beach Harbor Department. The city's shoreline is a combination of a 5.5-mile stretch of sandy beach along with a fortified shoreline within portions of the sheltered embayments and port. Portions of the city lie at a low elevation and have major industry along the water's edge, notably the Port of Long Beach—the second busiest seaport in the United States—as well as transportation, water, and power infrastructure, beaches, marinas, homes, and businesses.


**Coastal Hazards considered:**
tidal inundation, king tides, 100-year storm

**Modeling system used for mapping:**
CoSMoS

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Fire stations (3 by 2030, 7 by 2100), marine safety facilities (5 by 2030, 8 by 2100), Southeast Resource Recovery Facility, parks (23 by 2030, 41 by 2100), marinas, roads (49 miles by 2030, 98 miles by 2100), bike paths (4 miles by 2030, 15 miles by 2100), bridges (60 by 2100), NRG Long Beach Generating Station, Alamitos Generating Station, Seabright substation (2030), Marina substation (2100), transmission lines (8 miles by 2030, 20 miles by 2100), stormwater outfalls (23 by 2030, 49 by 2100), stormwater pump stations (7 by 2030, 14 by 2100), storm drains (15 miles by 2030, 67 by 2100), wastewater pump stations (4 by 2030, 17 by 2100), force and gravity mains (28 miles by 2030, 78 miles by 2100), potable water facilities (1 by 2030, 4 by 2100), potable mains (26 miles by 2030, 80 miles by 2100), water hydrants (217 by 2030, 512 by 2100) |
| Natural Assets | Alamitos Beach, Junipero Beach, Belmont Shore beach, Peninsula Beach, Bayshore Beach (projected to be 100% lost by 2100), Peninsula Beach, Mothers Beach, Jack Dunster Marine Reserve, Los Cerritos Wetlands Complex (northern by 2030, southern by 2100) |

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# Other Economic Vulnerabilities

This analysis assumes that different types of financial consequences are expected from temporary event-based storm flooding compared to permanent progressive tidal inundation from sea level rise; separate assessment methodologies and categories of impacts were evaluated in some cases. The asset inventory, vulnerability profiles, and adaptation actions developed for the City of Long Beach Climate Action and Adaptation Plan were used to develop order of magnitude financial cost estimates for the impact categories evaluated. The costs of adaptation for 2100 are in addition to the costs for 2050.

## Proposed Adaptation and Mitigation Measures

### *Policy Adaptation Strategies*

**2030:** Establish floodplain ordinance. Incorporate sea level rise language into plans, policies, and regulations. Establish a flood impacts monitoring program. Incorporate sea level rise and flooding adaptation into city lease negotiations. Upgrade the city's existing Stormwater Management Plan. Conduct citywide beach stabilization study. Conduct studies of combined riverine/coastal flooding and increased precipitation impacts on watershed flooding.

**2050:** Investigate sea level rise adaptation funding mechanisms and strategies.

**2100:** Investigate feasibility of managed retreat. Evaluate feasibility of storm surge barrier at Alamitos Bay.

### *Natural or Nature-Based Adaptation Strategies*

**2030:** Restore dunes.

**2100:** Expand beach nourishment. Construct living shoreline/berm.

### *Building and Infrastructure Strategies*

**2030:** Inventory and flood-proof vulnerable sewer pump stations.

**2050:** Relocate/elevate critical infrastructure. Elevate riverine levees.

**2100:** Elevate/extend curb. Retrofit/extend sea wall. Elevate streets/pathways. Retreat / realign parking lots. Extend/upgrade existing seawalls.

**The Cost of Inaction**

If the City of Long Beach does not take action to mitigate the potential impacts of sea level rise and coastal storms, the financial costs could be significant. In 2030 and 2050, coastal storms pose greater financial risk to the Long Beach waterfront property compared to gradual tidal inundation from sea level rise. By 2100, sea level rise poses greater financial risk to waterfront property compared to the coastal storm impacts that were evaluated. Significant impacts to public trust lands in the City of Long Beach result from impacts to the beaches along the open coast and bays.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (11 in.) | 2050 (24 in.) | 2100 (37–66 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **$57.25** | **$118.55** | **$276.65** |
| **Losses in Non-Market Value** | | **$12** | **$48.9** | **$74.1** |
| **Cost of Adaptation** | | | **$145.3–$188.7** | **$63.9–$80.9** |

* Replacement cost from Table 4, p.14; non-market value Table 5, p.15; value of exposed assets Table 6, p.15.

# City of Newport Beach

*Orange County*

**Granted Land Type:**
Jurisdiction with Recreational Amenities

## Public Trust Uses

*Primary Uses:* Commerce, Recreation
*Secondary Uses:* Navigation, Environmental Stewardship

## Site Description

The City of Newport Beach manages tidelands, submerged lands, and filled tidelands from the Newport Bay entrance channel to areas inside the Newport Harbor and up the coast towards the east Santa Ana River Jetty. It was also granted Big Canyon Park, located in Upper Newport Bay. The coast between the river and the harbor entrance consists of sandy beaches with coastal structures, including the groin field between 28th Street and 56th Street in West Newport Beach, two public piers, and the ocean jetties of the harbor entrance. The harbor has 17 miles of bulkhead wall, six islands with residential development, more than a dozen mooring sites, and over 1,100 docks for commercial, private, marina, and recreational boaters. Between Newport Pier and the harbor entrance is Balboa Peninsula, a relatively low and flat 3-mile-long sand spit, with sandy beaches and coastal foredunes that are backed by low-lying residential and commercial development.


**Coastal Hazards considered:**
tidal inundation, 100-year storm, shoreline erosion

**Modeling system used for mapping:**
CoSMoS

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Docks (>1,100), mooring areas, lifeguard facilities, parking lots, roads, pedestrian paths, restrooms, groins, bulkhead walls, riprap, Balboa Pier, Newport Pier, West Harbor entrance jetty, East Harbor entrance jetty, Harbor entrance channel, Lido Channel, commercial infrastructure, stormwater infrastructure, wastewater infrastructure, parks, Semeniuk Slough |
| Natural Assets | West Newport Beach, Balboa Peninsula Beach, Big Corona Beach, Little Corona Beach |

# Other Economic Vulnerabilities

Single-family residential homes represent the largest potential financial/economic losses, with more than half of the total estimated losses at all sea level rise scenarios. In addition, many commercial properties will be impacted, notably the Balboa Bay Yacht Club and Resort. The losses in non-market value are also significant and will increase substantially over time. By 2030 (0.8 feet of sea level rise), the total loss is $22.7 million; it increases to $40 million with 1.6 feet of sea level rise, and $105 million with 4.9 feet of sea level rise.

## Proposed Adaptation and Mitigation Measures

### *Protect*

One adaptation strategy proposed is to protect coastal resources within tidelands with a seawall or bulkhead wall. This strategy is only effective insofar as sufficient dry beach is present between the sea and the tidelands asset being protected. Beach nourishment is proposed for West Newport Beach, Balboa Peninsula, and Big Corona Beach. Beach nourishment is considered a “soft protection” strategy and is temporary by design—the added beach width will begin dispersing soon after placement, and the length of time the dry beach remains at a site will vary.

### *Accommodate*

There are no accommodation strategies currently planned; however, they may be considered in the future.

### *Retreat*

A managed retreat approach involving relocation of vulnerable resources would offer benefits to the community by mitigating impacts of coastal squeeze (beach loss) for a sea level rise scenario of 4.9 feet. Many of the resources and amenities would either need to be removed from this area entirely or would require site-specific adaptation measures to be more resilient to the evolving shoreline erosion hazards.

**Public Access**

With sea level rise of 0.8 feet and a 100-year storm, access and roadways along the harbor side of the Peninsula are vulnerable to coastal flooding, including the Bay Front Boardwalk on Balboa Island and the Edgewater Avenue Boardwalk on the Peninsula. With sea level rise of 4.9 feet and a 100-year storm, flooding extends inland on the Peninsula and impacts the Oceanfront Boardwalk. In fact, with sea level rise of 4.9 feet and a 100-year storm, most all public access routes in and outside of the study area could be affected by future sea levels and shoreline conditions if no mitigation and adaptation measures are taken.

**Anticipated Costs of Sea Level Rise (millions)[*]**

| | Current | 2030 (9.6 in.) | 2050 (19.2 in.) | 2100 (58.8 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **$13.3** | **$27** | **$37.1** |
| **Losses in Non-Market Value** | | **$22.7** | **$39.9** | **$104.8** |
| **Cost of Adaptation** | | **$2.2** | **$4.4** | **$24.5** |

[*] Costs were provided for 0.8, 1.6, and 4.9 feet. For the purposes of AB 691, these are interpreted as near-term (year 2030), mid-term (year 2050), and long-term (year 2100) sea level rise. Repair/Replacement/Maintenance from Table 6-3 and Flooding Costs from Table 6-4; Non-Market Value from Table 6-12.

# Newport Bay

*Orange County*

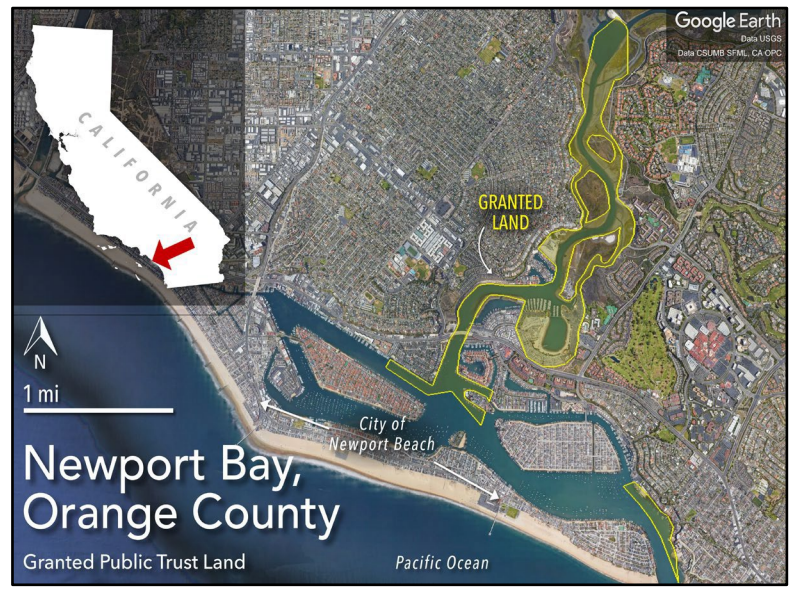
**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Commerce, Navigation
*Secondary Uses:* Recreation, Environmental Stewardship

## Site Description

Newport Bay is in Orange County within the City of Newport Beach. Public Trust lands granted to the County of Orange are located throughout upper Newport Bay and select portions of lower Newport Bay. Upper Newport Bay, extending north of the Pacific Coast Highway, covers an area of approximately 1,000 acres, a large portion of which is designated as county tidelands. The majority of upper Newport Bay is wide and shallow, forming intertidal habitat areas such as mudflats and coastal wetlands, with short stretches of sandy beach and bulkheads that front developed shoreline. Tidelands within lower Newport Bay surround areas of residential and commercial development. Bulkheads and attached recreational boating infrastructure make up the majority of tideland shoreline in lower Newport Bay except for a small sandy beach area adjacent to the Newport Beach Harbor Patrol building.




**Coastal Hazards considered:**
tidal inundation, wave run-up, storms (annual, 20-year, 100-year), shoreline erosion

**Modeling system used for mapping:**
CoSMoS

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Marinas/Docks, Parking Lots, Streets/Walkways, Restrooms, Bulkhead Wall, Commercial Areas, Storm Drain and Wastewater Utilities |
| Natural Assets | Parks, Beaches |

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# Other Economic Vulnerabilities

County of Orange tidelands generate revenue through rents and concessions as well as fees paid for parks and recreation services. Total county tideland revenue was greater than $4 million in financial year 2016−2017, accounting for most of the overall tideland revenue. Newport Dunes Marina and Resort represents the largest individual source of revenue at approximately $3 million. County of Orange tidelands contain approximately 17 acres of sandy beach area, resulting in a total annual service flow of approximately $975,000 based on EPA non-market service valuations and adjustments to 2019 dollars using Consumer Price Index values. Sea level rise is projected to significantly reduce this sandy beach area over time.

## Proposed Adaptation and Mitigation Measures

### *Protect*

Protective devices can potentially be employed along coastal parking lots and access points within the study area to mitigate sea level rise impacts. Seawalls or other additional shoreline protection can be used to address projected flood impacts within resources such as Newport Sea Base and the Newport Dunes Marina parking lots. Revetments can be implemented to reduce sea level rise impacts to the Newport Dunes Resort and the Newport Aquatic Center, or nature-based strategies, such as living shorelines (pictured above) can be employed to protect structures without further hardening existing shorelines.

### *Accommodate*

Parking lots and other coastal access resources can be elevated using fill or other methods to offset increased water elevations and maintain the current height of the shoreline relative to sea level. Accommodation strategies for boating infrastructure, including any floating docks, access gangways, and guide piles, are linked to the structural design tolerance for high water levels. Temporary or permanent flood-proofing retrofits and improvements to stormwater infrastructure can also be employed to reduce the impacts and recovery time following flood events.

### *Retreat*

Retreat measures are most feasible for resources that have open space located landward at higher elevations, such as the Newport Dunes Marina parking lot, where inland auxiliary parking and boat storage could potentially serve as relocation destinations. Sandy beach areas can also retreat landward through natural processes as water elevations rise if open space is made available. Because boating infrastructure depends on proximity to the shoreline, retreat strategies may be necessary to account for potential shoreline migration over long-term sea level rise scenarios. Although limited, there is some topographic variation within County of Orange tidelands that provides opportunity for the relocation of high-value, long-term upland development to higher ground.


*Figure 4 Living shoreline concept designed to protect inland areas from sea level rise*

**Recreation and Coastal Access—Sea Level Rise Vulnerability**

Recreational and coastal access resources within the study area have a low overall vulnerability to short-term sea level rise hazards, due in large part to limited hazard exposure, with only select areas of Newport Sea Base and the Newport Harbor Patrol projected to become flooded under a 0.8- or 1.6-foot sea level rise scenario. These areas are more vulnerable to long-term sea level rise hazards. Non-storm flood projections under a 4.9-foot sea level rise scenario cover significant areas of these resources, and **only limited areas remain available with 6.6 feet of sea level rise.** Any areas subject to frequent non-storm flooding are likely to experience a significant decline in public utility as access becomes disrupted on a regular basis.

## Anticipated Costs of Sea Level Rise (millions)*

| | Current | 2030 (9.6 in.) | 2050 (19.2 in.) | 2100 (58–79 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | | | |
| **Losses in Non-Market Value** | | **$0.136/year** | **$0.214/year** | **$0.572–$0.766/year** |
| **Cost of Adaptation** | | | | |

* Information was not presented in this report on costs for the years 2030, 2050, and 2100.

# City of Avalon

*Los Angeles County*

**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Site Description

The City of Avalon is on the northeastern shoreline of Santa Catalina Island in Los Angeles County. The granted state lands extend from the Hamilton Cove area in the west to select areas bordering Pebbly Beach Road to the east. The area has shorelines backed by cliffs and bluffs of varying height, a series of bays with primarily narrow, rocky beaches, and a portion to the southeast of a narrow to non-existent beach seaward of Pebbly Beach Road. It is impacted by southeasterly swells that can produce short-period, wind-driven wave hazards of sufficient magnitude to impact coastal infrastructure. Commercial and recreational uses include cruise ship and ferry services and infrastructure, as well as marinas, boat launches, retail, restaurants, and many other visitor-serving public trust resources. In addition, there are subtidal marine resources, kelp forests, and hard bottom habitats that support rich biodiversity and are world-renowned for scuba diving and snorkeling. Whale watching, recreational fishing, and beachgoing are also widely popular activities in this area.

## Public Trust Uses

*Primary Uses:* Commerce, Recreation
*Secondary Uses:* Safety & Navigation, Environmental Stewardship


**Coastal Hazards considered:**
tidal inundation, 100-year storm, overtopping, wave run-up, wave height

**Modeling system used for mapping:**
CoSMoS

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Catalina Island Yacht Club, Tuna Club, Green Pleasure Pier, Mooring and Boating Infrastructure (347 moorings, pump-out facility, fuel station, miscellaneous seasonal docks), Cabrillo Mole Terminal, various pedestrian pathways and public access points consisting of seawalls or revetments with stairs over top |
| Natural Assets | Casino Point State Marine Conservation Area, Lover's Cove State Marine Conservation Area, other beach, intertidal, and subtidal marine habitat |

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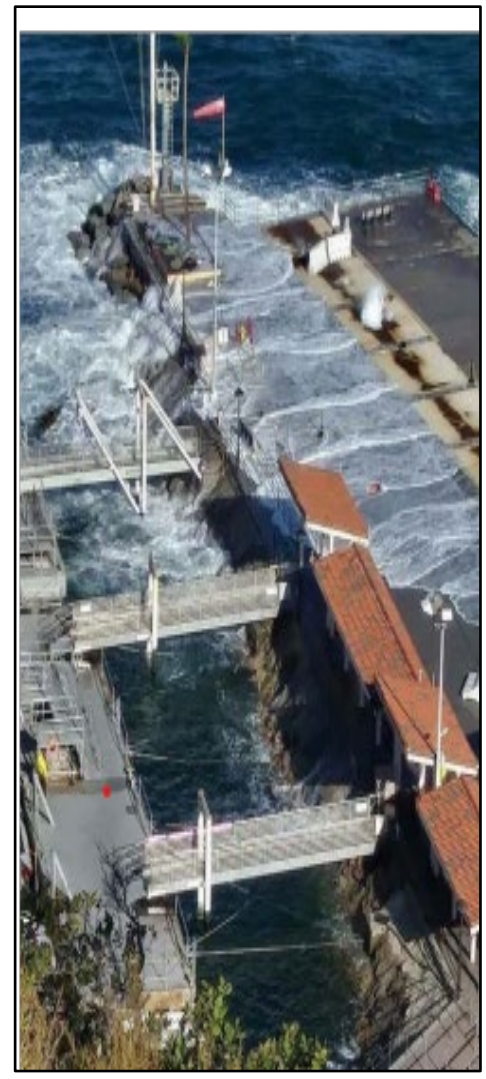
# Other Site Vulnerabilities

An economic analysis of Catalina Island tourism estimated that in 2016 approximately 910,800 visitors accounted for $166.7 million of direct spending, which generated $5.8 million in local tax revenue and supported 1,254 jobs. The retail district of Avalon and the harbor were by far the most visited areas of the island. It includes flagship, pile-supported structures along the waterfront—the Catalina Island Yacht Club, Tuna Club, and Green Pleasure Pier—that are at high risk from rising seas. Moorings are also hugely important to city revenues, as well as annual permit and transfer fees. In 2018 the City operated 361 moorings resulting in over $2 million of generated revenue. Given that the City's tourism-dependent economy is focused on activities on or near the water, it is expected that adverse impacts to tideland resources could translate to significant direct and indirect financial impacts.



## Proposed Adaptation and Mitigation Measures

### *Protect*

Ongoing maintenance and enhancement of existing shoreline protection within the Cabrillo Mole. Augment existing shoreline protection system with retrofits or replacement of existing infrastructure.

### *Accommodate*

Wet or dry flood-proofing. Beach nourishment. Elevation of the Cabrillo Mole to prevent loss of access and flooding of structures. Elevate coastal access resources with fill or other methods to offset increased water elevations.

### *Retreat*

Retreat measures are most feasible for resources that have open space located landward at higher elevation such as the southeastern portion of Avalon Bay. Sandy beach areas can also retreat landward through natural processes as water elevations rise if open space is made available.

**Public Access**

The vital recreation and tourism sector for Avalon highly depends on public access to the water. At 24 inches of sea level rise, the beach area within Descanso Bay and Avalon Bay will be submerged. Beaches below the seawalls in Avalon Bay and Descanso Bay will be completely submerged at high tide with 48 inches of sea level rise. Coastal access points within Lover's Cove and the Cabrillo Mole boat ramp are also impacted at 48 inches of sea level rise. All public beaches and coastal access points within Avalon Bay will be submerged with 6 feet of sea level rise.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (24 in.) | 2050 (48 in.) | 2100 (60 in.) |
|---|---|---|---|---|
| **Losses in Non-Market Value** | **n/a** | **$2.7** | **$4.9** | **$10.2** |
| **Direct Spending on Recreation** | **$168.7** | | | |

* Losses in Non-Market Value from Table 7, p.48; Direct Spending from p. 43.

# City of Oceanside

*San Diego County*

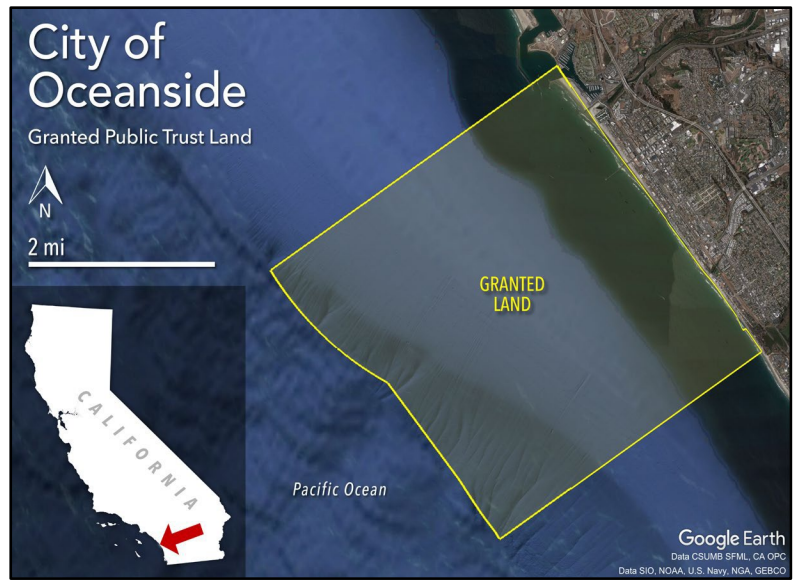
**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Fishing, Recreation
*Secondary Uses:* Navigation

## Site Description

The City of Oceanside was originally granted sovereign waterfront lands in 1963. These lands—made up of beaches, bluffs, and wetland habitats—accommodate a variety of built and natural Public Trust assets. These assets include beach and park access for recreation, waterfront tourism provided by the Oceanside Pier, critical infrastructure (transportation, water, and communications), and several other commercial developments. With future sea-level rise, many of these assets will become vulnerable to tidal inundation, storm flooding, wave impact, and erosion. Several adaptation strategies are already in place, including beach nourishment and sand bypassing, the Oceanside Small Craft Harbor breakwater, and sea walls and revetments. Through a holistic and phased approach, the City plans to continue implementing a variety of traditional and nature-based solutions so that appropriate adaptation strategies can be chosen over time as specified triggers for action are reached.




**Coastal Hazards considered:**
tidal inundation, storms (annual, 20-year, 100-year), wave run-up, shoreline erosion/cliff retreat, river flooding

**Modeling system used for mapping:**
CoSMoS

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | **Building Assets**: Commercial/retail offices; general industrial; mixed use; lifeguard headquarters; emergency shelter sites; hotels and lodging.<br>**Infrastructure Assets**: Roads; railroads; water, wastewater, sewage and storm drain infrastructure; electrical transmission lines; natural gas pipelines; communication infrastructure; shoreline protective devices; groins, jetties, breakwaters, pier; river levees and floodwalls; fire hydrants; wells.<br>**Hazardous Materials**: Hazardous material sites; underground chemical storage tanks.<br>**Cultural Assets:** Historic resources; Cemeteries; Native cultural resources. |
| Natural Assets | Beaches, bluffs, wetlands, preserves and critical species habitats, parks and open space, access, trails |

# Other Economic Vulnerabilities

The City of Oceanside submitted a vulnerability analysis and adaptation plan for its entire coastal zone. The table below attempts to display only what is part of their granted lands.

## Proposed Adaptation and Mitigation Measures

***Protect***

Coastal sediment management (e.g., beach and dune enhancement, sand bypassing); sand retention structures (e.g., groins and artificial headlands, breakwaters, offshore reefs); shoreline protection devices (e.g., seawalls, revetments); raising and/or modifying the harbor breakwater.

***Accommodate***

Elevating of structures and/or property grades; raising the marina facilities; raising the pier.

***Retreat***

Managed retreat; abandoning the harbor; abandoning the pier.

Consistent with California Coastal Commission Sea-Level Rise Policy guidance, this Coastal Hazard Adaptation Plan includes a variety of adaptation strategies, including traditional coastal engineering and nature-based infrastructure solutions. In choosing appropriate adaptation strategies, the City of Oceanside will consider multi-objective measures and a holistic approach, rather than focusing on independent or single-purpose solutions to protection. Given the ES-4 | Executive Summary Coastal Hazard Adaptation Plan June 2019 uncertainty in sea level rise projections and erosion/ flooding model limitations, planning for sea level rise requires a phased approach. Certain adaptation strategies will be used in the near-term, while others will be needed in the long-term. This phased approach provides a way to manage the inherent uncertainty in timing and extent of potential sea level rise impacts.

**Anticipated Costs of Sea Level Rise (millions)**

| | Current | 2030 (9.6 in.) | 2050 (19.2 in.) | 2100 (68.4 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **$3.0** | **$4.1** | **$4.2** | **$5.6** |
| **Losses in Non-Market Value** | | **$40** | **$112** | **$160** |
| **Cost of Adaptation** | **$136.4** | **$190.4** | **$199.4** | **$398.5** |

# City of San Diego

*San Diego County*

**Granted Land Type:**
Smaller Harbor/Marina with Recreational Amenities or Natural Assets

## Public Trust Uses

*Primary Uses:* Commerce, Navigation
*Secondary Uses:* Environmental Stewardship, Fisheries, Recreation

## Site Description

The City of San Diego's granted public trust lands include more than 4,000 acres of land and water, 27 miles of shoreline, and eight official swimming areas. Climate change is expected to increase the risk of flooding and erosion on these lands, with potential impacts to City and non-City assets and resources. This report identifies these risks, presents an inventory of vulnerable resources and facilities, and outlines potential adaptation strategies to address these vulnerabilities.

Climate models project that sea level in the San Diego region will rise faster over the course of this century than it did during the previous 100 years, increasing the potential for flooding and erosion along the coastline. Such potential impacts will be greatest during coastal storms, when storm surge occurs alongside higher sea levels.

Because granted lands lie along the coast, the greatest risks posed by climate change to these lands are related to sea level rise and storm surge. Sea level in the San Diego region is expected to rise 5 to 14 times faster over the course of this century than it did in the previous century, leading to risks of increased flooding.


**Coastal Hazards considered:**
100-year storm, shoreline erosion/cliff retreat

**Modeling system used for mapping:**
**CoSMoS**

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Lifeguard stations (32), water pipes (226 segments), wastewater pipes (436 segments), wastewater pumps (23), bridges (6), major arterials (24 segments), stormwater drain pump stations (2), stormwater outfalls (96), recreation centers (2) |
| Natural Assets | Elk Parks (1,089 acres), conservation areas (2), bog and marsh habitat (2 acres), historic/cultural resources (6) |

# Other Economic Vulnerabilities

Adaptation costs were measured qualitatively using a "Low/Medium/High" ranking system for each individual adaptation option. For example, building marshes to serve as buffers against sea level rise was rated "High," indicating a cost greater than $100 million, whereas considering sea level projections when determining the length of long-term leases was rated "Low," indicating a cost less than $4 million. Losses in non-market value were provided only for year 2100 and no current costs were provided.

## Proposed Adaptation and Mitigation Measures

### *Protect*

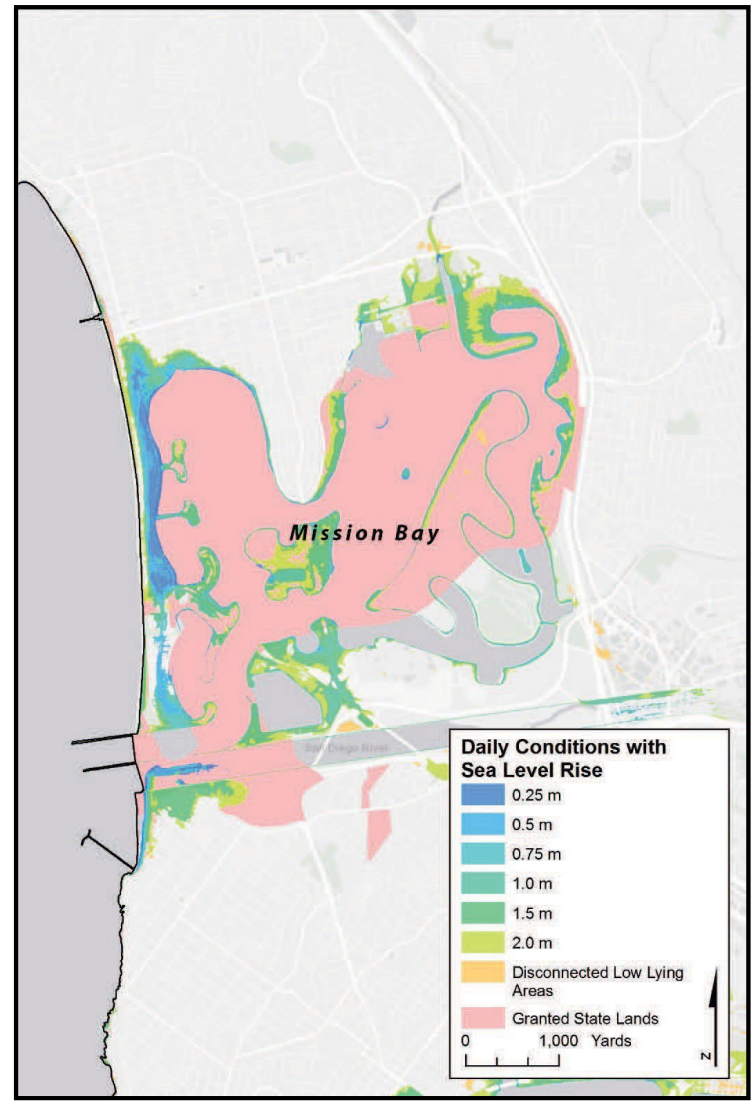
Screen planned infrastructure for climate risks. Require new facilities in flood hazard zones to be raised above the existing base elevation plus projected sea level rise over the life of the infrastructure. Require changes in infrastructure design and materials to increase waterproofing. Implement flood-proofing measures on building and infrastructure when conducting routine maintenance.

### *Accommodate*

Build marshes to serve as buffers against sea level rise. Make public places resilient to sea level rise (waterproof, movable, elevated facilities). Restore coastal dunes and habitat. Identify buildings requiring redundant power sources and purchase backup sources. Consider sea level rise projections when determining the length of long-term leases.

### *Retreat*

Create habitat/open space. Convert parking lots to restore open space. Convert leaseholds to mitigation areas. Develop a long-term managed retreat plan, including triggers for relocation or removal of structures.




**Partnerships:** The City has developed partnerships to respond to climate change with California Office of Emergency Services, U.S. Department of Defense, FEMA Region IX, Caltrans HQ, Caltrans District 11, Port of San Diego, San Diego Metropolitan Transit System, Scripps Institute of Oceanography, California Health and Human Services Agency, Community Action Partnership, County of San Diego, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, Coastal Conservancy, Circulate San Diego, Clean Tech San Diego, San Diego Bike Coalition, Environmental Health Coalition, San Diego Association of Governments, University of California San Diego, San Diego Chamber of Commerce, San Diego Gas and Electric, San Diego Audubon, El Dorado Properties, and San Diego Airport.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (9.6 in.) | 2050 (19.2 in.) | 2100 (39–79 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **$400–$530** | **$530–$700** | **$700–$1,223** |
| **Losses in Non-Market Value** | | | | **$21–$34** |

* Assets at Risk added up from Table 5, pp. 30-31; Non-Market Value Losses added up from Table 6, p 32.

## Jurisdictions with Recreational Amenities:

These trustees' summary documents are arranged in the same order as the trustees appear in the report. Listed from North-South within their granted land type category, this section contains the Jurisdictions with Recreational Amenities:

- Crescent City
- County of San Mateo – Pescadero
- City of Santa Cruz
- City of Carpinteria
- City of Santa Monica

# Crescent City

*Del Norte County*

**Granted Land Type:**
Smaller Harbor/Marina

## Public Trust Uses

*Primary Uses:* Recreation
*Secondary Uses:* Commerce, Safety & Navigation, Environmental Stewardship

## Site Description

Crescent City is situated on a low-lying portion of the Pacific coast in northern California. In 1868, the state granted Crescent City 194 acres of sovereign land. The city controls land and tideland properties seaward of the 1948 ordinary high-water mark, bounded by the Redwood Highway to the north, Crescent City Harbor District granted lands boundary to the east, Lighthouse Way breakwater to the south, and Front Street to the North. The grant area supports recreational activities, with a campground, community pool, cultural center, and various park related assets. The grant area also contains the city's wastewater treatment plant. A notable natural resource within the grant is Elk Creek estuary. This estuary has been highly altered from its natural state by encroaching development, tideland fill, and harbor sedimentation. Shorelines within the grant area were created by fill shortly after the 1964 tsunami and ongoing harbor sedimentation. The entirety of the shoreline is armored with a combination of riprap and concrete rubble. These areas currently protected by shoreline armor are not projected to be vulnerable until 2100, except along Elk Creek and the Shoreline RV Campground, which are expected to be inundated by approximately 2075. The land grant area is protected by four manmade breakwaters and one shoreline breakwater groin structure. Crescent City is vulnerable to extreme coastal events combined with rising seas.

**Coastal Hazards considered:**
sea level rise, tsunamis, inundation, flooding

**Modeling system used for mapping:**
**NOAA**

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | B Street pier, beachfront levee, beachfront park, cultural center, harbor trail, Kidtown & Dog Park, Lighthouse Way breakwater, Northcoast Marine Mammal Center, Shoreline RV Campground, swimming pool, wastewater treatment plant |
| Natural Assets | Elk Creek Estuary |

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# Other Site Vulnerabilities

The 2100 sea level rise projection of 6 feet will directly impact all of the city's assets on the eastern half of the grant. The Elk Creek Estuary will be inundated during much of the tide cycle and the tidal impacts will extend inland along the Elk Creek drainage north of the Redwood Highway and beyond the limits of the city's granted lands. This inundation would result in significant damage to the existing city assets with these areas and extend the coastal processes of shoreline scour further inshore than the current established shoreline.

## Proposed Adaptation and Mitigation Measures

### *Protect*

Elevate, extend, and armor levee on east and west sides of Elk Creek. Develop and implement a program to capture perishable data after significant events to support future migration efforts, including the implementation and maintenance of the hazard mitigation plan.

### *Accommodate*

Replace and elevate B Street Pier. Elevate and strengthen Lighthouse Way Breakwater. Elevate pedestrian bridge over Elk Creek. Elevate sections of the Redwood Highway. Beach renourishment northwest of Lighthouse Way Breakwater. Develop a debris management plan.

### *Retreat*

Limit new development in mapped hazard area. Where appropriate, support retrofitting, or purchase or relocate structures located in high hazard areas, prioritizing those structures that have experienced repetitive losses and/or are located in high or medium ranked hazards.

Crescent City is economically vulnerable to impacts from sea level rise and other extreme storm and tidal events. The founding industries of the region, logging and fishing, have been in decline for decades, and the city is losing population and tax revenue. The 1964 tsunami caused widespread adverse effects to the former thriving downtown commercial shopping district, and the area is said to have never recovered. These factors mean it is less likely to have the resources to prepare and respond to hazards like flooding. The region is shifting to a more tourism-driven economy, and therefore the protection of the waterfront and its amenities is vital.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (12 in.) | 2050 (24 in.) | 2100 (72 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **n/a** | **$40.6** | **$48.7** | **$188.1** |
| **Losses in Non-Market Value** | **n/a** | **$78/year, decreasing through time** | | |
| **Cost of Adaptation** | **n/a** | **$11** | **$34** | **$493** |

* Replacement cost from Table 4, p.14; non-market value Table 5, p.15; value of exposed assets Table 6, p.15.

# Pescadero

*San Mateo County*

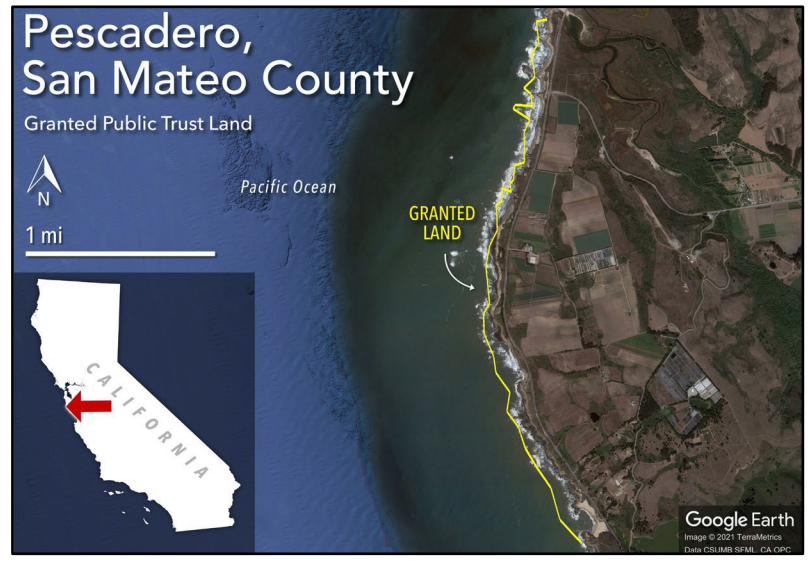
**Granted Land Type:**
Jurisdiction with Recreational Amenities

## Public Trust Uses

*Primary Uses:* Recreation, Public Access, Environmental Stewardship
*Secondary Uses:*

## Site Description

San Mateo County's location between San Francisco Bay and the Pacific coast make it especially vulnerable to sea level rise. The State of California granted the intertidal resources along the San Mateo County Pacific coast from Pescadero Creek to Bean Hollow in 1893 through the California State Lands Commission to the County of San Mateo. To meet requirements of Assembly Bill No. 691 (AB 691), the County has prepared this sea level rise assessment. The intent of this document is to identify and characterize the impacts of sea level rise to intertidal resources in the State Grant Area, and to provide resources, information, and strategies for adaptation. A comprehensive South Coast Sea Level Rise Vulnerability Assessment and Adaptation Report, which includes Pescadero, will be released in Fall 2022 by San Mateo County. It will provide updated information regarding coastal hazards and adaptation solutions, including nature-based strategies that maintain access to the coast and transportation connectivity.




**Coastal Hazards considered:**
tidal inundation, shoreline erosion/cliff retreat

**Modeling system used for mapping:**
in-house

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | State park comfort stations, Highway 1, residential land and structures (adjacent to study area), public beach access parking lots: Bean Hollow at Arroyo de los Frijoles, Gazos Creek State Beach, North lot at Pescadero State Beach, and Pomponio State Beach |
| Natural Assets | State park land, Agricultural or multiuse land, beach and rocky intertidal areas |

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# Other Economic Vulnerabilities

To better quantify the vulnerabilities identified, the table below provides estimates of replacement and repair costs and land at risk from sea level rise, coastal erosion, and tidal inundation. The economic analysis provided estimates for loss in non-market value by recreation type as well as estimates of lost facilities and land. All of the land, structures, and infrastructure analyzed can be overlaid with the sea level rise and erosion hazard zones to quantitatively assess impacts from sea level rise flooding, inundation, and erosion.

## Proposed Adaptation and Mitigation Measures

***Protect***

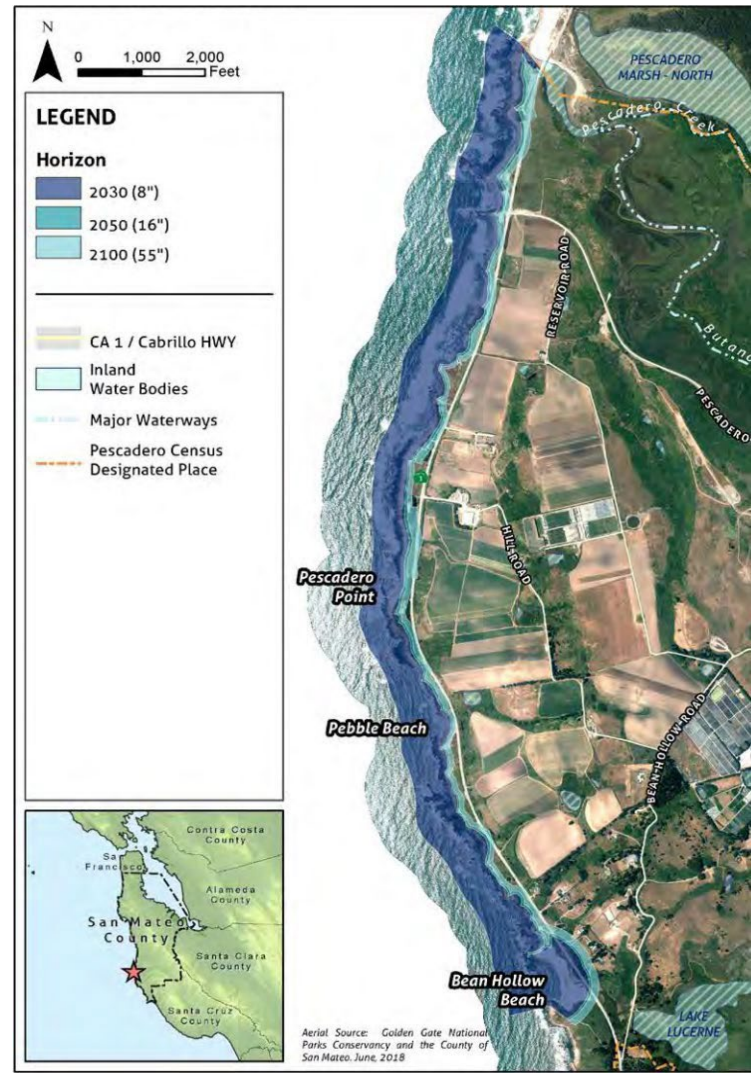
Armoring and rock revetments for Highway 1 areas subject to erosion; periodic sand nourishment and dune restoration.

***Accommodate***

Realign and maintain coastal access points, with potential realignment of Highway 1, in the future.

***Retreat***

Relocate parking lots and comfort stations.




Pescadero is unique for AB 691 in the sense that it is does not contain any harbor infrastructure and the intertidal land grant consists primarily, if not entirely, of natural resources. Due to San Mateo County being a trustee of multiple legislatively granted public trust lands overseen by the State Lands Commission, San Mateo County was required to submit a Pescadero sea level rise assessment.

**Anticipated Costs of Sea Level Rise (millions)[*]**

| | Current | 2030 (9.6 in.) | 2050 (38.4 in.) | 2100 (78 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **$25.4** | **$30.9** | **$39.9** |
| **Losses in Non-Market Value** | **$9.2[†]** | **$3.6** | **$4.6** | **$5.0** |
| **Cost of Adaptation** | | **$7.3** | **$18.8** | **$9.3** |

[*] Repair Costs Table 4, p.3-3; Non-market Value Table 8, p. 3-7; Adaptation Costs, Table 9, p. 4-1. The new South Coast Sea Level Rise Vulnerability Assessment and Adaptation Report includes an updated full economic assessment of impacts as well as a cost-benefit analysis of potential adaptation strategies.

[†] Current value.

# City of Santa Cruz

*Santa Cruz County*

**Granted Land Type:**
Jurisdiction with Recreational Amenities

## Public Trust Uses

*Primary Uses:* Recreation
*Secondary Uses:* Commerce, Fisheries

## Site Description

The City of Santa Cruz, lying on the northern side of Monterey Bay, was granted approximately 411 acres of Public Trust lands in 1969. These lands, which extend from Lighthouse Point on the west to the tip of the Santa Cruz Harbor Jetty on the east, are made up of 385 acres of submerged seabed and 26 acres of beaches. With the only physical structure within the granted land area being the Santa Cruz Municipal Wharf, much of the City's granted lands have been left in their natural state—beaches, sea cliffs, and the mouth San Lorenzo River make up the majority of the grant. The city's grant supports a variety of Public Trust resources and uses, including public access, recreation, commerce and tourism, navigation, and habitat conservation. The wharf alone currently supports 19 businesses in its various buildings and acts as a coastal access point. Many of these coastal resources will be threatened by the potential impacts of sea level rise, such as rising tides, coastal storm flooding, and erosion. In its effort to prepare for these impacts, the City of Santa Cruz is working to develop a landscape-scale plan and a monitoring/triggers/ threshold program that will direct implementation in a strategic and cost-effective manner


**Coastal Hazards considered:**
tidal inundation, 100-year storm, shoreline change/ erosion

**Modeling system used for mapping:**
In-house model

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Santa Cruz Municipal Wharf |
| Natural Assets | Bluffs and cliffs, Cowell's Beach, Main Beach, and Seabright Beach, surf breaks from Steamer Lane to Cowells, river mouth |

# Other Economic Vulnerabilities

All financial impacts are for the City of Santa Cruz's entire coastal hazard zone and not just for the granted land area, besides specific details given about the costs of wharf maintenance and adaptation.

## Proposed Adaptation and Mitigation Measures

### *Policy Adaptation Strategies*

Review and update annually Emergency Operations Plan. Work with the city's Office of Emergency Services to manage the early warning system for evacuation of areas susceptible to flooding, tsunami inundation, seiches, or dam failure. The Fire and Planning and Building Departments will review new development design, circulation and access to ensure that development provides for minimum emergency response times and that emergency vehicles always have safe and expedient passage. Update the city's Local Coastal Program. Comply with the National Flood Insurance Program.

### *Natural or Nature-Based Adaptation Strategies*

Continue with a program to minimize the alteration of floodplains, stream channels and natural protective barriers that accommodate overflow. Increasing native biodiversity and maintaining terrestrial littoral transport processes along coastal bluffs of West Cliff and Natural Bridges. Dune stabilization projects at Twin Lakes State Beach.

### *Building and Infrastructure Strategies*

Protect and preserve the coastline and city infrastructure through the permit review process. Encourage and support the protection of cultural, historic and architecturally significant structures to preserve neighborhood and community character as defined in the General Plan.

The city of Santa Cruz actively participates in multiple climate change action collaborations and used surf break degradation as an indicator of future revenue losses, but every aspect of the city—its economic prosperity, social and cultural diversity, scenic beauty and historical character—is threatened by potential impacts of sea level rise.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (4 in.) | 2050 (28 in.) | 2100 (63 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | | **$2.175** | **$15.8** |
| **Losses in Non-Market Value** | | | | |
| **Cost of Adaptation** | **Cost of wharf improvements through 2100: $15.9** | | | |

* P. 33; Repair and replacement costs—for wharf improvements.

# Carpinteria

*Santa Barbara County*

**Granted Land Type:**
Jurisdiction With Recreational Amenities

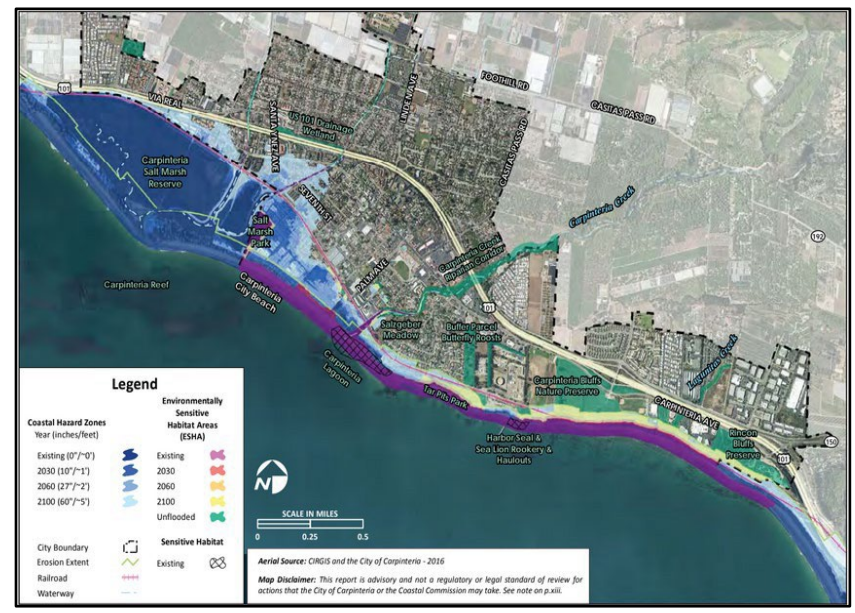
## Public Trust Uses

*Primary Uses:* Recreation, Environmental Stewardship
*Secondary Uses:* Commerce

## Site Description

The City of Carpinteria is located in southern Santa Barbara County. The City is located almost entirely on a coastal plain between the Santa Ynez Mountains and the Pacific Ocean. In general, the area's topography slopes from the foothills of the Santa Ynez Mountains in the north towards the Pacific Ocean to the south. Between the foothills and the populated area of the City is an agricultural zone.

Existing coastal hazards from severe storms cause erosion and wave flooding. Routine tidal inundation already affects community resources; sea level rise could exacerbate already difficult and often competing management challenges. Many of the affected areas were once historic wetlands before the development of Carpinteria. As the habitats have been altered and land uses expanded into flat low-lying areas, infrastructure, roads, and neighborhoods have been built in these areas. These habitats, land uses, and built infrastructure will need to adapt to rising sea levels. The process of examining existing and future vulnerabilities is the first step for a community to take in understanding the extent of the potential challenges and to begin discussing and formulating effective adaptation strategies over time to maintain the quality of life in Carpinteria.




**Coastal Hazards considered:**
sea level rise, tidal inundation, 100-year storm, erosion

**Modeling system used for mapping:**
**In-house model**

**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Coastal access points, Carpinteria State Beach Campground, Union Pacific Railroad, recreation trails, Tar Pits Park, US Highway 101, bike paths, parking lots, Linden Field, legacy inactive oil wells, stormwater drains, stormwater drain inlets, stormwater drain outlets, water supply pressure regulators, water pipes, sewer pump stations, sewer pipes |
| Natural Assets | Carpinteria State Beach, Carpinteria City Beach, Salt Marsh Park, Carpinteria Bluffs, Rincon Beach Park, Carpinteria Harbor Seal Rookery |

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# Other Site Vulnerabilities

Areas containing the highest number of minority households and households below the poverty level in the City are the most at risk of being impacted from sea level rise. Additionally, bicycle and bus/transit routes that are utilized by low-income populations in the City as the primary means of transportation would be impacted. For instance, the 2017 Thomas Fire and related winter 2018 debris flows closed U.S. 101 for approximately three weeks, severely impacted services and associated jobs, increased childcare expenses, and destroyed homes.

## Proposed Adaptation and Mitigation Measures

### *Protect*

Continue winter storm berm program to protect Beach Neighborhood. Create a cobble and vegetative dune system along the City beach. Develop a sediment management and beach nourishment program, continue opportunistic beach nourishment. Construct sand retention structures perpendicular to the shoreline and/or offshore. Armor Carpinteria Bluffs to slow erosion. Complete storm damage and shoreline protection feasibility study (USACE)

### *Accommodate*

Improve stormwater infrastructure in Beach Neighborhood and along the Carpinteria Bluffs. Establish policy and program framework for adaptation such as development standards for accommodation of SLR. Place a special zone district over properties within defined coastal hazard areas. Elevate the railroad downtown, and raise the railroad on a causeway at the Carpinteria Salt Marsh to provide opening for tidal inundation.

### *Retreat*

Relocate development subject to repetitive damage. Relocate highly vulnerable utility infrastructure

**State/City Beach Economic Revenues:** The total estimated spending for beach visitation is $48 million annually, generating $445,000 in sales taxes for the City, and just under $1.9 million in Transient Occupancy Tax for the City from overnight visitors who do not camp. Loss of the State and City Beaches could result in an economic impact associated with loss of beach visitation and associated spending. In addition to economic impacts, the State and City beaches are strongly associated with the community's identity and serve as important open space and recreation opportunities.

## Anticipated Costs of Sea Level Rise (millions)*

| | Current | 2030 (12 in.) | 2050 (24 in.) | 2100 (72 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **2.89** | **9.53** | **24.01** | **66.59** |
| **Losses in Non-Market Value** | **n/a** | **$60.4/year, recreation value** | | |
| **Cost of Adaptation** | **n/a** | **n/a** | **n/a** | **n/a** |

* Repair and replacement costs are from Figs. 6.4, 6.6, 6.13, and 6.14, and Tables 6.5, 6.6. They include estimates for every category except residential land use, which is not a public trust consistent use. Non-market value is from Table 6.16. Adaptation costs are variable, estimates can be found in Chapter 8.

# City of Santa Monica

*Los Angeles County*

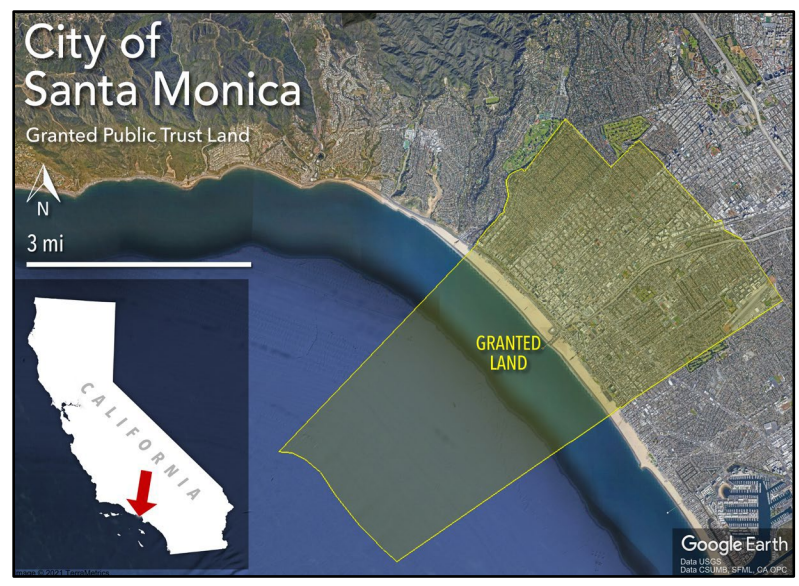
**Granted Land Type:**
Jurisdictions with Recreational Amenities

## Public Trust Uses

*Primary Uses:* Recreation
*Secondary Uses:* Commerce, Navigation, Environmental Stewardship

## Site Description

The City of Santa Monica, located on the eastern shore of Santa Monica Bay, was granted sovereign tide and submerged lands in 1917. The majority of the coastline consists of sandy beaches and includes a few man-made structures, such as the Santa Monica Pier and several groins. The city's granted lands include critical habitat for shorebird species and serve as public spaces for tourism, recreation, and gathering. Santa Monica State Beach, situated within the city's granted lands, plays an important role in providing coastal recreation for the greater Los Angeles region, with the Santa Monica Pier drawing approximately 8 million annual visitors. Climate change-induced sea level rise will cause erosion and narrowing of the city's beaches, leading to frequent flooding of public infrastructure and transportation networks, thus heavily impacting Public Trust resources and assets. Through careful planning and community engagement, the city has made a preference for natural, or soft, adaptation measures and managed retreat that would allow for the natural migration of the shoreline and would limit development in areas that become increasingly affected by onshore flooding.




**Coastal Hazards considered:**
tidal inundation, 100-year storm, storm wave run-up, shoreline change/erosion/retreat

**Modeling system used for mapping:**
In-house model

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Roads (up to 1,150 ft by 2100), bike paths (up to 1,857 ft by 2030, 16,540 ft by 2100), storm mains (up to 700 by 2030, 2,446 by 2050, 5,040 by 2100), storm drains (up to 9 by 2100) sewage mains (up to 2,270 ft by 2100), parking lots (up to 15,438 $ft^2$ by 2030, 316,547 $ft^2$ by 2050, 979,278 $ft^2$ by 2100), water mains (up to 157 ft in 2030, 312 ft by 2050, 6,360 ft by 2100) pump stations, public restrooms (2 by 2030, 3 by 2050, 5 by 2100), Annenberg Beach House and Community Center (2100), Santa Monica Breakwater |
| Natural Assets | Sandy beaches (up to 154 acres by 2030, 194 acres by 2050, 231 acres by 2100), wetlands (1 acre) |

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# Other Economic Vulnerabilities

The total value of vulnerable public assets exceeds $74 million not including the value of non-market services provided by the beach. An additional $115 million in private property is at risk, and the total annual non-market value of lost beach is $11 million. In 2017, tourism revenue was nearly $2 billion for the city. The range in costs for adaptation is large, with managed retreat being the least expensive proposed option, and hard protection being the most expensive. The range in losses in non-market value depend on the adaptation strategy selected, with accommodation involving the most losses, and natural protection allowing for lower losses.

*Dune restoration pilot project*

## Proposed Adaptation and Mitigation Measures

### *Protect*

**Soft Protection:** Create a living shoreline through dune restoration (see photo). Nourish beaches to prevent erosion.
**Hard Protection:** Harden pier and stabilize. Repair or replace the Santa Monica breakwater. Install dikes and groins to stall sea level rise.

### *Accommodate*

Elevate or flood-proof existing and new buildings in flood zones. Increase stormwater pumping capacity and number of wells. Increase setback policy. Use adaptive redesign to flood-proof critical public infrastructure. Redesign bike pathways and walkways to withstand temporary inundation. Increase drainage at vulnerable roadways.

### *Managed Retreat*

Limit new shoreline development. Regulate vulnerable infrastructure. Demolish and relocate public buildings and critical infrastructure. Relocate bicycle pathways. Purchase vulnerable private property and convert to public use.

**Community Awareness**
In 2016, the city installed two telescopic viewers on the Santa Monica Pier. In partnership with the USC SeaGrant, the U.S. Geological Survey and Owlized, Inc. “The Owls on the Pier” offered passersby the augmented reality experience into potential future scenarios of sea level rise impacts on Santa Monica’s beach. The Owls surveyed participants on their views and concerns about climate change and sea level rise and their preference for climate adaptation approaches. Over 10,000 people visited the Owls, and more than 2,500 of those participated in the survey. Additional community awareness campaigns on sea level rise impacts and flood risks are needed in order to inform the public of potential risks, as well as inform coastal property owners of options that they have.

**Anticipated Costs of Sea Level Rise (millions)[*]**

| | Current | 2030 (11.8 in.) | 2050 (24 in.) | 2100 (65.7 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **$2.6** | **$2.7** | **$8.4[†]** |
| **Losses in Non-Market Value** | | **$74.1** | **$260.8** | **$816.4** |
| **Cost of Adaptation** | | **$2.7–$186.9** | **$2.7–$195.7** | **$28.9–$204.5** |

[*] Repair/Replacement Costs Table 8, p. 36, public losses, NMV Losses Table 10, p.42; Adaptation Costs from Table 9, p. 39 to Table 12, p. 47. These tables lay out costs for different adaptation pathways.
[†] Does not include estimates of private losses, which are not a part of the Public Trust, but are included in this report. Private losses by 2100 are estimated to be approximately $22.72 million.

## Small Harbor/Marina

These trustees' summary documents are arranged in the same order as the trustees appear in the report. Listed from North-South within their granted land type category, this section contains the Small Harbors and Marinas:

- City of Sausalito*
- City of Berkeley
- City of Emeryville
- City of Redwood City*
- Santa Cruz Port District
- Port San Luis Harbor District
- Dana Point Harbor District

* The City of Sausalito did not submit an AB 691 assessment and does not have a two-page summary document.
* The City of Redwood City did not submit an AB 691 assessment and does not have a two-page summary document.

# City of Berkeley

*Alameda County*

**Granted Land Type:**
Smaller Harbor/Marina

## Public Trust Uses

*Primary Uses:* Recreation, Environmental Stewardship, Safety & Navigation

## Site Description

The state granted the City of Berkeley the salt marsh, and all tide and submerged lands within the city boundaries in 1913. In present day, the grant includes the Berkeley Marina, parks, trails, picnic areas, a 17-acre off-leash dog area, bird-watching, the Shorebird Park Nature Center, the Adventure Playground, unparalleled panoramic views, and amenities for boaters and non-boaters alike. Damages to the Berkeley Marina are projected to be moderate by 2030 and rise considerably by the end of the century without mitigation. By 2030, in a 100-year storm event, some roads and parking areas will experience temporary flooding, particularly on Marina Boulevard and northeast of the protected area of the Marina. By 2100, in a 100-year storm event, most of the land surrounding the protected area of the Marina, several buildings, significant parking areas, and the majority of University Avenue and Marina Boulevard will experience temporary flooding. By that time, there will be significant risk to the revetment, particularly from wave action and storms. Access to the Berkeley Marina via University Avenue will periodically disrupted during 100-year storm events by 2030 and flooding will increase in frequency near the end of the century.


**Coastal Hazards considered:**
tidal inundation, 100-year storm

**Modeling system used for mapping:**
ART

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Berkeley Marina (1,100 boat slips, 100 liveaboard slips), marina buildings and facilities, ferries (2), Skates on the Bay restaurant, Hs Lordships Restaurant, Seawall Drive, Marina Boulevard, Spinnaker Road, University Avenue Berkeley Municipal Pier, trails (7 miles), parking lots, hotel, nature center, revetment (around entire granted area), breakwaters (2) |
| Natural Assets | César E. Chávez Park, Shorebird Park, Horseshoe Park, the Berkeley Meadow |

# Other Site Vulnerabilities

Potential financial impacts to the Berkeley Marina caused by projected sea level rise include damage to commercial and public buildings and infrastructure, loss of public resources, loss of habitat and natural resources, and loss of berth rental revenue to the City. All below cost figures are based on the scenario of Low Risk Aversion plus 100-year extreme tide. Losses in property values were not evaluated in the AB 691 assessment.

## Proposed Adaptation and Mitigation Measures

### *Natural or Nature-Based Adaptation Strategies*

The city will monitor the ongoing full-scale pilot projects around the Bay that are enhancing protection by marsh development to evaluate whether a 'living shorelines' strategy could replace some or all of the rock revetment

### *Building and Infrastructure Strategies*

Elevate and re-grade Spinnaker Road and the Perimeter Trail (east side of César E. Chávez Park). Potentially elevate University Ave. Upgrade rock breakwater (by 2100). Revetment repair, which could include constructing an armor overlay (beginning in 2030 in some locations), raising of the revetment crest (beginning in 2050 in some locations), upgrading surface drainage, widening upgrade (by 2070). Alternatively, construct floodwalls around entire marina

**Partnerships**

The City of Berkeley plans to collaborate with the East Bay Regional Park District on adaptation planning at the areas that adjoin the Eastshore State Park. The city is in an existing partnership with San Francisco Bay Ferry (WETA) on a ferry terminal planning study. If the ferry terminal is feasible, the terminal location, a replacement of a section of the existing pier on Seawall Drive, will be designed to mitigate sea level rise.

**Anticipated Costs of Sea Level Rise (millions)[*]**

| | Current | 2030 (6 in.) | 2050 (13.2 in.) | 2100 (68.4 in.)[†] |
|---|---|---|---|---|
| **Repair and Replacement Costs** | **n/a** | **n/a** | **$3.019** | **$17.94** |
| **Losses in Non-Market Value** | **n/a** | **$12/year** | | |
| **Cost of Adaptation** | **n/a** | **$1.05** | **$11.05** | **$15.59** |

[*] Repair etc. Costs Appendix G; Non-Market Losses section 4.4.1; SLR adaptation Appendix H. Costs in the table reflect sea level rise for 2030 and 2050, and the combined impact of sea level rise plus a 100-year extreme storm in 2100.

[†] The scenario for 2100 is the amount of sea level rise projected (28.8 in.) plus an estimated 40 in. temporary water level during a 100-year storm.

# City of Emeryville

*Alameda County*

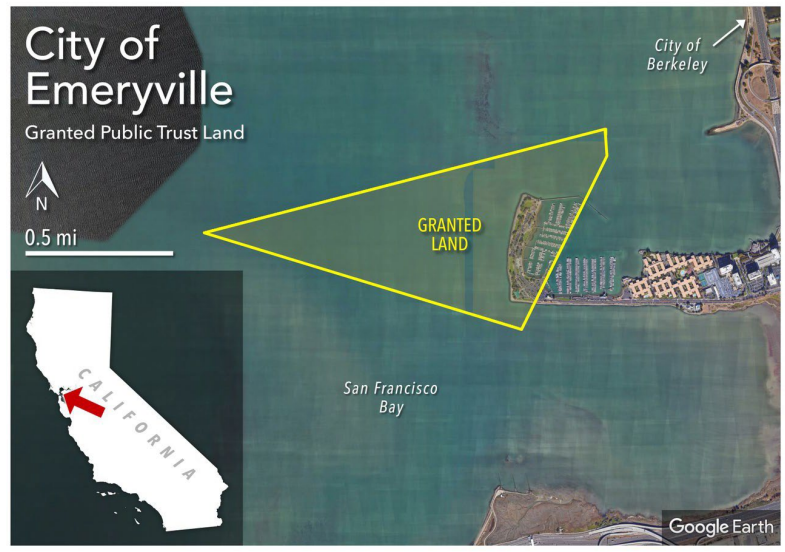
**Granted Land Type:**
Smaller Harbor/Marina

## Public Trust Uses

*Primary Uses:* Commerce, Safety & Navigation, Fisheries
*Secondary Uses:* Recreation, Environmental Stewardship

## Site Description

Emeryville's public trust grant is located between Emeryville Marina and Emery Cove Yacht Harbor, as shown below, at right. There is a public trust easement that extends to the city's East Bay shoreline. By mid-century, a big storm could cause temporary flooding of the north end of the restaurant, parking for the restaurant and the Marina, the lawn north of the restaurant, about 300 feet of Powell Street, the boat ramp, the trail from the Marina restroom south, and some trees, picnic tables, benches, trash bins and lights. The docks could rise to about 2 feet higher than the adjacent shore. The ramp angle to the slips would then be about the same as it is now, going up from shore rather than down. Water on Powell Street could be pumped toward the boat ramp parking lot to restore access to the Marina. Park users would not be able to use the lawn north of the restaurant, the two picnic tables just south of the Marina office, or the trail on the east side until flood waters recede; however, most of the park would be usable.




**Coastal Hazards considered:**
tidal inundation, 100-year storm, overtopping, shoreline change

**Modeling system used for mapping:**
ART

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Emeryville Marina Park and facilities (2 restrooms, office, pedestrian pathway), pump station, fuel station, breakwater, fishing boat dock, windsurf ramp, Powell Street, Hong Kong East Ocean Seafood Restaurant |
| Natural Assets | Park |

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# Other Economic Vulnerabilities

The total estimated cost of sea level rise adaptation is $725,000 by 2050 and $4,500,000 by 2100 for a total of 5,225,000. The non-market recreational value of Marina Park is estimated at $770,000 per year, based on city observations of park use and values based on research by Economic and Planning Systems for East Bay Regional Parks District in 2017. Storm flooding of park access and half of the park, as would occur with 2100 sea level rise and 100-year storm, would cause a loss of recreational value of about $2,000 a day. The City also received approximately $585,959 in rental income from commercial buildings that are vulnerable to future sea level rise.

## Proposed Adaptation and Mitigation Measures

### *Protect*

By **2050 sea level rise + 100-year storm (52 in.):** Sandbags to protect the restaurant. By **2100 sea level rise + 100-year storm (66 in.):** Relocate and rebuild restaurant.

### *Accommodate*

By **2050 sea level rise + 100-year storm (52 in.):** Pump floodwater on Powell Street toward the boat ramp parking lot to restore access to the Marina; stabilize and waterproof streetlights; rinse trees with fresh water after floods and/or replace with saline-tolerant trees. By **2100 sea level rise + 100-year storm (66 in.):** Adjust docks (3.5 ft higher than land); seal manholes and upgrade pump station.

### *Retreat*

By **2050 sea level rise (12 in.):** Relocate 200 feet of trail south of the park restroom. By **2100 sea level rise (24 in.):** Rebuild/relocate the Marina Office; relocate 1,000 feet of trail south of the park restroom. By **2100 sea level rise + 100-year storm (66 in.):** Create beach to protect infrastructure.


**Partnerships & Future Monitoring Plans**

The City works with the San Francisco Bay Conservation and Development Commission's Adapting to Rising Tides program. Sea leve3l rise is addressed in Emeryville's 2017 Local Hazard Mitigation Plan, which includes a section on plan review, evaluation and implementation. The LHMP will be monitored, evaluated, and updated every 5 years. The next General Plan (circa 2030–2050) is also anticipated to address sea level rise in more detail than the current General Plan.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (-- in.) | 2050 (12 in.) | 2100 (24 in.) |
|---|---|---|---|---|
| **Losses in Non-Market Value** | **n/a** | **$0.77/year, lost recreation value** | | |
| **Cost of Adaptation** | **n/a** | | **$0.725** | **$4.5** |
| **Annual Revenues (average)** | **$0.586** | **--** | **--** | **--** |

* Annual revenues, Table 1, p.1. Losses in Non-Market Value and Cost of Adaptation from Table 2, p.7.

# Santa Cruz Port District

*Santa Cruz County*

**Granted Land Type:**
Smaller Harbor/Marina

## Public Trust Uses

*Primary Uses:* Recreation, Commerce
*Secondary Uses:* Navigation, Fishing

## Site Description

In 1968, the State of California granted the Santa Cruz Port District sovereign tidelands and submerged lands within the north Santa Cruz Harbor, located on the northern side of Monterey Bay. The Santa Cruz Port District, enacted in 1950 when there was a need for a homeport and refuge for a growing number of fishing boats and other small craft, now manages approximately 37 acres of granted lands, 26 of which are seabed (submerged) areas. The entirety of the Santa Cruz north harbor area can be considered a man-made facility, with construction completed in 1973. The harbor area supports a wide range of landside and waterside businesses, marine surf and rescue operations, and a wealth of recreational and commercial boating opportunities. The harbor hosts numerous annual events and activities both on land and on the water for the enjoyment of the public. Because the shoreline within the harbor area is man-made and protected with riprap, the main shoreline changes resulting from sea level rise are associated with rising tides, impacting public access, commerce, and recreational/commercial activities. Some adaptation strategies the Port District plans to implement to combat these impacts include elevating the area around the harbor, reinforcing berms, and improving harbor infrastructure.


**Coastal Hazards considered:**
tidal inundation, king tides, 100-year storm

**Modeling system used for mapping:**
NOAA

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Marina restrooms and docks, Moorage for the District's dredge, RV Park area, marine engine repair facility, dry storage area, Maintenance and dredge yards, Garbage collection/compaction area, oil recycling stations, lift stations, pedestrian walkways |
| Natural Assets | Multiple scenic viewpoints with benches overlooking the harbor area, and access to the Arana Gulch watershed's pedestrian and biking trails and green space |

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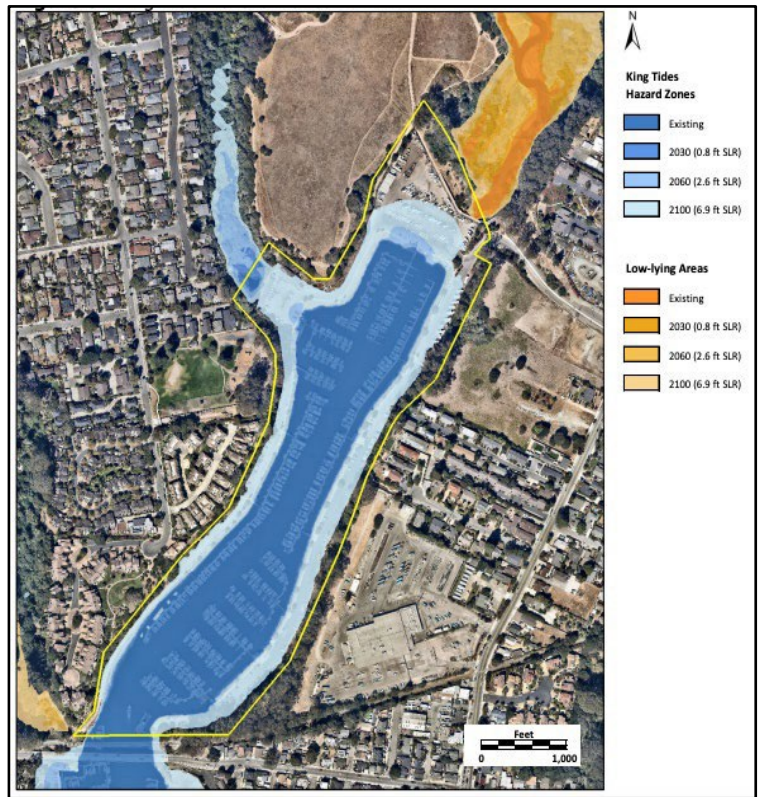
# Other Economic Vulnerabilities

Estimates are in 2019 dollars. These costs reflect impacts to hourly parking in the daytime hours from 8:00 a.m. to 6:00 p.m. based on parking area information from WDI (2016). It is estimated that losses in revenue due to impacts to parking areas could be on the order of $50/day by 2050, $100/day by 2060, and $1,000/day by 2100. Noted in the assessment is that by 2060, other costs will be significant, but these costs were not estimated in this analysis.




*King Tide Hazard Zones*

## Proposed Adaptation and Mitigation Measures

### *Protect*

By 2030, protect visitor serving venues and natural resources such as native coastal vegetation.
By 2100, elevate the area around the harbor by raising the grade of land side areas with fill and reestablishing paving, access pathways, and existing infrastructure.
By 2100, as an alternative to raising site grades in general, the harbor basin perimeter could be improved with a raised berm to confine floodwaters to the harbor basin. This type of solution might only be feasible up to a point, as access to and from the harbor basin would need to ramp up and over the berm.

### *Accommodate*

By 2030, rebuild dock abutments and access paths with a higher hinge point for the float or install a new abutment structure that allows vertical adjustments to be made over time.
By 2100, most buildings can be elevated.

### *Retreat*

By 2100, replace and relocate some buildings.

Based on the current outlook, initial sea level rise related impacts could start to affect the north harbor around 2050 to 2060. These estimates are based on the medium to high risk sea level rise projection, which has a 1 in 200 chance (0.5 percent risk) of occurring. In terms of sea level rise threshold, the above equates to a rise of the mean sea level of 1.9 to 2.6 feet. Adaptation and mitigation to improve sea level rise resilience at the north harbor can therefore be timed with a threshold of 1.9 to 2.6 feet of sea level rise from present day. At that time, the projected rate of sea level rise remains moderate at around 0.8 inches per year or 8 inches over a decade, which leaves room for planning of capital improvement projects, including identifying funding options.

**Anticipated Costs of Sea Level Rise (millions)f***

| | Current | 2030 (9.6 in.) | 2050 (31.2 in.) | 2100 (82.8 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **n/a** | **$0.0001** | **$0.011** | **$11.0** |
| **Losses in Non-Market Value** | | | | |
| **Cost of Adaptation** | **$8.35 per year** | | | |

* Estimates for losses in parking revenues; Table 7, p. 27.

# Port San Luis Harbor District

*San Luis Obispo County*

**Granted Land Type:**
Smaller Harbor/Marina

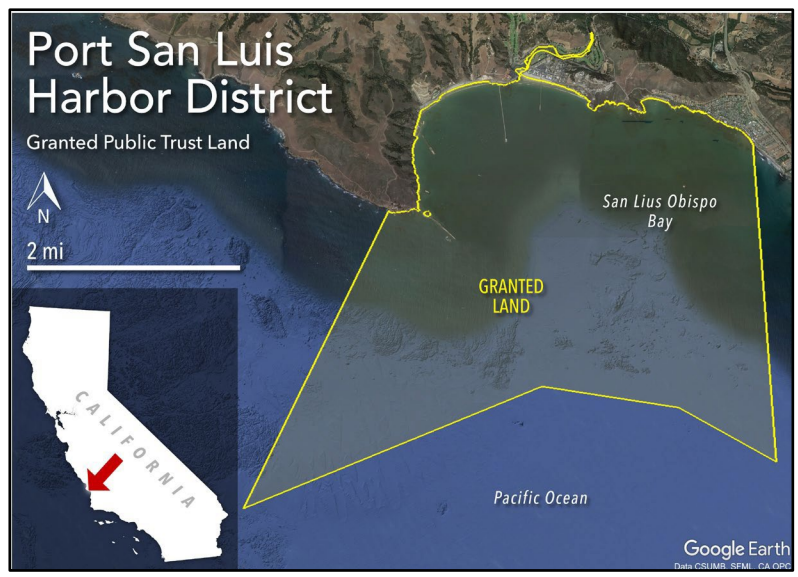
## Public Trust Uses

*Primary Uses:* Commerce
*Secondary Uses:* Recreation, Environmental Stewardship, Navigation

## Site Description

The Port San Luis Harbor District (District), located on the Central California Coast in San Luis Obispo County, is a major center for commercial, recreational and industrial activities. The coast, of which 8,400 acres of state tidelands is under the control of the District, represents a fascinating interaction between land, water, and human enterprise. As trustee, the mission of the District is to develop a harbor that meets the needs of the people of California.

Currently, the District shoreline, and adjacent areas, are subject to fluvial (creek runoff) and coastal (wave and storm surge) flooding during large (100-year) storm events. Flooding from San Luis Obispo Creek has potential impacts to the community of Avila Beach. Coastal flooding affects the entire shoreline during storms with high tides. This flooding will increase with sea level rise. Most District facilities (buildings, piers, parking lots) are located outside of areas affected by sea level rise.




**Coastal Hazards considered:**
tidal inundation, king tides, 100-year storm, overtopping, shoreline change, tsunamis

**Modeling system used for mapping:**
CoSMoS

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | District facilities, boat launch facilities, parking areas, piers, and dredge and disposal areas |
| Natural Assets | Beaches and creeks |

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# Other Economic Vulnerabilities

Property losses do not include insured value, which is approximately $13,353,874.

## Proposed Adaptation and Mitigation Measures

### *Policy Adaptation Strategies*

Adjust routine operations, maintenance and inspection, and capital budget expenses to prepare for more frequent and intense storms, wave overtopping and flooding; educate the public about climate change and related impacts (e.g., via plaques at key locations of public access or via outreach and education sessions to inform and engage the public in maintaining shoreline access for all; identify and invest in non-motorized transportation corridors that will provide alternatives if significant roadways are disrupted.

### *Natural or Nature-Based Adaptation Strategies*

Continue beach nourishment via dredging to replenish areas of sediment loss.

### *Building and Infrastructure Strategies*

Repair and improve revetment, jetty, and breakwater; establish alternative access route in the event Avila Beach Drive is inundated; design new facilities and upgrade existing facilities to be resilient to sea level rise over their intended service life; reinforce bulkheads and relocate any infrastructure that is located underneath them; use flood-proof materials in construction of new infrastructure and in the repair or protection of existing infrastructure. (Additional proposed measures are in Section 6.3.)

*Figure 5 Wave overtopping at the Port San Luis Boat Lift*

**Wave Overtopping**
The waterfront edge at Harford Landing is exposed to wave overtopping annually during winter storms. The image above shows an example of conditions during a significant wave overtopping event.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (8.4 in.) | 2050 (21.6 in.) | 2100 (80 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | **$0.31** | **$0.47** | **$0.77** | **$5.6** |
| **Losses in Non-Market Value** | **$0** | **$0.21** | **$2.7** | **$43.2** |
| **Cost of Adaptation** | **$0** | | | |

* Property Losses Section 5.2; Non-Market Losses section 5.1.

# Dana Point Harbor

*Orange County*

**Granted Land Type:**
Smaller Harbor/Marina

## Public Trust Uses

*Primary Uses:* Commerce, Navigation
*Secondary Uses:* Recreation

## Site Description

Dana Point Harbor is located in southern Orange County within the City of Dana Point. The harbor is located immediately east of Dana Point Headland, a notable landform and natural boundary between the narrow pocket beaches to the north and sandy beaches to the south. Dana Point Harbor, which was built and granted Public Trust lands by the state in the late 1960s, spans 260 acres in Dana Cove and is protected by two breakwaters. The harbor area is a valued resource for the region. In addition to recreational boat slips, it contains a calm water beach in Baby Beach, historic ships such as the *Pilgrim* and *Spirit of Dana Point*, art galleries, the Ocean Institute, the county-owned Dana Point Youth & Group Facility, whale watching and sportfishing hubs, commercial areas, hotels, and yacht clubs. With sea level rise, many of these Public Trust resources are at risk from coastal flooding and wave run up. By inventorying these resources and identifying how various coastal hazards will evolve with sea level rise, Dana Point Harbor can better understand and prepare for future challenges associated with sea level rise.


**Coastal Hazards considered:**
tidal inundation, storms (annual, 20-year, 100-year)

**Modeling system used for mapping:**
CoSMoS

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Federally owned breakwaters, interior bulkhead wall, interior rock revetment, roadways, stormwater infrastructure, potable water infrastructure, electrical and irrigation water infrastructure, docks, piers, boat launches, commercial development |
| Natural Assets | Beaches and parks |

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# Other Economic Vulnerabilities

Dana Point Harbor and associated tidelands include several sources of revenue generation. Total tideland revenues were greater than $27 million in 2017. These revenues are generated almost entirely through rents and concessions, which account for more than $25 million of revenue. The next most significant source of revenue is park and recreation fees that account for more than $700,000. Other revenue streams include other charges for services, interest accruals, and other miscellaneous sources. The total value of tideland assets is approximately $102 million. Though the majority of Dana Point Harbor is engineered in nature, non-market values loss within Dana Point Harbor is likely due to projected significant loss of sandy beach area at Baby Beach as sea level rise increases. Beaches such as Baby Beach provide non-market value in several ways including recreation and storm buffering capacity. Baby Beach contains approximately 1.1 acres of sandy beach area, resulting in a total annual value of approximately $62,000 based on EPA non-market service valuations and adjustments to 2018 dollars using Consumer Price Index values.

*Figure 6 Overtopping of west breakwater (April 2007)*

**Long Term Vulnerability**

Under a 4.9-foot sea level rise scenario, projections extend past all interior shoreline bulkheads and significant portions of rock revetments. Water levels projected under this scenario also approach the upper limits of the western Harbor breakwater. Shoreline protection infrastructure in its current state will be highly sensitive to such hazards. Interior bulkheads are projected to be overtopped even under non-storm conditions, resulting in frequent loss of all flood protection benefits and reduced utility of landward resources. Wave overtopping of interior rock revetments is also likely to become more common due to substantial increases in wave transmission through outer breakwaters. In addition to increased flood hazards, increased wave action within the Harbor under long-term sea level rise conditions will reduce the safety of navigational channels through increased wave height and shoaling.

## Proposed Adaptation and Mitigation Measures

### *Protect*

Beach nourishment and dune restoration at Baby Beach; around boating and marina infrastructure, employ “living breakwater” as a green solution, redesign or reinforce breakwater structures, and use barriers to prevent flooding of parking areas; for upland development, retrofit or replace existing bulkhead wall and rock revetment, and install berms and walls.

### *Accommodate*

For stormwater infrastructure, employ green infrastructure strategies like permeable pavement or rainwater harvesting and reduce extent and duration of flooding with bio-swales or detention basins.

### *Retreat*

Relocate park amenities at Baby Beach; for upland development, remove or relocate vulnerable structures and employ additional shoreline setbacks when designing new structures.

**Anticipated Costs of Sea Level Rise (millions)[*]**

| | Current | 2030 (19.2 in.) | 2050 (19.2 in.) | 2100 (58–79 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | | | |
| **Losses in Non-Market Value** | | **$9.6** | **$24** | **$43.2** |
| **Cost of Adaptation** | | | | |

[*] Information was not presented in this report on costs for the years 2030, 2050, and 2100. Non-market losses from Table 8.7.

## The Large Ports

These trustees' summary documents are arranged in the same order as the trustees appear in the report. Listed from North-South within their granted land type category, this section contains the Large Ports:

- Port of Oakland
- San Francisco Port Commission
- Port of Los Angeles
- Port of Long Beach
- San Diego Unified Port District

# Port of Oakland

*Alameda County*

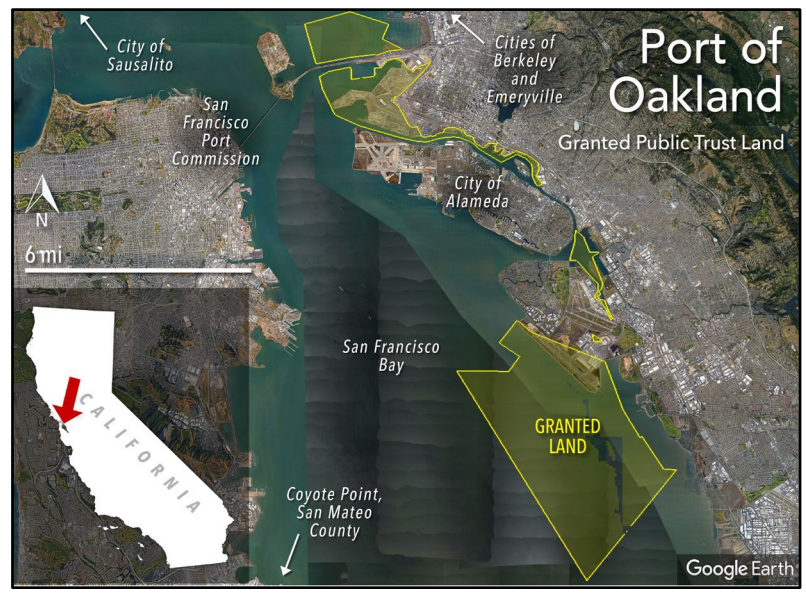
**Granted Land Type:**
Large Port

## Site Description

The Port of Oakland, which operates as a trustee under the City of Oakland, manages more than 875 acres of granted Public Trust lands. The port acts as an international gateway and economic engine for the San Francisco Bay Area, encompassing a busy seaport, airport, and an array of commercial buildings and waterfront parks. These public assets create jobs, provide recreation, and drive commerce throughout the region. The port supports more than 73,000 jobs in the region, and nearly 827,000 jobs across the United States. Jack London Square, one of the most robust waterfront development properties in the U.S., hosts large public educational and recreational events throughout the year, making it a large cultural hub. With all of these assets at risk from sea level rise impacts, the port intends to utilize an iterative and ongoing planning process to protect assets and maintain business continuity as conditions change over the long-term.

## Public Trust Uses

*Primary Uses:* Commerce
*Secondary Uses:* Navigation




**Coastal Hazards considered:**
tidal inundation, 100-year storm

**Modeling system used for mapping:**
**ART**

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Maritime non-terminal tenant area, Matson Terminal, Charles P. Howard Terminal, Ben E. Nutter Terminal, TraPac Terminal, multiple rail lines, electrical substations, sanitary sewer lift stations, storm drainage discharge points, Jack London Square, Clay St. Fire Department, Oakland Airport Business Park, roadways, The Embarcadero, Oakland Airport North Field and South Field, hangar buildings, airport mechanical buildings, airport perimeter dikes, stormwater pump houses |
| Natural Assets | Arrowhead Marsh, San Leandro Creek, Elmhurst Creek |

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# Other Economic Vulnerabilities

Many large ports were unable to provide quantitative cost estimates due to the extent and proprietary nature of some operations. See qualitative keys in Table 3 and 4 for more information about what the impacts of sea level rise will cost the Port of Oakland. Non-market value was assessed based on Recreational Value and Other Ecosystem Services Values; Refer to technical memo.

## Proposed Adaptation and Mitigation Measures

### *Port*

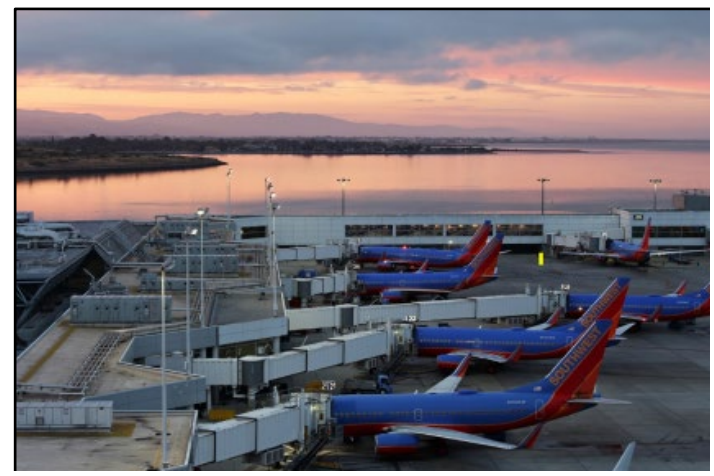
Enhance existing dunes area; add a living shoreline, and construct seawall to protect the park area, International Container Terminal and maintain roadway access; add riprap to stabilize shoreline along peninsula of Middle Harbor Shoreline Park; raise seawall along maritime area and elevate footpath between terminals; raise grade of shipping berths when the terminals reach the end of their useful life; inventory stormwater drainage points for back flow prevention; raise shoreline elevation to address a narrow flood pathway along Burma Road that provides access for Bay floodwaters to reach low-lying, inland areas of the port.

### *Commercial Real Estate*

Construct seawall between Clay and Jefferson Streets to prevent flood pathway; elevate San Francisco Bay Trail around Jack London Square Area and The Embarcadero; provide temporary flood protection during storm events to provide a short-term option until an area shoreline protection solution is implemented; use dredge spoils to artificially increase the marsh elevation at a similar rate as sea level rise; implement watershed restoration and elevate existing levee along creek channel.

### *Airport*

Following the South Field Perimeter Dike Improvement Project, raise the crest of dike design incrementally over time to maintain FEMA + 1 foot of freeboard; add backflow prevention to two discharge points on the North Field to prevent negative flow from daily high tides; add culvert and two pump stations to provide efficient drainage connections between flood storage areas; provide redundant protection around critical facilities (Mechanical Buildings).



**Diverse Stakeholders**
All potential strategies require significant approvals or participation from local and regional stakeholders as collaborators. Planning will need to be an iterative and ongoing process to protect assets and maintain business continuity as conditions change over the long-term.

**Anticipated Costs of Sea Level Rise**

| | Current | 2030 (12 in.) | 2050 (24 in.) | 2100 (36–66 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **Port: High<br>CRE*: Medium<br>Airport: Very High** | **Port: High<br>CRE: High<br>Airport: Very High** | **Port: Very High<br>CRE: Very High<br>Airport: Very High** |
| **Losses in Non-Market Value** | | **Port: Low<br>CRE: Medium<br>Airport: High** | **Port: Low<br>CRE: Medium<br>Airport: High** | **Port: High<br>CRE: Medium<br>Airport: Very High** |
| **Cost of Adaptation** | | **Port: High<br>CRE: Medium<br>Airport: Medium–High** | **Port: High<br>CRE: Medium<br>Airport: High** | **Port: High<br>CRE: Medium<br>Airport: Very High** |

* CRE = commercial real estate

# San Francisco Port Commission

*City and County of San Francisco*

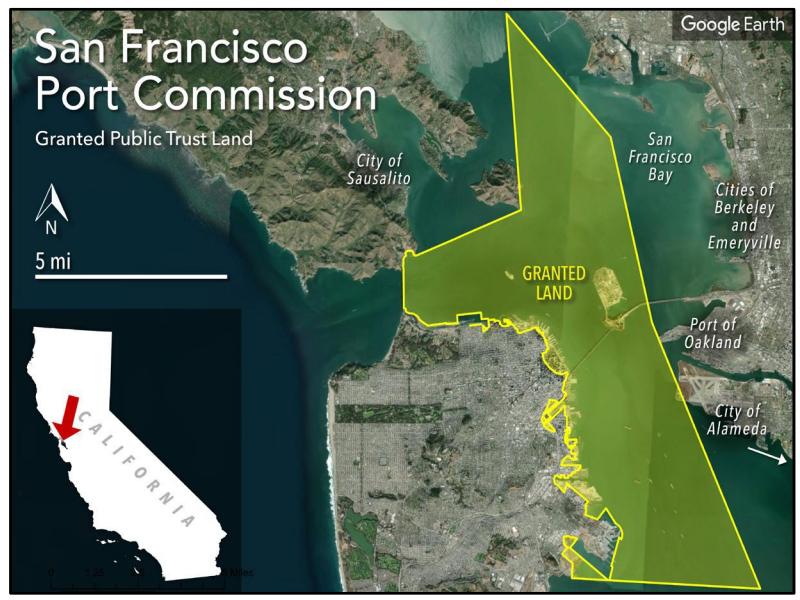
**Granted Land Type:**
Large Port

## Public Trust Uses

*Primary Uses:* Commerce, Navigation
*Secondary Uses:* Fisheries, Recreation, Environmental Stewardship

## Site Description

The City and County of San Francisco, through the San Francisco Port Commission, was granted sovereign tide and submerged lands in 1968 through legislation referred to as the Burton Act. Since the enactment of the Burton Act, the Legislature has amended the port's statutory trust grant through more than 20 statutes. Today, the port manages 8 miles of waterfront lands, commercial real estate, and maritime piers from Hyde Street on the north to India Basin in the southeast. The waterfront acts as a gateway to a world-class city and encompasses major landmarks and assets such as Fisherman's Wharf, Pier 39, the Ferry Building, Oracle Park, and Pier 70. With future sea level rise, more than 6 percent of San Francisco's land could be inundated by temporary or permanent flooding. Through proactive, thoughtful adaptation planning, the port can minimize and meet challenges to make San Francisco a more resilient city in the face of immediate and long-term threats of sea level rise.




**Coastal Hazards considered:**
tidal inundation, storms (2-, 5-, 10-, 25-, 50-, and 100-year), king tides

**Modeling system used for mapping:**
ART

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Piers (13), Mission Creek Harbor, seawalls, Pier 52 Boat Launch, Agua Vista Park Pier, Islais Creek North (PUC Promenade), Islais Creek South (Islais Landing), Bayview Gateway, Heron's Head Extension, San Francisco Bay Railroad, Intermodal Container Transfer Facility |
| Natural Assets | Parks (6), Mission Creek Shoreline Garden, Pier 94 wetlands |

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# Other Economic Vulnerabilities

To help inform preliminary decision-making around prioritizing critical seawall improvements, the port completed high-level preliminary estimates in 2017 to assess the economic value at-risk from a seawall breach resulting from a natural disaster, including sea level rise scenarios. These initial estimates showed significant variation; some very preliminary findings suggest direct sea level rise impacts to port facilities could reach $9.1 billion for a total water level of MHHW + 66 inches. With recent advances in climate change science now available, a comprehensive reexamination of projected cost impacts is now under way as the port and city continue bolstering its adaptation strategies. The San Francisco Port Commission uses sea level rise projections of 12, 24, and 84 inches for the years 2030, 2050, and 2100, respectively. (Cost information was not presented in the report for the years 2030, 2050, and 2100.)

**Port Structure Vulnerability**
More than 55 percent of the piers begin to flood at Sea Level Rise Scenario 4 (MHHW + 4 feet), and although the structures can recover from temporary flooding, damage can occur, and the use of space is disrupted. Any permanent flooding would require adaptation or abandonment of the asset. Specific piers have essential infrastructure that would have impacts beyond the location such as the city's recycling facility or major San Francisco Bay Railroad connections. As flooding becomes more frequent and widespread, access to some facilities, particularly substructures, may grow more unreliable, maintenance and operations costs would increase, as would costs of disruption and physical damage.

## Proposed Adaptation and Mitigation Measures

The Port's adaptive planning framework allows the Port to act now to address risks to life safety and emergency response, while adapting over time to address additional seismic and increasing flood risk to envision a future San Francisco Waterfront that is resilient to conditions projected for 2100 and beyond. The framework is also designed to allow the Port to be responsive to community priorities, changes in science, and funding and partnership opportunities.

### *Policy Adaptation Strategies*

The Port is engaged in many planning endeavors that include policy development and updates. The Waterfront Resilience Program is the main strategy and includes the following The Embarcadero Seawall Program, Waterfront Resilience Program Communications and Engagement Plan, and Citywide Resilience Coordination.

### *Natural or Nature-Based Adaptation Strategies*

Nature-based strategies are being incorporated into other development projects. One example is the India Basin Waterfront Parks and Trails Project to create a new 1.8-acre public park and rehabilitate two existing open spaces, India Basin Shoreline Park (5.6 acres), and India Basin Open Space. The proposed development will adapt to sea level rise by grading, elevating its waterfront riprap and seawall, and designing floodable shoreline open space.

### *Building and Infrastructure Strategies*

The majority of the port's measures to address sea level rise are development projects, including Pier 70 development, redevelopment of the Potrero Power Station, and The Embarcadero Seawall Program that will strengthen the seawall and create a more resilient waterfront.

# Port of Los Angeles

*Los Angeles County*

**Granted Land Type:**
Large Port

## Public Trust Uses

*Primary Uses:* Commerce, Navigation

## Site Description

The Port of Los Angeles—located adjacent to the Port of Long Beach on the north side of San Pedro Bay—manages granted Public Trust lands within the City of Los Angeles, which became a trustee in the early 1900s. The Port's granted lands include 7,500 acres of submerged lands and tidelands. With 27 terminals and 43 miles of waterfront, the Port is the busiest container seaport in the United States and is an important gateway for international commerce on the west coast as well as the nation. As a public resource, the Port of Los Angeles offers a multitude of community and commercial assets, including parks and recreational areas, retail establishments, cruise facilities, and marinas. Additionally, the Port's operations have created an estimated 1.6 million jobs nationwide, making it critical to the lives of millions of Americans. Sea-level rise is a significant risk that challenges the long-term viability of the Port. If left unmitigated, business operations will be temporarily impacted, international cargo may move elsewhere, and community/commercial or natural habitat assets could be destroyed. By assessing vulnerabilities and developing a suite of strategies, the Port of Los Angeles will be able to adapt over time, become more resilient to sea level rise, and remain a strong economic engine locally, regionally, and nationally.


**Coastal Hazards considered:**
tidal inundation, 100-year storm, overtopping

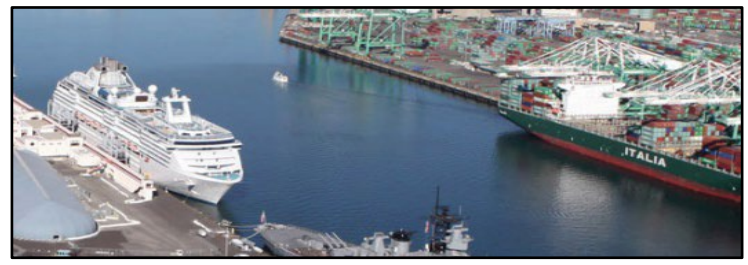
**Modeling system used for mapping:**
in-house

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Nustar, Valero, Shell, Vopak "liquid bulk" areas, Vopak and Rio Tinto Materials cargo terminals, Pilots Station, LAHD Construction & Maintenance, Breakwater, Millennium Marine, SD Pump Station, Fire Station #110, pumping plants, electrical substations, Al Larson's Boat Shop, Cerritos and Island Yacht anchorages, Ports O' Call, Los Angeles Waterfront Sportfishing and Cruises, Alta Sea, multiple transportation networks |
| Natural Assets | Sandy area north of Pier 300; marsh at Wilmington Marina; Ficus trees; heron nesting habitat |

# Other Economic Vulnerabilities

Many large ports were unable to provide quantitative cost estimates due to the extent and proprietary nature of some operations. See qualitative keys in Tables 7-1 and 7-2 for more information about what the impacts of sea level rise will cost the Port of Los Angeles.




## Proposed Adaptation and Mitigation Measures

It is likely that the assets vulnerable under 37 and 66 inches of sea level rise (year 2100 mid- and high-range) will be addressed through governance strategies over time, given that the projected life span of most port facilities is less than 50 years and there will be an opportunity to rebuild many of these assets prior to them being exposed to these higher, end-of-century sea level rise scenarios.

### *Policy Adaptation Strategies*

Monitor sea level rise science and state guidance updates every 5 years and reevaluate the list of vulnerable assets if necessary; add language regarding sea level rise and potential impacts and adaptation strategies to planning documents and design guidelines; create a Sea Level Rise Adaptation Working Group with stakeholders from all relevant divisions; identify funding opportunities that would support implementation of sea level rise adaptation strategies; participate in the California Association of Port Authorities Sea Level Rise group.

### *Natural or Nature-Based Adaptation Strategies*

Monitor and inventory natural resources and existing habitats (wetlands, subtidal, species, etc.) and identify strategies to protect, enhance, and adapts to future sea level rise.

### *Building and Infrastructure Strategies*

Complete a study to determine the most appropriate temporary flood protection in the case of a future storm event; develop a general one-page sea level rise vulnerability zone map; update terminal lease requirements to reference this sea level rise adaptation plan to highlight to tenants that they may be located in an area that is vulnerable to sea level rise; collaborate with tenants (terminal and community/commercial assets) that have assets in areas that are potentially exposed under the 12-inch sea level rise scenario.

**Anticipated Costs of Sea Level Rise**

| | Current | 2030 (12 in.) | 2050 (24 in.) | 2100 (37–66 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **Medium** | **High** | **High** |
| **Losses in Non-Market Value** | | **Low** | **Medium–Low** | **Medium–Low** |
| **Cost of Adaptation** | | **High** | **High** | **High** |

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# Port of Long Beach

*Los Angeles County*

**Granted Land Type:**
Large Port

## Public Trust Uses

*Primary Uses:* Commerce
*Secondary Uses:* Navigation

## Site Description

The Port of Long Beach, which became a trustee under the City of Long Beach in the early 1900s, manages granted Public Trust lands within the Long Beach Harbor District in San Pedro Bay. The port's granted lands includes approximately 3,200 acres of submerged lands and tidelands, 25 miles of waterfront, and acts as a major gateway for trans-Pacific trade. Handling trade valued at $170 billion annually and supporting 2.6 million jobs across the nation, the Port of Long Beach is the second busiest container seaport in the United States. Being such an important economic engine for both southern California and the country, it is critical that the Port be proactive in its effort to combat sea level rise impacts. The Port is particularly vulnerable to storm surge and wave hazards, affecting coastal infrastructure, transportation, energy, water, water quality, and coastal ecosystems within the area. The Port intends to make sound, science-based decisions as it invests in maritime infrastructure, and to prioritize its resource allocations in a way that considers near-term and long-term climate change vulnerabilities and risks.


**Coastal Hazards considered:**
tidal inundation, 100-year storm

**Modeling system used for mapping:**
In-house

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | **2030**: Pier S, Pier D, Pier A, Pier B, Pier C, Railways and road of Piers E, F, G, J, and T; Freeway Route 47— Some areas partially and temporarily inundated<br>**2050**: 2 more areas of Pier D inundated<br>**2100**: Partial permanent inundation of buildings and tanks and permanent inundation of railway on Pier A; loss of rail access on Piers F, G, and J. |
| Natural Assets | |

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# Other Economic Vulnerabilities

The Port provided qualitative cost estimates due to the extent and proprietary nature of some operations. The estimates consider 1) potential cost of repair of damage and 2) the value of lost use of assets, 3) the anticipated cost to implement adaptation strategies, and 4) the anticipated benefits from adaptation at the Port. See Appendix B – Cost of Sea Level Rise: A High-Level Financial Analysis for more information about the financial impacts of sea level rise at the Port of Long Beach.

No direct financial impacts or cost estimates were released with this analysis due to the confidential nature of the value of cargo, port functions, and facility/equipment damage considerations, though these impacts and costs were considered in developing the cost classification for each scenario at an order of magnitude level. Even without direct financial or cost estimates, the relative relationship of losses under a no-action scenario compared to the cost of mitigation can be used to provide a threshold to estimate the relationship of costs and avoided losses, or benefits. This approach protects proprietary data, and allows for some level of cost variance within an order of magnitude context.

## Proposed Adaptation and Mitigation Measures

### *Policy Adaptation Strategies*

Address climate change impacts through port policies, plans, and guidelines (completed); add sea level rise analysis to the Harbor Development Permit (completed); develop a port climate change policy; add climate change considerations to terminal/ tenant leases; modify additional design criteria guidelines to include climate change; understand potential climate change impacts and protect critical security systems.

### *Natural or Nature-Based Adaptation Strategies*

None identified at this time, not feasible at this location.

### *Building and Infrastructure Strategies*

Piers A and B Study—Combined impacts of riverine and coastal flooding; Pier S shoreline protection; Pier S substation protection—evaluation of multiple strategies; modify existing stormwater drainage model design parameters to include climate change; develop Dominguez Channel shoreline protection concept design (follow-up to Strategy #3).

**Anticipated Costs of Sea Level Rise**

| | Current | 2030 (16 in.) | 2050 (36 in.) | 2100 (55 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | **Medium–Low** | **Medium** | **High** |
| **Losses in Non-Market Value** | | **Medium–High** | **High** | **High** |
| **Cost of Adaptation** | | **Medium** | **High** | **High** |

# San Diego Unified Port District*

*San Diego County*

**Granted Land Type:**
Large Ports

## Site Description

The State Legislature formed the San Diego Unified Port District (District) in 1962 through the San Diego Unified Port Act and granted certain public trust tidelands and submerged tidelands in and around San Diego Bay. The District encompasses portions of five cities—San Diego, National City, Chula Vista, Imperial Beach, and Coronado—and the San Diego International Airport. With approximately 5,750 acres of water and land, the District hosts a wide range of Public Trust-compliant uses and improvements including public access, maritime, commercial, industrial, institutional, conservation, and recreation. Sea level rise is projected to potentially impact the coastal lands along the San Diego Bay, creating a set of challenges and related opportunities to build the resilience and adaptive capacity of the area. The potential effects of projected sea level rise, such as inundation, storm events, and increased risk of flooding and coastal erosion, have the potential to impact the District, including natural resources, public access, infrastructure, and business operations.

## Public Trust Uses

*Primary Uses:* Commerce, Navigation, Recreation, Environmental Stewardship, Fisheries


**Coastal Hazards considered:**
tidal inundation, 100-year storm

**Modeling system used for mapping:**
CoSMoS

**Sea level rise scenarios/elevations**
**LINK TO FULL ASSESSMENT**

| Vulnerable Public Trust Resources | |
|---|---|
| Built Facilities | Roads, rail, bikeways, pathways, marine terminals, buildings, piers, stormwater management, sewer lifts, boat launch ramps |
| Natural Assets | Beach accessible areas, parks, salt marshes, eelgrass, upland habitat |

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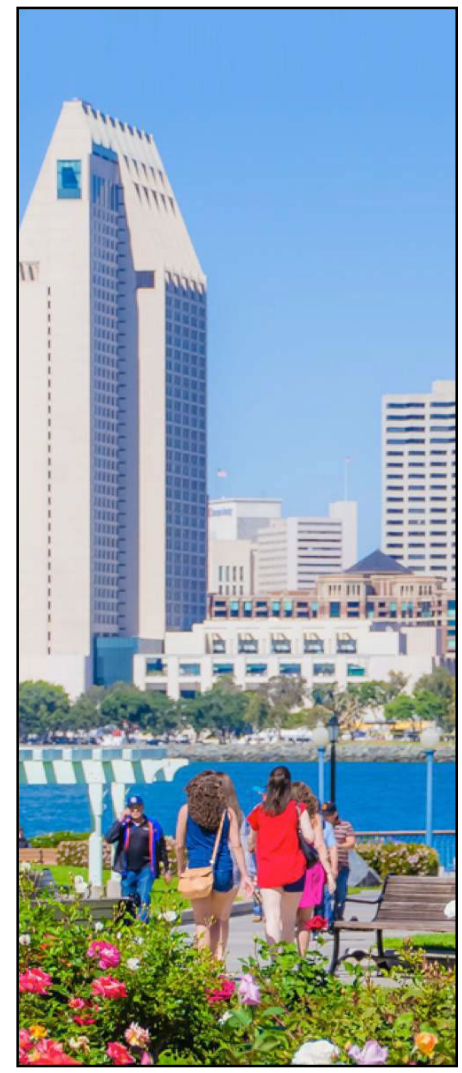
*Since this full assessment was submitted, there have been changes to the San Diego Unified Port District's granted land area.

# Other Economic Vulnerabilities

Costs listed below for repair and replacement are for the "no action" scenario. Losses in non-market value are extensive and estimated in detail per year on p. 136 of the report. Adaptation strategies with associated costs are described in detail on p. 142. For example, restoring salt marsh or eelgrass for sea level rise accommodation would cost between $16,000 and $45,000 per acre.



## Proposed Adaptation and Mitigation Measures

### *Policy Adaptation Strategies*

Protect District mission-driven uses by employing adaptation strategies that protect against sea level rise, and then accommodate temporary coastal flooding and inundation; limit redevelopment in at-risk locations; design standards and provide adequate setbacks.

### *Natural or Nature-Based Adaptation Strategies*

Living shoreline, living breakwaters (oyster reef/floating reef); bio-enhancing concrete, beach nourishment; wetland terraces, sediment augmentation, and restoration.

### *Building and Infrastructure Strategies*

Embankments, retractable barriers/aquafence; elevate infrastructure, floodable park; revetments, breakwaters (branch box/floating/submerged); bulkhead, seawall, groins; floating sector gate.

**Partnerships**
Collaboration with other relevant jurisdictions will be fundamental to the District's success in implementing the framework. Of significance, the District and Navy Regional Southwest recently entered into a Memorandum of Agreement to align their planning initiatives related to projected sea level rise and coastal flooding. As the two largest land managers along San Diego Bay, a continued partnership between the District and the Navy is crucial to protecting coastal dependent uses. Likewise, working with academia is important for the District to identify and fill research gaps. As a result, the District and academic institutions such as Scripps Institution of Oceanography will continue their long-standing relationship of research in San Diego Bay.

**Anticipated Costs of Sea Level Rise (millions)***

| | Current | 2030 (9.6 in.) | 2050 (19.2 in.) | 2100 (30–59 in.) |
|---|---|---|---|---|
| **Assets at Risk or Repair and Replacement Costs** | | $48.4 | $58.7 | $114.5–$1,035 |
| **Losses in Non-Market Value** | $40–$61 | | | $11.9–$12.3 |
| **Cost of Adaptation** | n/a | $16.1 | $16.1 | $24.8–$39.2 |

* Repair Costs from Table ES-6 and ES-7 pp. 15-16 (loss of port revenue not included); Loss in Revenue from Table ES-6 and ES-7 pp. 15-16 (loss in Port revenue); Tables 4 and 5, pp, 28-29 provide detailed estimates of City and non-City assets.