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## CITY OF PACIFICA

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June 19, 2018

Dear Members of the Pacifica Community:

Attached is Pacifica's Preliminary Draft Sea Level Rise Adaptation Plan. The City will hold a Public Workshop regarding the Preliminary Draft Adaptation Plan on Saturday, June 23<sup>rd</sup> from noon to 3:00PM at the Pacifica Community Center, 540 Crespi Drive. Written comments are being accepted at the address listed below and will continue to be accepted for 30-days after the Final Draft Adaptation Plan is published.

This Preliminary Draft Adaptation Plan presents adaptation alternatives that, together with the economic analysis currently being prepared, will inform the Local Coastal Plan (LCP) policies to be developed. In reality, no one can say with complete certainty if erosion and sea-level rise will behave as modeled. Therefore, the adaptation alternatives analysis process and results provide an indication of what may be feasible in the future and will illuminate the scale of funding that will be needed to adapt.

Throughout the planning process, the City has received a large number of comments. Responses to comments on the Final Draft Vulnerability Assessment are provided in Appendix A of the Preliminary Draft Adaptation Plan. In the Preliminary and Final Draft Adaptation Plan, the City will evaluate numerous issues: managed retreat; habitat preservation and restoration; recreational opportunities; public access; private property use, maintenance, and protection; economic impacts; community and social impacts; "soft" vs. "hard" shoreline protection (i.e. natural vs. armoring); and the unknown nature of the future impact of sea level rise.

An issue receiving significant community interest is managed retreat. This is in part due to how the California Coastal Commission's published guidance documents handle this topic and community concern about how the guidance will be used by the Coastal Commission when reviewing Pacifica's proposed LCP update. As you will read in the Preliminary Draft Adaptation Plan, staff and consultants are preparing a plan that is consistent with Commission guidance and strives to preserve the ability of private property owners to use, maintain, and protect their property.

The next steps in the LCP Update process include finalizing the economic analysis and releasing the Final Draft Adaptation Plan, responding to public comments, drafting LCP policy language, conducting additional public meetings, conducting public hearings, and submission of final documents to the CCC.

Direct written comments on the Preliminary Draft Adaptation Plan to:

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Sincerely,



Tina Wehrmeister  
Planning Director

# Preliminary Draft ADAPTATION PLAN Pacifica, CA

Prepared for  
City of Pacifica

June 2018



Near-king tides and high surf at Beach Boulevard on November 30, 2017 (J. Jackson)



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Preliminary Draft  
**ADAPTATION PLAN**  
Pacifica, CA

Prepared for  
City of Pacifica

June 2018

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# CHAPTER 1

## Planning for Sea-Level Rise in Pacifica

### 1.1. Purpose of the Adaptation Plan

The purpose of the Adaptation Plan is to inform the development of new sea-level rise policies that will be integrated into the City's Local Coastal Program (LCP) via an LCP update. The Adaptation Plan was developed for the entire Pacifica coastline and covers both public and private shorefront properties, though each property owner is responsible for implementing their own adaptation strategies consistent with policies in the LCP. The adaptation alternatives included are based on the technical analysis from the Vulnerability Assessment (ESA 2016), appended to this document, as well as input from the public, Community Work Group and Technical Work Group. This Adaptation Plan follows the California Coastal Commission's (CCC) Sea Level Rise Policy Guidance (2015) for addressing sea-level rise in LCPs. Additional information on the City's LCP Amendment is available on the City's website<sup>1</sup>.

This project will inform the City's long-term effort to address a range of coastal and climate change hazards in planning and regulatory processes. This information will assist the City in making informed decisions regarding land use and development standards from the project-level to the plan- and policy-level by providing an estimate of the costs and benefits of different adaptation strategies. This Adaptation Plan includes an analysis of specific adaptation alternatives to illustrate the potential costs and benefits of different approaches and provides recommendations of near term actions for adaptation to inform policy development. The alternative adaptation strategies must be explicitly defined through time to yield cost-benefit outputs that can indicate what is feasible and can be referred to for future funding pursuits. The alternative adaptation strategies that are analyzed in this plan are not meant to define which adaptation is best for the City and nor does it define the policies that shall be pursued by the City. Adaptation alternatives that are analyzed in this plan include planning-level engineering cost estimates, but have not gone through a thorough engineering feasibility and design process. The specific engineering designs required for each adaptation strategy shall be determined in the future.

The California Coastal Act defines coastal resources to include coastal development; public access and recreation; coastal habitats; Environmentally Sensitive Habitat Areas and wetlands; water quality and supply; archaeology and paleontological resources; and scenic and visual resources. Key coastal assets in Pacifica include community assets such as homes, businesses and infrastructure for the well being of its residents and visitors and the City's sandy beaches for public access and enjoyment as well as ecosystem services such as storm damage protection and sensitive species habitat (e.g. Western Snowy Plover).

On March 26, 2018, the City Council unanimously adopted the following goals for the Draft Local Coastal Land Use Plan Update and Adaptation Planning:

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<sup>1</sup> Pacifica Sea-Level Rise webpage can be accessed here :[www.cityofpacifica.org/sealevelrise](http://www.cityofpacifica.org/sealevelrise)

1. **Bolster efficacy of public safety efforts.** Evacuations of bluff top homes have been necessary to protect the health, safety, and wellness of residents. The Adaptation Plan will assist the City to protect human life, property, and critical infrastructure in response to a catastrophic event.
2. **Respond to climate change.** The Adaptation Plan will allow Pacifica to prepare for sea level rise and climate change impacts by identifying policies that enhance the coastal zone’s adaptive capacity.
3. **Preserve Existing Neighborhoods and Promote Environmental Justice and Local Economic Vitality.** Pacifica’s Coastal Zone, i.e. the land area west of Highway 1, includes:
  - 12% of the City’s population
  - The majority of older, and therefore more affordable, housing stock
  - Five of six hotels (80% of the rooms) that generate transient occupancy tax revenues for City operations and bring visitors who patronize businesses
  - More than half of commercial businesses, which provide vitality to the community and tax revenue for City operations
  - Public facilities that include City Hall, North Coast County Water District, Ingrid B. Lacy Middle School, the Pacifica Pier, drainage outfalls, waste water pumping stations, sewer force mains, and the Calera Wastewater Treatment Plant
  - Significant historical and public recreational assets including beaches, coastal trails, the Beach Blvd. promenade, parks and golf course.

The loss or disruption of these assets could have far reaching impacts and affect everyone in Pacifica, not just those living or doing business in the Coastal Zone. The Adaptation Plan will allow the city to create policies that will protect these areas from the impacts of sea level rise, erosion, and coastal flooding. Consistent with the Coastal Act, the Adaptation Plan shall protect existing homes, businesses, and infrastructure in Pacifica.

4. **Preserve and enhance coastal access.** Beach and bluff access to the coastline is a crucial element of Pacifica’s coastal character and is valued by the community. The Adaptation Plan will allow the city to identify where bluff erosion, sedimentation, and sea level rise may threaten coastal access.

## 1.2. Planning Process and Goals

Rising sea levels increase the risk of hazards to coastal communities from storms, flooding, and erosion. In response to the increased risks of coastal hazards, the California Coastal Commission (CCC) is working with local governments, such as the City of Pacifica, to complete LCP update that address the impacts of sea-level rise. An updated LCP can help cities address new coastal management challenges that result from sea-level rise and climate change.

Planning for sea-level rise includes identifying and applying different adaptation mechanisms based on the California Coastal Act requirements (Section 2.1), acceptable levels of risk, and community priorities. By

planning ahead, communities can reduce the risk of costly property and infrastructure damage from coastal hazards, can ensure the coastal economy continues to thrive, and can protect coastal habitats, public access and recreation, and other coastal resources for current and future generations. Adaptation strategies should be chosen based on the specific risks and vulnerabilities of a particular region or project site, in the context of applicable Coastal Act and LCP requirements.

### 1.3. Updating Pacifica’s Local Coastal Program

The Coastal Act requires local governments in the State’s Coastal Zone, such as the City of Pacifica, to create and implement LCPs to manage coastal development and protect coastal resources. Pursuant to the California’s Coastal Commission LCP Update Guide (CCC 2013), the City’s LCP should include policies and regulations that ensure new development minimizes risks to life and property in areas of high geologic, flood, and fire hazard consistent with Coastal Act section 30253. The best scientific estimates of projected sea level rise should be considered and factored into the City’s LCP standards that require new development to evaluate and avoid or minimize risks from flooding, wave run-up, coastal erosion, and extreme events such as tsunamis.

This document, Pacifica’s Sea-Level Rise Adaptation Plan establishes local adaptation goals and strategies to address the identified vulnerabilities. The Adaptation Plan assumes a long-range planning horizon and takes a phased approach that will involve future updates to the Adaptation Plan as needed. Preparation of the Pacifica Sea-Level Rise Adaptation Plan followed the steps outlined in the CCC’s Sea Level Rise Policy Guidance document as follows:

#### Step 1. Establish the Projected Sea-Level Rise Ranges

Table 1 shows projected future sea-level rise from the latest guidance from the State of California (CalNRA & OPC 2018). The rate of sea-level rise is projected to accelerate in the future. The sea-level rise projections are based on the latest “best available science” for/by the State of California based on the state-commissioned study “Rising Seas in California: An Update on Sea-Level Rise Science” by Griggs et al (2017). Background and additional information on SLR can be found in the memo Future Conditions Scenarios for Pacifica LCP Update (ESA 2017).

**TABLE 1  
SEA-LEVEL RISE SCENARIOS USED IN THIS STUDY, WITH PROBABILITY OF OCCURRENCE (CALNRA & OPC 2018)**

<b>Year</b>	<b>Low Risk (17% chance)</b>	<b>Med-High Risk (0.5 % chance)</b>	<b>Extreme risk (n/a)*</b>
2050	1 ft	2 ft	2.7 ft
2100	3 ft	6 ft	10 ft

\* The 2050 Extreme SLR scenario was not examined and is only provided for consistency. SLR of 6 ft at 2075 was considered in place of 10 ft at 2100 to assess flooding impacts under the Extreme scenario.

The Pacifica Sea-Level Rise Adaptation Plan acknowledges that the processes causing sea-level rise and the science of projecting sea-level rise are inherently uncertain. For example, the rate of sea-level rise is highly dependent on whether global greenhouse gas emissions will continue to increase or whether global emissions will be reduced. The rate of sea-level rise could be higher, or lower, than the above projections. Given the uncertainties, the Adaptation Plan is, therefore, not tied to specific timeframes or years, but

rather uses thresholds based on amounts of sea-level rise of up to 5.5 feet and responses to climate change, such as flood event frequency and coastal erosion distances.

## Step 2. Identify Potential Impacts from Sea Level Rise

Based on the best available hazard data from US Geological Survey (Coastal Storm Modeling System (CoSMoS), hosted online by Our Coast, Our Future) and the Pacific Institute, the potential hazards for land within the City were identified in the Future Conditions Scenarios Memorandum (ESA 2018).

Dominant coastal hazards in Pacifica include the following:

- long-term shoreline erosion
- storm-event coastal erosion of bluffs and beaches
- coastal flooding associated with major wave events
- rising groundwater levels in Linda Mar
- flooding from Laguna Salada and San Pedro Creek

Action is needed to manage impacts as each of these hazards increases with sea-level rise. This adaptation plan sets forth approaches to prepare for and manage impacts from each hazard source.

## Step 3. Assess the Risks and Vulnerabilities to Coastal Resources and Development

In the Sea-Level Rise Vulnerability Assessment (ESA 2018b, Appendix A), the following public and private assets were determined to experience some form of existing or future risk and related vulnerability to sea-level rise (e.g. coastal erosion and/or flooding):

- A. Property (public land and structures, private land and homes, hotels, businesses, etc.)
- B. Public Roads (local and regional)
- C. Water system
- D. Sewer pipes and pump stations
- E. Stormwater pipes and pump stations
- F. Parks, trails, coastal public access
- G. Beach and wetland habitats
- H. Other Utilities (e.g. communications, electricity, gas)

The City is currently vulnerable to coastal flooding and erosion, with significant damages experienced in the recent past (SLR Vulnerability Assessment, ESA 2018b). With future climate change and sea-level rise, the City's current vulnerabilities are projected to increase in both frequency and intensity, which can result in greater damages to much of Pacifica including low-lying areas and areas near coastal bluffs.

## Step 4. Identify Adaptation Measures

The Pacifica Sea-Level Rise Adaptation Plan can be considered a "toolbox" with a variety of adaptation measures that can address the short-term and long-term needs of property owners (public and private) for

protection, accommodation, and retreat as necessary to keep development safe and resilient, avoid flooding and erosion hazards, and incorporate safe setbacks. Consistent with Coastal Commission Guidance and comments received from the public, the Adaptation Plan includes a variety of adaptation approaches, nature based or green infrastructure solutions, and multi-objective measures that incorporate environmental considerations and a holistic approach, rather than focusing on independent solutions to protection.

This document, Pacifica’s Draft Sea-Level Rise Adaptation Plan will be released for a 30-day public review period. Upon completion of the public comment period, the City will prepare responses to comments and release a Final Draft Sea-Level Rise Adaptation Plan. The City will then draft sea level rise policies to be included in the Draft LCP. These draft policies will be released for public review prior to incorporating the policies into the Draft LCP for Pacifica’s Planning Commission and City Council consideration. Once approved by local decision makers, the Draft LCP will go to the California Coastal Commission for consideration and certification. The certified LCP will be brought back to the City Council for adoption before the LCP becomes effective.

## 1.4. Historical Coastal Hazard Response in Pacifica

Land in the City of Pacifica has experienced damage from coastal flooding and erosion hazards that has required actions to protect existing development and people. Various approaches have been employed by the City and private property owners to adapt to coastal hazards, including protection (e.g., coastal armoring), accommodation (e.g., Beach Boulevard is frequently closed during large winter storm events to accommodate flooding due to wave action) and retreat (e.g., the Pacifica State Beach project at Linda Mar in 2005). The City has also had to remove development along Esplanade that could no longer be protected from shoreline wave attack.

Since the mid-20th century, the shore has entered an accelerated erosion phase of unknown genesis but potentially related to Pacific Decadal Oscillations and El-Niño Southern Oscillation<sup>2</sup> conditions and potentially due to human activities including reduction of sand runoff from watersheds, and potentially a pulse and then decrease of sand associated with hydraulic mining in the mid-1800s (e.g. gold rush).

The 1982-83 El Niño caused major erosion events resulting in armoring efforts along Pacifica’s coast that have since continued. At the time, the Beach Boulevard seawall north of the pier was under construction to quickly prevent additional loss of homes to erosion in West Sharp Park. Beach erosion is exacerbated in areas where the built environment meets the beach (**Error! Reference source not found.**). Since 1983, coastal erosion has reached a greater density of built assets and property creating chronic shore management issues and resulting in much of the City’s shore being armored.

<sup>2</sup> Pacific Decadal Oscillations and El-Niño Southern Oscillations are patterns of climate variability that affect sea surface temperatures, Pacific tropical cyclone activity, and local storm surge, which in turn affect coastal flooding and erosion along the coast of CA.



Pacifica LCP 170663

SOURCE: Adelman & Adelman 2013

**Figure 1**  
Pacifica Skies Estates Mobile Home Park showing fill on beach and armoring in 1972

All shore protection structures require maintenance that can be costly, and even the most robust have been frequently augmented with new rock and other actions (e.g. Beach Boulevard and Land’s End [more recently known as Oceanaire Apartments] seawall repairs). The seawalls at Beach Boulevard and Rockaway are overtopped by waves and damage landward of these structures has occurred (**Error! Reference source not found.**) and can be expected in the future. More recently, the Land’s End seawall failed (**Error! Reference source not found.**) and the vertical public access is currently undergoing repair. Much of the armoring for public property has been financially supported by the City of Pacifica and State and Federal agencies. Following the 1983 El Niño and subsequent El Niño’s of 1997-98, 2009-10, and 2015-17, coastal armoring structures were constructed or repaired along Esplanade, Beach Boulevard, SF RV Resort, Rockaway and other locations. Recently, Pacifica has supported the City of San Francisco in their request to permit after the fact the levee at the Sharp Park Golf Course in order to prevent flooding in the West Sharp Park neighborhood (CCC 2017).

An alternative approach was taken by the City at the Pacifica State Beach<sup>3-4</sup>, where the natural shore was restored and the public parking area was reconstructed about 50 feet farther landward (**Error! Reference source not found.**). This project has resulted in almost no costs to the City since construction in 2005.



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SOURCE: B. Battalio, J. Jackson

**Figure 2**  
Wave overtopping at Beach Blvd (left) on January 22, 2016

<sup>3</sup> Kershner, J. (2010). Restoration and Managed Retreat of Pacifica State Beach [Case study on a project of ESA PWA]. Product of EcoAdapt's State of Adaptation Program. Retrieved from CAKE: <http://www.cakex.org/case-studies/restoration-and-managed-retreat-pacifi...> (Last updated December 2010) <http://www.cakex.org/case-studies/restoration-and-managed-retreat-pacifica-state-beach> Last visited December 2016.

<sup>4</sup> Philip Williams & Associates, Ltd. (PWA) PACIFICA STATE BEACH RESTORATION PHASE 1 Prepared for RRM Design Group and City of Pacifica, January 16, 2002, Amended May 22, 2002, PWA Ref. # 1547

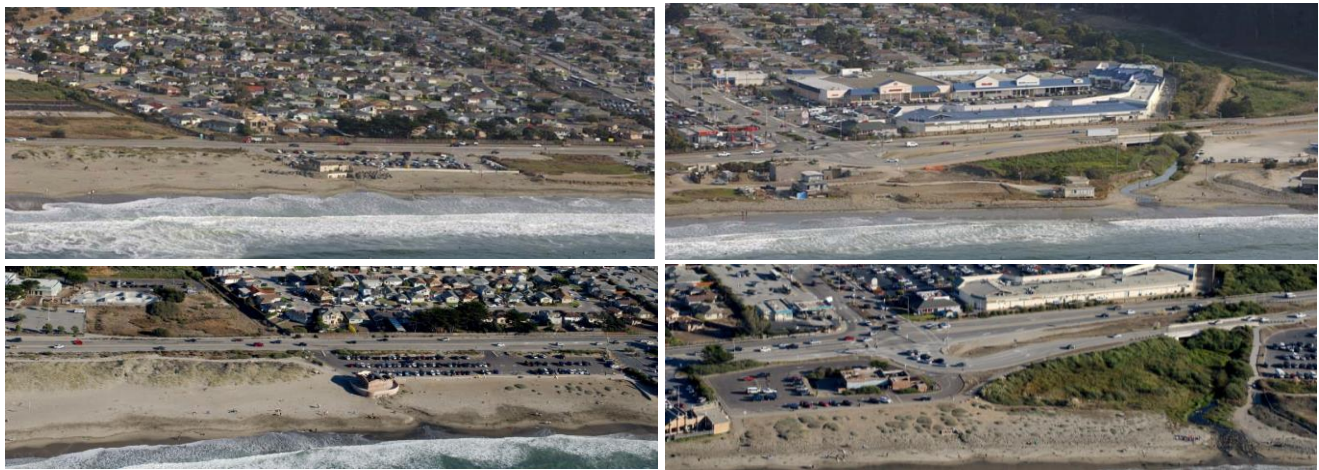
and seawall damage (center); Rockaway on November 30, 2017 (right)



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SOURCE: J. Jackson

**Figure 3**  
Structural failure of Land’s End Seawall (left) and erosion beyond end (right)



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SOURCE: Adelman & Adelman 2013

**Figure 4**  
Managed retreat at Pacifica State Beach pre (2002, top) and post (2013, bottom) project

The area south of the Pacifica Pier to Clarendon was renovated after the 1983 erosion damage by constructing a seawall and a park where private residential property had previously existed (**Error! Reference source not found.**), a good example of a hybrid approach to shoreline adaptation. The project was funded by public sources because the purpose of the project was to protect public property and infrastructure. The project was initiated after storm damage to the private properties. A similar approach was employed at Esplanade following the 1997-1998 El Niño winter, in which damaged homes were removed and converted to a bluff top trail, a rock revetment was constructed at the bluff toe (completed in 2000). The Esplanade project is being completed with the recent demolition of the last two bluff-edge homes in the 500-block and repairs to the revetment, the trail is also being extended to a large portion of the 400 block.

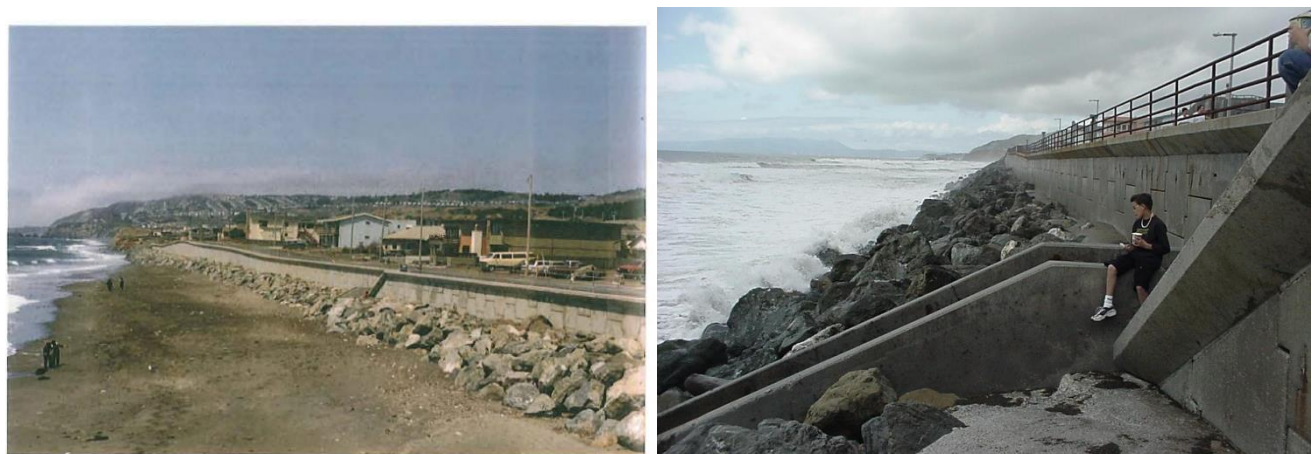


SOURCE: Adelman & Adelman 2013

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**Figure 5**  
 Beach Blvd in 1972 (top) and 2017 (bottom) showing removal of development, seawall construction and setback with public park.

In summary, coastal armoring has been the primary strategy employed in Pacifica to mitigate erosion and flood hazards, with mixed results in terms of protecting property but with uncertain resilience and future costs. Beaches and access have largely diminished where the armoring has occurred (**Error! Reference source not found.**) and shoreline erosion continues seaward of armoring; beaches are absent even during low tides at some armoring locations. As the beach (a buffer to backshore erosion) erodes, greater wave loading on the armoring and increased overtopping leads to higher maintenance of the structure as well as damage of landward assets. However, where shores are unarmored or armoring fails, the back shore erodes and pocket beaches persist. This indicates that a hybrid approach of armoring with gaps that form coves of sandy beaches with access is a potential adaptation strategy if not the expected outcome of the existing ad hoc shore management practices.



SOURCE: Geomatrix Consultants 1987 (left); B. Battalio 2002 (right)

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**Figure 6**  
 Beach Blvd seawall in 1985 (left) after construction (tide is estimated to be medium to low) and in 2002 (right) showing no beach at high tide.



Recent coastal erosion and flooding impacts and private and public responses in Pacifica are summarized below from north to south:

- Land's End Apartments– seawall failure, loss of vertical access
- Manor Apartments (300 block Esplanade Ave)– demolition of apartments after erosion endangered the apartments despite an existing rock revetment (shotcrete wall was not completed, loss of beach area).
- The Bluffs Apartments – loss of lateral access along rock revetment due to beach erosion
- 500 block Esplanade Ave – remaining two homes demolished, and prior bluff top trail endangered.
- West Avalon Drive at Esplanade Ave – loss of lateral access along 500 block Esplanade rock revetment due to beach erosion
- SF RV Park – emergency rock revetment constructed after bluff erosion and loss of bluff-top access trail; storm drain damaged just south of the RV park at the public parking lot and erosion of vertical access ramp.
- Pacific Skies Estates (a.k.a. Cottages at Seaside) to Beach Boulevard – loss of lateral access along revetments and seawalls
- Beach Boulevard –failure of retaining wall structure north of pier (1/11/2001 and 1/22/2016) and regular overtopping of both structures north and south of pier.
- Rockaway – wave overtopping of seawall caused hotel damage (1/21/2017), loss of lateral access along seawall from beach erosion is greatest at high tide.

## CHAPTER 2

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# Relevant Plans and Guidelines

### 2.1 California Coastal Act

The Legislature declares that the basic goals of the State for the coastal zone are to:

1. Protect, maintain, and where feasible, enhance and restore the overall quality of the coastal zone environment and its natural and manmade resources;
2. Assure orderly, balanced utilization and conservation of coastal zone resources taking into account social and economic needs of the state;
3. Maximize public access to and along the coast and maximize public recreational opportunities in the coastal zone consistent with sound resource conservation principles and constitutionally protected rights of private owners;
4. Assure priority for coastal-dependent development over other development on the coast;
5. Encourage state and local initiatives and cooperation in preparing procedures to implement coordinated planning and development for mutually beneficial uses, including educational uses, in the coastal zone.

Any request for permit approval of shoreline protection within the City of Pacifica is within the jurisdiction of the CCC. The standard of review for approval of this type of permit is the Coastal Act and the City's certified LCP.

Section 30001 of the Legislature declares:

- That the California coastal zone is a distinct and valuable natural resource of vital and enduring interest to all the people and exists as a delicately balanced ecosystem;
- That the permanent protection of the state's natural and scenic resources is a paramount concern to present and future residents of the state and nation;
- That to promote the public safety, health, and welfare, and to protect public and private property, wildlife, marine fisheries, and other ocean resources, and the natural environment, it is necessary to protect the ecological balance of the coastal zone and prevent its deterioration and destruction.
- That existing developed uses, and future developments that are carefully planned and developed consistent with the policies of this division, are essential to the economic and social well-being of the people of this state and especially to working persons employed within the coastal zone.

## 2.3 Pacifica Local Coastal Program

Pacifica’s LCP guides development and protects coastal resources within the Coastal Zone. LCPs must be consistent with the California Coastal Act of 1976, as amended. Pacifica’s LCP is made up of two parts: (1) the Land Use Plan (a compilation of goals, policies, and recommended programs), and (2) Implementation Plan Ordinances (regulations that implement the provisions of the Land Use Plan and the California Coastal Act). The City’s 1980 Local Coastal Land Use Plan is currently in effect and is supported by Articles 43 and 44 of the Pacifica Zoning Ordinance (Title 9, Chapter 4) as the implementation plan. These articles of Pacifica’s Zoning Ordinance discuss the applicability of Coastal Development Permits and coastal development regulations. As previously discussed, this Adaptation Plan will inform policies that will be incorporated into a LCP Update. The Pacifica Zoning Ordinance may need to be amended in the future to be consistent with the updated LCP.

## 2.4 Other Pacifica Plans

The following plans for Pacifica and San Mateo County contain specific information relevant to this Plan.

### Climate Action Plan, Appendix E<sup>5</sup>

Plan Projected San Francisco Bay Area Climate Impacts includes the following discussion of adaptation planning (Page E-5):

- Even if we stopped emitting GHGs tomorrow, the climate would still continue to change due to the length of the carbon cycle — the ability of the earth to absorb the excess carbon in the ocean and plants. Therefore it is noted briefly here that cities should take the lead in planning for adaptation to climate change. The Climate Action Plan Task Force was not commissioned to provide specific recommendations as to adaptation planning for climate change and this aspect of the plan will be developed by the City independent of the Climate Action Plan Task Force. The Climate Action Plan Task Force recommends that Adaptation Planning be incorporated into the General Plan and the Local Coastal Plan.
- Effective adaptation planning and management entails dealing with uncertainty. It is a long-term process that should allow immediate action when necessary and adjust to changing conditions and new knowledge. Pacifica plans to initiate an inclusive planning process that ensures the resulting actions are feasible and widely accepted. Adaptation will likely be an ongoing process of planning, prioritization and specific project implementation.” (Page E-5)

### Hazard Mitigation Plan<sup>6</sup>

The City of Pacifica hazard mitigation action plan includes the following actions (Vol. 2 Page 252):

- PA-3— Pacifica will update its flood damage prevention ordinance to mitigate against damage of residential and commercial property in flood prone areas,
- PA-4—Pacifica seek to encourage and assist in the acquisition of grants for the purchase or relocation of property and structures in high hazard areas to mitigate against damage to vulnerable structures and infrastructure

<sup>5</sup> Accessible at: <http://www.cityofpacifica.org/civicax/filebank/blobdload.aspx?blobid=7490>

<sup>6</sup> Accessible at: <https://planning.smcgov.org/sites/planning.smcgov.org/files/documents/files/San%20Mateo%20HMP%20-%20Volume%20II%20-%20Final%20083016.pdf>

- PA-5— Pacifica will pursue opportunities to preserve and protect critical transportation infrastructure to mitigate against isolation, economic loss and ensure public safety.
- PA-7— Pacifica will preserve, protect, or relocate hazard prone infrastructure to maintain critical services and maintain the environment
- PA-8— Pacifica will develop and deliver business outreach programs to mitigate against the functional loss of community businesses and promote business resiliency.
- G-4—Where feasible, implement a program to record high water marks following high-water events.

## 2.5 CCC Sea-Level Rise Policy Guidance

In 2015, the CCC adopted the Sea Level Rise Policy Guidance document to aid jurisdictions in incorporating sea level rise into LCPs, Coastal Development Permits, and regional strategies (CCC 2015). The document outlines specific issues that policymakers and developers may face as a result of sea level rise, such as extreme events, challenges to public access, vulnerability and environmental justice issues, and consistency with the California Coastal Act. It organizes current science, technical, and other information and practices into a single resource to facilitate implementation of the Coastal Act by coastal managers at the state and local level. The policy guidance document also lays out the recommended planning steps to incorporate sea level rise into the legal context and planning strategies to reduce vulnerabilities and guide adaptation planning. The policy guidance has a strong emphasis on using soft or green (i.e. nature-based) adaptation strategies. The Pacifica Sea-Level Rise Adaptation Plan was prepared in accordance with the Coastal Commission Guidance document.

## CHAPTER 3

# Adaptation Planning Concepts

### 3.1 Adaptation Plan Overview and Process

The Adaptation Plan provides a framework for the City to prepare for identified vulnerabilities, monitor effects of coastal erosion and flooding with sea-level rise, and near-term recommendations for adaptation measures. Adaptation should be flexible or adaptive as strategies are tested, sea level rise science advances and actual conditions are monitored into the future. Project-level planning and approvals will be required to further develop and implement the adaptation measures included in this Adaptation Plan. The process should continue to involve the local community, and reflect the Pacifica community's risk tolerance, local conditions, and adaptation vision.

In accordance with CCC guidance (CCC 2015), the Pacifica Adaptation Plan:

- Is based on the best science and adaptation practices available today;
- Acknowledges that sea-level rise science and practices are evolving and that the City will evaluate future decisions and take action based on the best-available science and technology at the time;
- Includes a range of sea-level rise adaptation measures within the three general categories of adaptation: Protect, Accommodate, and Retreat; and
- Includes consideration of managed retreat (for public property) throughout Pacifica (Appendix B).

The CCC further guides that, after evaluating vulnerability and establishing policies for areas with identified hazards, communities can begin the process of evaluating and choosing adaptation strategies for specific areas. In most cases, especially for LCP land use and implementation plans, multiple adaptation strategies will be needed and every community will need to assess their risks and their potential options. There are a number of options for how to address the risks and impacts associated with sea-level rise.

### 3.2 Monitoring Change

The Adaptation Plan includes measurable thresholds that, if and when they occur, call for the implementation of adaptation measures to limit risks. The Adaptation Plan sets conceptual planning-level adaptation thresholds such that adaptation measures can be implemented to reduce future risks before they become critical. The City will need to monitor and evaluate the trajectory towards these thresholds to track whether and when these thresholds are met. For monitoring change such as beach widths or bluff top offsets, an established nearby survey benchmark is needed. Adaptation thresholds (triggers) and monitoring are summarized below.

## Sea-level rise amount

Certain adaptation measures will need to be taken when sea-level rise has risen by a certain amount (e.g., 1 ft, 2 ft, and 3 ft of sea-level rise). To monitor sea-level rise and progress towards the sea-level rise amount thresholds, the City will follow sea-level rise reports from the State and Scripps Institute of Oceanography (SIO) and sea-level rise data from the nearby NOAA tide gage at San Francisco<sup>7</sup>. Sea level is inherently variable in response to predictable astronomical tides and less-predictable atmospheric events such as El Niño and individual storms; however, given that extreme flooding occurs infrequently, sea-level rise may be realized before extreme flooding occurs. Tracking sea-level rise may, therefore, allow the City to anticipate and act in advance of the projected effects of sea-level rise.

## Flooding and storm damage frequency

In addition to the amount of sea-level rise, the frequency or risk of flooding and storm damage can be used as a threshold for adapting to sea-level rise. To monitor the frequency of flooding and storm damage, the City can track and keep records of coastal and River flooding and storm damage events and information. This could be a collaborative effort between City staff and residents in which reports, pictures, and videos are collected. The date, type, location, and severity of flooding (e.g., depth, duration, wave height), and damages can be collated into a file. The intent will be to track the frequency, extent, and severity of flooding to assess if and how the frequency of flooding is increasing. If significant and/or extreme flood events occur, then storm data (e.g. water levels, wave conditions) can be collected and storm frequencies can be recalculated to quantify the increase in flood risk for comparison against risk-based thresholds.

## Beach width

Considering the recreational and ecological values of maintaining a beach as well as the erosion and flooding buffer that beaches provide, beach width is used in this Adaptation Plan for considering when beach adaptation measures would be implemented (sand placement, revetment construction/maintenance). Specific beach width thresholds are discussed in Section 5 and should be further detailed as part of subsequent monitoring, analysis, and planning beyond this study. A long-term beach monitoring program including all of Pacifica's beaches is recommended for consideration as part of the implementation of the Adaptation Plan.

## Bluff top offset

The Adaptation Plan uses the bluff top offset or distance between the edge of the bluffs and assets such as the north end of Palmetto Avenue and sewer line as a threshold for bluff adaptation measures. When the bluff edge reaches the threshold set based on the distance at which the safety of the asset is at risk, the Adaptation Plan calls for implementation of bluff adaptation measures. Similarly, new development setbacks for hazard avoidance shall be based on bluff erosion rates and structure design life.

The City could compile readily available data for annual status reports and can consider preparation of a more comprehensive sea-level rise monitoring and thresholds analysis report on a regular cycle to identify significant changes or progress towards thresholds, evaluate if and when thresholds are reached, and plan next steps towards implementing adaptation measures. The City may conduct this process in consultation with technical experts and

<sup>7</sup> NOAA station home page for San Francisco can be accessed here: <https://tidesandcurrents.noaa.gov/stationhome.html?id=9414290>

will seek public input and review. The City may also consider participating in regional efforts, if initiated, to monitor and track sea-level rise and related effects.

### 3.3 Project-Level Planning and Lead Times

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

- Feasibility study including additional technical analyses, development and assessment of project alternatives and details, conceptual and preliminary engineering design, and cost estimating.
- California Environmental Quality Act (CEQA) and possibly National Environmental Policy Act (NEPA) environmental review and regulatory permitting. Regulatory permitting could require approvals and permits from the US Army Corps of Engineers, US Fish and Wildlife Service, National Oceanic and Atmospheric Administration, California State Lands Commission, California Coastal Commission, California Department of Fish and Wildlife, as well as other Federal and State agencies.
- Final engineering design.

Lead time is required to perform project-level planning, secure funding, and implement or construct an adaptation measure. All adaptation strategies discussed in the Adaptation Plan require substantial lead time. For example, levees, comprehensive armoring and sand retention structures can require significant lead time. With anticipated lead times, the City will be able to begin advanced planning before adaptation measures could be in place to limit risk.

### 3.4 Reevaluation

The Adaptation Plan is intended to establish a process in which new data and information will be assessed, as needed, to inform adaptation decisions and actions. As such, it is anticipated that the Adaptation Plan will be re-evaluated and updated in the future to capture advances in sea-level rise science and adaptation strategies.

## CHAPTER 4

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# Adaptation Alternatives Analysis

To start the conversation on adaptation to address coastal erosion, flooding and sea-level rise, ESA prepared a memo Pacifica Sea Level Rise Adaptation Background and Example Strategies (2018c). The memo includes a summary of Pacifica’s recent experience adapting to coastal hazards, background information on the range of adaptation measures that may be appropriate in Pacifica, as well as example strategies for each of the City planning sub-areas. The public and Community Workgroup convened on April 26, 2018 to discuss the memo, and provide comments and input to the City and consultants.

Considering feedback from the public and workgroups on the Adaptation Background and Example Strategies memo and engineering feasibility, ESA coordinated with the City to develop a selection of alternative adaptation alternative strategies for each sub-area that address the coastal flooding and erosion vulnerabilities identified in the Vulnerability Assessment. These alternative strategies were discussed with the public and workgroup members on May 31, 2018.

### 4.1 Adaptation Measures

The alternative adaptation strategies (an approach consisting of one or more actions or “measures”) that are analyzed in this Plan employ various adaptation measures (specific action) originally presented in the memo on Pacifica Sea Level Rise Adaptation Background and Example Strategies (ESA 2018c). Most strategies are hybrids that include more than one measure that fall into the protect, accommodate or retreat categories specified in the Coastal Commission guidance. All measures that are a part of any alternative are described below.

#### **Setbacks for Development / Hazard Avoidance**

Use of setbacks is a long-used technique in California, implemented at a local policy level and by the state Coastal Commission, which requires new development to be located so that it can be safe from erosion and slope failure for some identified time period – typically the expected economic life of the development. Eventually the development can be expected to be at risk from erosion, and there will be the future question about whether the development can be removed or whether it can be protected. Setbacks are relevant for all areas with private property and most relevant for any coastal parcel potentially facing erosion and flood hazards being developed or redeveloped.

The cost of development setbacks is relatively minor compared to some of the other land use planning tools. The largest cost is likely to be used for obtaining the site specific erosion rate and/or vegetation line data necessary to calculate the setback distance. This cost would be borne by a private property owner/developer. A major benefit of development setbacks, in addition to keeping lives and property safe, is that they maintain natural shoreline dynamics, including preserving beaches for recreational and ecological value.



## Managed Retreat or Relocation of Buildings and Facilities

Managed Retreat is a broad strategy that can encompass the use of all erosion mitigation measures while allowing long term shore recession over time, requiring the removal or relocation of structures and infrastructure, realignment of roads, etc. Often, managed retreat is really “retreat and then manage” over a period of decades until erosion hazards become significant again. ESA has completed various projects in the past that implemented retreat of oceanfront development to restore beaches and shoreline habitat<sup>8-9-10-11</sup>. The cost of these managed retreat projects ranged from about \$4.5 million to \$45 million per acre of beach: The lower value is associated with built assets that are public and limited (e.g. parking lot) while the higher value entails high-value utilities. A more recent re-analysis of these values results in \$2,000 to \$20,000 per foot of shore and \$1 Million to \$10 Million per acre of beach for low asset density backshores.

Managed retreat is often assumed incorrectly to mean essentially “allow erosion” and remove built assets. However, Managed retreat is intended to realign assets landward with the migrating shore, and can include shore protection structures (e.g. seawalls), sand placement and accommodation such as raising homes on pile-foundations to “buy time” for funding, etc. For example, the Ocean Beach Master Plan (SPUR, 2012) is a managed retreat plan that includes armoring to protect wastewater infrastructure through 2050, with a range of possible actions after that (removal, reconstruction landward, enhance armoring). Asset functions are often maintained rather by construction of replacements farther landward (e.g. the new parking lot at Pacifica State Beach). Allowing erosion is a “low-management” level or retreat, similar to the recent retreat in Pacifica whereas managed retreat implies planning and avoiding crises and emergencies, and reducing costs.

In this document, managed retreat is considered an optional adaptation measure for private properties. A recent example of optional retreat was 528 Esplanade where the property owner approached to City to voluntarily donate the land for public purpose and to receive a private tax benefit.

## Transfer of Development Rights

Transferable Development Rights (TDR) programs allow the transfer of the development rights from one parcel to another parcel. These programs are tools used by land use planners to direct development away from certain sensitive areas (sender sites) and into areas that can better accommodate it (receiver sites). TDRs could be applied where undeveloped sensitive or hazardous parcels exist (to transfer potential development from) and desirable areas to transfer potential development to are available. TDR programs are widespread throughout the country and vary based on local land use planning priorities and needs. Pacifica’s General Plan and Zoning Ordinance identifies sender sites (from which a development right is voluntarily transferred by the owner) and receiver sites (to which a development right is added). The owner of a sender site can sell a TDR to the owner of a receiver site. The seller typically retains ownership of the “sending” property, but relinquishes the right to develop it via a

<sup>8</sup> Philip Williams & Associates, Ltd. (PWA) PACIFICA STATE BEACH RESTORATION PHASE 1 Prepared for RRM Design Group and City of Pacifica, January 16, 2002, Amended May 22, 2002, PWA Ref. # 1547

<sup>9</sup> Philip Williams & Associates, Ltd. (PWA) SURFER’S POINT MANAGED SHORELINE RETREAT & ACCESS RESTORATION Preliminary Design Prepared for RRM Design Group and the City of Ventura, August 2, 2005 PWA Ref. # 1708.

<sup>10</sup> ESA, 2015. ESA, SPUR, Moffatt & Nichol, McMillen Jacobs Associates, AGS, Inc., Coastal Protection Measures & Management Strategy for South Ocean Beach, Ocean Beach Master Plan: Coastal Management Framework, Prepared for the CCSF Public Utilities Commission. Project D120925.00

<sup>11</sup> PWA 2008. Goleta Beach County Park, Park Reconfiguration Alternative, Prepared for The Coastal Fund at UCSB, Surfrider Foundation – Santa Barbara Chapter, Environmental Defense Center, Prepared by Philip Williams & Associates, Ltd. November 24, 2008, PWA REF. #1940.00

recorded property restriction, while the buyer is able to intensify development on the receiver site more than would otherwise be permitted under existing zoning. Sending sites may be sensitive land areas such as endangered species or wetlands habitat, or areas prone to coastal hazards such as erosion or landslides. Owners of sender sites receive monetary compensation from the sale of the TDR and in the form of potentially smaller property taxes, while owners of receiver sites have assurance of future development rights on their site, sometimes at a higher density than may be allowed by the base zoning. TDR programs may provide a higher level of certainty over traditional zoning efforts because of the specificity of the amount and location of future development.

Other considerations could include access to services, water limitations, agricultural conversion and zoning changes. As with other mechanisms to avoid hazardous shoreline areas, TDR programs may result in significant public benefits in the form of beach preservation.

### **Beach and/or Dune Nourishment**

Beach nourishment refers to placement of sand to widen a beach. The beach then provides flood and erosion protection to the backshore. However, it is generally assumed that the beach will diminish with time, requiring “re-nourishment”. As sea level rises, the frequency of required nourishment increases because the rate of sand addition to build the beach up increases. Potential problems with beach nourishment include the construction impact to people and beach ecology, and changes to shore conditions that may result from difficulty in finding sand with the desired grain sizes. The success of the nourishment depends on the volume of nourished material, the grain size, and the proximity or use of sand retention structures. Dune nourishment would include placement of sand, graded and planted to form back beach dunes. Dune nourishment is recognized as a natural way of mitigating backshore erosion as well as maintaining a wider beach through sacrificial erosion of the dunes (sand replenishes the beach as waves erode the dunes, slowing the overall shoreline erosion). A variant includes placement of cobble (rounded rock) which is often naturally present as a lag deposit<sup>12</sup> below beaches in California.

Considered as an adaptation measure in Southern Monterey Bay (ESA PWA, 2012), Opportunistic Beach Nourishment uses sand that is extracted from a flood channel, debris basin, navigation channel, harbor area, a by-product of construction or other source, where the main reason for extracting the sand is not to use it for beach nourishment. Costs associated with Opportunistic sand can be low, especially when providing a cost savings to the entity providing the sediment source by avoiding or reducing transportation and disposal costs. Beach Nourishment may be a viable short term solution in areas with low erosion rates, but the long-term effectiveness of this measure for reducing erosion is doubtful.

### **Seawalls and Revetments**

**Seawalls** are vertical structures along a beach or bluff, used to protect structures from wave action as a course of last resort. A seawall works by absorbing or dissipating wave energy. They may be either gravity- or pile-supported structures. Seawalls can have a variety of face shapes. Seawalls and bulkheads are normally constructed of stone or concrete, however other materials can be used. Current seawall projects usually require design elements that allow the structure to resemble the natural environment in that area, in order to blend in with the

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<sup>12</sup> Lag deposit refers to coarser sediments that accumulate over time at lower elevations during periods of eroded beaches, and subsequently covered by sand after the beaches recover.

existing geologic conditions. Effectiveness is dependent on the design and location of the seawall and other factors such as whether the ends of a structure are connected to adjacent stable structures or bluffs, etc.

**Revetments** provide protection to existing slopes affronting a threatened structure, and are constructed of a sturdy material such as stone. Similar in purpose to a seawall, revetments work by absorbing or dissipating wave energy. They are made up of: an armor layer--either stone or concrete rubble piled up or a carefully placed assortment of interlocking material which forms a geometric pattern, a filter layer --which provides for drainage, and retains the soil that lies beneath, and a toe--which adds stability at the bottom of the structure. Revetments are the most common coastal protection structure along the shore of Pacifica. In comparison to seawalls, revetments tend to have greater visual impacts and require a larger footprint, which leads to a larger placement loss of beach area and impacts to public access along the shore. Both seawalls and revetments lead to the “passive erosion” loss of the beach if the shoreline is eroding yet the back beach cannot retreat. This impact will be accelerated by sea level rise. These structures may also introduce active erosion effects which accelerate beach loss when beach width narrows and wave run-up frequently reaches the structure. As the beach disappears and sea level rises, wave run-up and overtopping will also worsen over the structure as the waves begin to discharge near or on the structure, which will require more frequent maintenance or reconstruction. Both seawalls and revetments have a high construction cost (ESA PWA 2012), and high cost to public and private beach resources.

### Sand Retention Structures

These large coastal engineering structures are often used in conjunction with large beach nourishment to retain sand. The retention structures essentially slow the rate of sand transport away from the nourishment area, thereby slowing the rate of beach width reduction. These solutions have a high construction cost.

Offshore artificial reefs consist of fill in the surf zone that reduces the wave power reaching shore and changes the pattern of sand transport, thereby conceptually reducing transport of sand from the nourished area. Artificial reefs installed to act as submerged breakwaters have received increased attention in recent years as a means of shore stabilization and erosion control, primarily due to their low aesthetic impact and enhanced water exchange relative to traditional emergent breakwaters (Vicinanza et al., 2009) and the potential to enhance local surfing conditions (Ranasinghe & Turner, 2006). They however can pose a navigation hazard.

Artificial headlands with stems are proposed as a large scale coastal engineering solution to manage erosion and maintain beaches along Northern Pacifica. This type of sand retention structure scheme is comprised of a series of engineered rock headland units with submerged reefs and a jetty (or stem) connected to the backshore. By segmenting the coast into smaller cells, the system would aid in maintaining a wider beach for a longer period after beach nourishments, with the widest beach located updrift of each unit such as formed north of Mori Point. This concept is shown in Figure 7 below.



SOURCE: ESA

**Figure 7**

Artificial headlands concept for north Pacifica (nourished beach not shown)

**Traditional and Horizontal Levees**

Levees have been the standard practice for flood protection in riverine and estuarine environments. Where constrained by infrastructure or commercial/residential structures, raising existing levees may be an effective adaptation strategy, but the risk to assets behind levees and maintenance costs may increase as sea level rises. Levees are typically constructed of compacted earth fill and can be susceptible to erosion if exposed to wave action. Small levees are proposed to mitigate flood source of Laguna Salada (from either coastal or riverine flooding) for adjacent Sharp Park and West Fairway Park neighborhoods.

The horizontal levee (ecotone levee) is a barrier to coastal storm surge that combines the function of a linear flood protective device (levee) with the natural flood protection benefits of wetland habitat. Instead of a traditional levee, the horizontal levee is comprised of a levee or other structure set back from the coastline with a wide flat slope between the structure and the water that is vegetated with native wetland vegetation. The flat vegetated slope provides a natural buffer from storm surge and wave action. This concept has been developed for and applied to areas with limited wave energy, such as San Francisco Bay (USACE 2015). The horizontal levee concept could take the form of dune restoration and a setback levee at the Sharp Park Golf Course to provide room for shoreline recession with SLR while improving beach ecology, for example. Like beach nourishment, this type of dune restoration would provide an erosion buffer to the smaller levee behind it but would need to be rebuilt periodically depending on shoreline erosion trends.

**Structural Adaptation/Elevation**

Structural Adaptation is the modification of the design, construction and placement of structures sited in or near coastal hazardous areas to improve their durability and/or facilitate their eventual removal. This is often done through the elevation of structures or specific site placement. Structural modification entails reconfiguring development to withstand progressively increasing coastal hazards. Examples are pile foundations that support development above projected flood elevations and that allow wave run-up and erosion to progress without damage to structures, and waterproofing or reinforcing for severe events. Structural adaptation can be applied to any parcel or infrastructure although the cost and technical feasibility of an effective modification would be required. Cost may be high depending on the density of development on the coast. As part of the Climate Ready Southern Monterey project, ESA developed unit cost estimates for elevating structures in both flood zones and in wave impact zones where wave impact results in increased loads on the structure.

**Elevate / Reconstruct Road**

As part of the Climate Ready Southern Monterey project, ESA developed unit cost estimates for elevating roadways with bridges or trestles, as well as cost for reconstruction of a secondary roadway. Critical roadways determined at risk in the vulnerability assessment could be improved by a combination of elevation by earth fill and armoring. Roads exposed to wave action on the coast will require heavier armoring in order to be kept in place, while roads that are not exposed to significant wave impacts may be sufficiently armored with a lower cost revetment or combined with a fronting ecotone slope.

## 4.2 Development of Alternative Adaptation Strategies

The adaptation measures listed in Section 4.1 above were narrowed down from a larger list of adaptation measures presented in Pacifica Sea Level Rise Adaptation Background and Example Strategies (ESA 2018c) that were identified as being potentially suitable for Pacifica. A series of meetings were held with the Community Working Group (CWG) and the Technical Working Group (TWG) to gather input and get feedback on documents posted on the City’s Sea-level Rise website. To develop the preferred adaptation strategies, ESA and the City reviewed the potential adaptation measures with respect to each sub-area, and considered the following factors:

- Does the measure protect existing development (where applicable)?
- Does the measure align with community values (City Council, Community Work Group and public input received throughout project to date)?
- Compatibility with geographic/morphologic setting (is there space/right conditions for success)?
- Does the measure support and/or improve existing recreational and ecological functions?

Table 1 below lists all adaptation alternatives that were compiled for Pacifica, with measures that are included in one or more sub-area alternatives shown in bold. Pros and Cons are listed for each measure that is also ranked as positive (+), neutral (=) or negative (-) in terms of suitability in each sub-area considering the factors listed above and whether the measure protects existing development (a top priority for the City). Managed retreat (optional strategy for private property) was identified as appropriate for the Fairmont West and Pacifica State Beach sub-areas due to lower density of assets and land ownership, but it is also considered for the other sub-areas at the direction of the Coastal Commission (Technical Working Group meeting on May 31 2018).

All strategies options identified for private property must be privately funded.

**Table 1. Adaptation Measure Suitability Matrix**

Measures	Pros	Cons	Fairmont West	West Edgemar and Pacific Manor	Northwest Sharp Park	Sharp Park, West Fairway Park and Mori Point	Rockaway Beach, Quarry and Headlands	Pacifica State Beach	West Linda Mar	Pedro Point and Shelter Cove
<b>Setbacks for Development</b>	Avoid hazards, enables natural shoreline, sustains beach	development at risk if erosion is worse than estimated, need open space	+	-	-	-	+	-	-	-
Deed Restrictions and Conservation Easements	Conserves views, natural shoreline and beach,	Needs open space to initiate	=	-	-	-	=	+	-	-
Rolling Easements	Conserves views, natural shoreline and beach,	Complicated once easement reaches development, need open space	+	-	-	-	+	+	-	-
Fee Simple Acquisition	Avoid hazards, enables natural shoreline, sustains beach	Expensive, requires landowner agreement.	=	-	=	-	=	=	=	=
<b>Managed Realignment or Relocation</b>	Avoid hazards, enables natural shoreline, sustains beach	Expensive in developed areas, legal challenges, need place to relocate.	+	-	-	=	=	+	-	-
<b>Transfer of Development Rights</b>	Avoid hazards, enables natural shoreline, sustains beach	Land must be undeveloped	+	-	-	-	+	-	-	-
<b>Beach Nourishment</b>	Habitat and recreational value, buffers against backshore erosion	Limited sand available, high rates needed with SLR.	+	+	+	+	+	+	+	n/a
<b>Dune Restoration / Nourishment</b>	Habitat value, buffers against backshore erosion and flooding	Require space, monitoring	-	-	-	=	-	+	n/a	-
Horizontal Levee (Ecotone Levee)	Habitat value, buffer against erosion and flooding forces	Require space, monitoring	-	-	-	=	-	-	-	-
<b>Structural Adaptation/Elevation</b>	Raise structure above flood hazard zone, limit damages	costly, alters exposure landward of structure, may need to raise again	-	-	+	+	+	+	+	+
<b>Elevate / Reconstruct Road</b>	Reduces flood exposure, uses available space.	May need wider easement to raise on fill, does not address erosion alone.	-	-	=	=	=	+	+	-
<b>Seawalls and Revetments</b>	Familiar/in use, prevents erosion, maintains property in place	Costly construction and maintenance, esp. with sea level rise, loss of beach on eroding shores	+	+	+	+	+	=	+	+
<b>Sand Retention Structures</b>	Helps retain sand, potential recreation and habitat function	costly, not effective without beach, requires maintenance with sea level rise, ocean impacts	+	+	+	+	=	=	n/a	-
<b>Traditional Levee</b>	Prevents flooding	Require space, not suitable for wave action .	-	-	-	+	-	-	=	-

Notes: Bold text indicates measures that were used in adaptation strategies for one or more sub-areas

+ measure is suitable for the sub-area

= measure may be suitable for sub-area

- measure is not suitable for the sub-area

n/a indicates that the measure is not applicable for the sub-area due to existing land uses or ownership, level of development, or geographic conditions

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The alternatives presented for each sub-area in the subsections below and corresponding economic cost-benefit results (Section 4.3) are meant to inform the policies to be developed for the LCP update. Please note that the order of the alternatives listed in the tables below is not listed in any order of preference, they are numbered only to identify analysis results in figures and tables in the report. The alternatives are defined through time to enable the cost-benefit analysis, and are dependent on SLR projections from State guidance. In reality, erosion and sea-level rise will likely not behave as modeled for the alternatives analysis. That said, the adaptation alternatives analysis process and results provide an indication of what may be feasible in the future and illuminates the scale of funding that will be needed to adapt to sea-level rise.

## **Fairmont West**

The following community values and concerns were identified in the draft Vulnerability Assessment public engagement meetings for the Fairmont West sub-area (shown in Figure 8):

- Tobin’s Folly photographic spot
- Manmade historic spot (Dollaradio)
- GGNRA Mussel Rock trail hiking and dog walking
- Parking/trail access
- Hang gliding area

Bluff top assets in the Fairmont West sub-area are primarily subject to coastal erosion hazards. Due to the high bluffs, SLR adaptation strategies to address flooding are not applicable in this sub-area. To address coastal erosion hazards with SLR while addressing the above values and concerns, proposed adaptation strategies for this area include protection measures such as revetments and beach nourishment, as well as retreat due to the relatively low asset density on the bluffs. Details on alternative adaptation strategies analyzed for this plan are presented in Table 3 below.

The managed retreat alternative involves relocating the road and sewer infrastructure at a future date. The road (Palmetto Ave) is the main access route for the neighborhood to the rest of Pacifica, so it cannot be removed without an established alternate route (this level of planning is beyond the scope of this study).





SOURCE: ESA, Pacifica, San Mateo County

Pacifica LCP 170663

**Figure 8**  
Fairmont West Sub-area and existing coastal armor

**Table 2. Fairmont West Sub-area Adaptation Strategies**

Adaptation Alternative	Adaptation Measures	Description
<b>1 Accommodate / Protect Hybrid</b>	Transfer of development rights, Armor	<p><b>Now:</b> Allow erosion to proceed, option to transfer development rights. Maintain Dollaradio and armoring.</p> <p><b>Future:</b> Assumes existing armor is maintained at Dollaradio. Backshore is allowed to erode until need to armor to protect road and utilities.</p>
<b>2 Protect</b>	Armor, Beach nourishment, Sand retention structures, Transfer of development rights	<p><b>Now:</b> Place 100ft wide beach nourishment. Maintain Dollaradio and armoring.</p> <p><b>Future:</b> Place sand: 100ft beach nourishment every time beach width falls below minimum threshold, increasing frequency as SLR accelerates. Build sand retention structures, timing to be determined with shore response modeling (part of overall artificial headlands strategy for north Pacifica).</p>
<b>3 Retreat</b>	Managed retreat of infrastructure, transfer of development rights	<p><b>Now:</b> Allow bluff erosion to proceed, maintaining beach area. Assume Dollaradio armoring is maintained. Implement TDR (optional) and hazard avoidance measures in undeveloped parcels.</p> <p><b>Future:</b> relocate road with consideration to maintain access to private property, relocate wastewater main away from erosion hazard. Timing TBD via shore response modeling. Maintain revetment for Dollaradio.</p>

## West Edgemar and Pacific Manor

The following community values and concerns were identified in the draft Vulnerability Assessment public engagement meetings for the West Edgemar and Pacific Manor sub-area (shown in Figure 9):

- Trailheads for Milagra Ridge Trail
- Bluff/gateway to Pacifica
- Economic center
- Structures hang over bluffs
- Coastal trail loss
- TWG: California State Lands Commission has lease rock revetment adjacent to 528-572 Esplanade Avenue

Bluff top assets in the West Edgemar and Pacific Manor sub-area are primarily subject to coastal erosion hazards. Due to the high bluffs, SLR adaptation strategies to address flooding are not applicable in this sub-area. To address coastal erosion hazards with SLR while addressing the above values and concerns, proposed adaptation strategies for this area include protection measures such as revetments and beach nourishment. The adaptation strategy of retreat was also included at the direction of the CA Coastal Commission (REF). Details on the alternative adaptation strategies analyzed for this plan are presented in Table 3 below.



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SOURCE: ESA, Pacifica, San Mateo County

**Figure 9**  
West Edgemar and Pacific Manor Sub-area and existing coastal armor

**Table 3. West Edgemar and Pacific Manor Sub-area Adaptation Strategies**

Adaptation Alternative	Adaptation Measures	Description
<b>1 Protect</b>	Armor	<p><b>Now:</b> Armor bluffs between Manor Dr and Bill Drake Way and along SF RV Resort.</p> <p><b>Future:</b> Maintain armor as needed to remain effective, timing TBD via shore response modeling.</p>
<b>3 Protect</b>	Armor, Beach nourishment, Sand retention structures	<p><b>Now:</b> Place 100ft wide beach nourishment. Maintain armoring and build armor between Manor Dr and Bill Drake Way and SF RV Resort.</p> <p><b>Future:</b> Future: Place sand: 100ft beach nourishment every time beach width falls below minimum threshold, increasing frequency as SLR accelerates. Build sand retention structures, timing to be determined with shore response modeling (part of overall artificial headlands strategy for north Pacifica).</p>
<b>3 Retreat</b>	Managed removal/relocation of assets	<p><b>Now:</b> Option to private property owners to remove or abandon existing armoring structures protecting property once it is damaged or no longer effective and to allow erosion.</p> <p><b>Future:</b> Remove or relocate public structures and infrastructure only when no longer necessary to support existing development.</p>

### Northwest Sharp Park

Community values and concerns were identified in the draft Vulnerability Assessment public engagement meetings for the Northwest Sharp Park sub-area (Figure 10) were minimal and more focus was given to the neighboring sub-area to the south. High bluff top assets in the Northwest Sharp Park sub-area are primarily subject to coastal erosion hazards. Due to the high bluffs, SLR adaptation strategies to address flooding are not applicable in this sub-area. Alternative adaptation strategies for this sub-area include protection measures such as revetments and beach nourishment. The adaptation strategy of retreat was also included at the direction of the CA Coastal Commission (REF). Details on the alternative adaptation strategies analyzed for this plan are presented in Table 4 below.



SOURCE: ESA, Pacifica, San Mateo County

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**Figure 10**  
Northwest Sharp Park Sub-area and existing coastal armor

**Table 4. Northwest Sharp Park Sub-area Adaptation Strategies**

Adaptation Alternative	Adaptation Measures	Description
<b>1 Protect</b>	Armor	<p><b>Now:</b> Maintain existing armor, build new armoring elsewhere.</p> <p><b>Future:</b> Maintain armor as needed to remain effective, timing TBD via shore response modeling.</p>
<b>3 Protect</b>	Armor, Beach nourishment, Sand retention structures	<p><b>Now:</b> Maintain existing armor, build new armor elsewhere. Nourish beach by 100 feet.</p> <p><b>Future:</b> Place sand: 100ft beach nourishment every time beach width falls below minimum threshold, increasing frequency as SLR accelerates, timing TBD via shore response modeling. Build sand retention structures</p>
<b>3 Retreat</b>	Managed removal/relocation of assets	<p><b>Now:</b> Option to private property owners to remove or abandon existing armoring structures protecting property once it is damaged or no longer effective and to allow erosion.</p> <p><b>Future:</b> Remove or relocate public structures and infrastructure only when no longer necessary to support existing development.</p>

## Sharp Park, West Fairway Park and Mori Point

The following community values and concerns were identified in the draft Vulnerability Assessment public engagement meetings for the Sharp Park, West Fairway Park and Mori Point sub-area (shown in Figure 11):

- Old Wastewater Treatment Plant property is an economic asset
- Surfing, fishing
- Potential Plover habitat
- Snake and frog protective area
- Sharp Park Golf Course
- GGNRA – Mori Point Trails
- Open Salada Creek to ocean
- Berm Trail
- Mori Point trailheads for neighborhoods
- Mori Road/Trail Beach access from Moose Lodge
- Palmetto Ave: historic district and home of Pacific Coast Fog Fest
- What is being used to consider the life of new/current projects and cost/benefit ratio?
- Whale watching at Sharp Park beach
- Golf course acts as a protective structure
- Whale watching at Mori Point
- Boardwalk to Mori Point
- Snake and frog habitat in Sharp Park, particularly in the golf course
- Beach Boulevard Promenade
- Promenade (Seawall) too low to protect the neighborhood
- Gap at Clarendon between seawall and levee
- WSP and Fairway Park need a protective levee for flooding in golf course
- Sharp Park Golf Course acts as flood control infrastructure
- Wetland at golf course acts as hazard mitigation
- Lake in golf course is too shallow and always floods
- Water from Highway 1 flooding inundates golf course
- Concern over protective devices (armor, etc.) to environmental assets

Technical workgroup feedback includes:

- Western Snowy Plover habitat at Sharp Park Beach
- Future stairways to beach and overlook
- California coastal trail/emergency access route
- Coastal Commission retained jurisdiction (former tidal lands)
- Information on permitted activities beach
- CRLF & SFGS habitat
- State Lands Commission leases at: fishing piers; sewer outfall; riprap adjacent to Beach Boulevard, between Bella Vista Avenue and Santa Rosa Avenue; storm water outfall at Clarendon Avenue and Beach Boulevard.
- Recognize wetlands as flood control structure and natural asset flood control

The backshore along the Sharp Park, West Fairway Park and Mori Point sub-area is low enough such that assets and property are subject to wave run-up and overtopping under existing conditions. Sea level rise adaptation

strategies thus must address coastal flooding as well as erosion. Current management at Clarendon includes beach berm building between the Beach Blvd seawall and SFGC levee, which leads to storm water ponding on the landward side and requires a portable pump station. Aside from coastal flooding from wave run-up and overtopping, flooding hazards at Sharp Park include rainfall-runoff entering Laguna Salada during storm events which cannot drain directly to the ocean due to the presence of the levee and limited capacity pump station. To address the coastal erosion and flooding hazards with SLR while addressing the above values and concerns, the proposed adaptation strategies include protection measures such as revetments and beach nourishment as well as flood management measures for Laguna Salada. The adaptation strategy of retreat is also included at the direction of the CA Coastal Commission (Appendix B). Details on the alternative adaptation strategies analyzed for this plan are presented in Table 5 below.



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SOURCE: ESA, Pacifica, San Mateo County

**Figure 11**  
Sharp Park, West Fairway Park and Mori Point Sub-area and existing coastal armor



**Table 5. Sharp Park, West Fairway Park and Mori Point Sub-area Adaptation Strategies**

Adaptation Alternative	Adaptation Measures	Description
<b>1 Protect</b>	Armor, levees	<p><b>Now:</b> Maintain existing armor, extend seawall to close Clarendon gap to SPGC levee. Assumes SF will armor and maintain SPGC levee. Build stormwater detention basins with setback levees and stormwater pump stations at Clarendon/Lakeside Ave and end of Fairway Drive.</p> <p><b>Future:</b> Maintain armoring, increase seawall height to limit wave overtopping.</p>
<b>2 Protect</b>	Armor, Beach nourishment, Sand retention structures, Levees	<p><b>Now:</b> Maintain existing armor, extend seawall to close Clarendon gap to SPGC levee. Nourish beach by 100 feet. Build stormwater detention basins with setback levees and stormwater pump stations at Clarendon/Lakeside Ave and end of Fairway Drive.</p> <p><b>Future:</b> Maintain armoring, raise seawalls to limit wave overtopping. Place sand: repeat 100 foot beach nourishment every time beach width falls below minimum threshold, increasing frequency as SLR accelerates. Build sand retention structures, timing to be determined with shore response modeling (part of overall artificial headlands strategy for north Pacifica).</p>
<b>3 Retreat</b>	Managed removal/relocation of assets	<p><b>Now:</b> Option to private property owners to remove or abandon existing armoring structures protecting property once it is damaged or no longer effective and to allow erosion.</p> <p><b>Future:</b> Remove or relocate public structures and infrastructure only when no longer necessary to support existing development.</p>

## Rockaway Beach, Quarry and Headlands

The following community values and concerns were identified in the draft Vulnerability Assessment public engagement meetings for the Rockaway Beach, Quarry and Headlands sub-area (shown in Figure 12):

- Highway 1
- Lack of data for potential restoration of historical wildlife corridors along Highway 1
- Quarry has an accessible trail
- Could city purchase quarry to keep it open as a barrier?
- North Coastal trail provides beach access
- Viewpoint
- Fishing
- TWG: flood mitigation bank potential for quarry

Adaptation alternatives in this sub-area primarily focus on existing development along Rockaway Beach. To address coastal erosion and flooding hazards with SLR while addressing the above values and concerns, adaptation strategies include protection measures such as revetments and beach nourishment for the Beach while development setbacks are considered for the Quarry and Headlands. The adaptation strategy of retreat is also included at the direction of the CA Coastal Commission (Appendix B). Details on the alternative adaptation strategies analyzed for this plan are presented in Table 6 below.



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SOURCE: ESA, Pacifica, San Mateo County

**Figure 12**  
Rockaway Beach, Quarry and Headlands Sub-area and  
existing coastal armor

**Table 6. Rockaway Beach, Quarry and Headlands Sub-area Adaptation Strategies**

Adaptation Alternative	Adaptation Measures	Description
<b>1 Protect / Accommodate Hybrid</b>	Armor, managed removal of assets, Development setbacks	<p><b>Now:</b> Maintain existing armoring structures, allow erosion in south cove (City owned). Development setbacks for quarry property.</p> <p><b>Future:</b> Erosion continues in south cove until Hwy 1 threatened, assume Caltrans armors embankment or takes an alternative adaptation strategy. Relocate south cove public facilities as needed. Armor will be upgraded in the future as needed to maintain efficacy as beaches narrow and wave impacts on the armor increases with sea level rise. The schedule of upgrades/repairs will be determined by shore response modeling. Armoring upgrades could include raising armor to prevent overtopping with sea level rise.</p>
<b>2 Protect / Accommodate Hybrid</b>	Armor, Beach nourishment, Development setbacks	<p><b>Now:</b> Place sand: 100ft beach initially and every time beach width falls below minimum threshold. Development setbacks for quarry property.</p> <p><b>Future:</b> Nourish 100ft beach every time beach width falls below minimum threshold to delay need to armor Hwy 1 and reduce maintenance needs for existing armor, increasing nourishment frequency as SLR accelerates, timing TBD via shore response modeling.</p>
<b>3 Retreat / Accommodate Hybrid</b>	Managed removal/relocation of assets, Development setbacks	<p><b>Now:</b> Option to private property owners to remove or abandon existing armoring structures protecting property once it is damaged or no longer effective and to allow erosion. Development setbacks at Quarry and Headlands.</p> <p><b>Future:</b> Remove or relocate public structures and infrastructure only when no longer necessary to support existing development.</p>

## Pacifica State Beach

The following community values and concerns were identified in the draft Vulnerability Assessment public engagement meetings for the Pacifica State Beach sub-area (shown in Figure 13):

- Western Snowy Plover habitat at Pacifica State Beach
- CRLF habitat at San Pedro Creek
- Construction at Parks Building
- SLR level of 5.7ft could underestimate flooding which will affect approval of new development, cost of protecting current assets, adequacy of protection options, effects on environmental assets
- Spring flowers along coastline
- Surfing at Linda Mar Beach
- Biking/running trails
- Public restroom and permeable surfaces
- Wildlife concern along Linda Mar Trail – potential to raise land?
- Trail concern along Linda Mar Beach St. uphill to Rockaway
- How are we considering hazard avoidance for new developments vs. existing infrastructure? According to NRA document, we should avoid new building (and San Pedro Creek area)

The Pacifica State Beach sub-area is less developed, but provides a buffer for West Linda Mar from coastal hazards. Adaptation strategies proposed for this Sub-area take this into account along with the above values and concerns, and include protection measures such as revetments and beach nourishment as well as a retreat/protect hybrid. Details on the alternative adaptation strategies analyzed for this plan are presented in Table 7 below.



SOURCE: ESA, Pacifica, San Mateo County

Pacifica LCP 170663

**Figure 13**  
Pacifica State Beach Sub-area and existing coastal armor

**Table 7. Pacifica State Beach Sub-area Adaptation Strategies**

Adaptation Alternative	Adaptation Measures	Description
<b>1 Protect</b>	Armor, Flood protection	<b>Now:</b> Maintain existing armoring structures, build new armor on private lands south parking and pump stations. Allow erosion of northern dunes. <b>Future:</b> Floodproof pump stations. Raise and armor Highway 1 to counteract erosion and wave overtopping exposure for West Linda Mar, timing TBD via shore response modeling and Caltrans adaptation planning.
<b>2 Protect</b>	Armor, Beach nourishment	<b>Now:</b> Maintain existing armoring structures, build new armor on private lands south parking and pump stations. Allow erosion of northern dunes. <b>Future:</b> Nourish 100' beach and dunes when beach width falls below the minimum beach width, timing TBD via shore response modeling. Assumes Caltrans Raises and armors Hwy 1 as needed. Floodproof pump stations as needed.
<b>3 Retreat / Protect Hybrid</b>	Managed retreat, Armor	<b>Now:</b> Allow erosion at publicly owned areas (optional for privately owned commercial facility in this sub-area). <b>Future:</b> Remove parking and relocate pump stations. Raise and armor Highway 1 (part of West Linda Mar hybrid strategy) to counteract erosion and wave overtopping exposure, timing TBD via shore response modeling and Caltrans adaptation planning.

## West Linda Mar

The following community values and concerns were identified in the draft Vulnerability Assessment public engagement meetings for the West Linda Mar sub-area (shown in Figure 14):

- Linda Mar Boulevard floods
- San Pedro Creel Tail – wildlife EOR & creek
- Plans to relocate gas stations?
- Adaptation requirements for local businesses?
- Adaptation to floods along river as sea level rises?
- Storage unit concerns
- Work with school to update infrastructure adaptation plan

West Linda Mar used to be a lagoon, is currently susceptible to high groundwater levels and is vulnerable to flooding from San Pedro Creek (FEMA 2017). Future SLR will further expose this sub-area to flooding from wave run-up and overtopping and will exacerbate groundwater issues and flooding exposure from San Pedro Creek. To address coastal flooding hazards with SLR while addressing the above values and concerns, adaptation strategies for this sub-area focus on reducing flood risks and managing groundwater. The adaptation strategy of retreat is also included at the direction of the CA Coastal Commission (Appendix B). Details on the alternative adaptation strategies analyzed for this plan are presented in Table 8 below. Adaptation strategies that are implemented at Pacifica State Beach have implications for the West Linda Mar sub-area. Accordingly, results of the cost benefit analysis for these two sub-areas is presented together in Section 4.3.



SOURCE: ESA, Pacifica, San Mateo County

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**Figure 14**  
West Linda Mar Sub-area and existing coastal armor

**Table 8. West Linda Mar Sub-area Adaptation Strategies**

Adaptation Alternative	Adaptation Measures	Description
<b>1 Protect</b>	Armor/Flood Protect	<b>Future:</b> Assumes Caltrans will raise Highway 1 (with armor) to protect the highway from wave overtopping (which will also provide protection to the neighborhood). Build levee/floodwall along San Pedro Creek to limit river flooding exposure and coastal exposure with future SLR. Add pump station and sub drain to manage rising groundwater with SLR in lowest areas of neighborhood.
<b>2 Accommodate</b>	Elevate structures, Groundwater management	<b>Now:</b> Follow requirements of City’s Flood Damage Prevention Ordinance. <b>Future:</b> install sub drain and groundwater pump station to manage rising groundwater with SLR. (~120 structures affected by 2100 groundwater, ~300 structures affected by 2100 coastal storm (100-yr))

## Pedro Point and Shelter Cove

The following community values and concerns were identified in the draft Vulnerability Assessment public engagement meetings for the Pedro Point and Shelter Cove sub-area (shown in Figure 15):

- Adaptation for local businesses
- Adaptation to floods along river as sea level rises

To address coastal erosion and flooding hazards with SLR while addressing these values and concerns, the adaptation alternatives include protection measures such as revetments and beach nourishment. The adaptation strategy of retreat is also included at the direction of the CA Coastal Commission (Appendix B). Details on the alternative adaptation strategies analyzed for this plan are presented in Table 9 below.



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SOURCE: Multiple

**Figure 15**  
Pedro Point and Shelter Cove Sub-area and existing coastal armor



**Table 9. Pedro Point and Shelter Cove Sub-area Adaptation Strategies**

Adaptation Alternative	Adaptation Measures	Description
<b>1 Protect</b>	Armor	<p><b>Now:</b> Assume existing private armoring structures are maintained and expanded along Shoreside Dr. Armoring of the headland is included in the form of a rock revetment but detailed slope stability and engineering analyses would be required to validate any design to limit erosion of the headland.</p> <p><b>Future:</b> Maintain armored toe of headland. Shelter Cove not considered in this plan due to access issues.</p>
<b>2 Protect / Accommodate Hybrid</b>	Armor, Beach nourishment, Elevate structures.	<p><b>Now:</b> Assume armor is maintained and expanded along Shoreside Dr. In conjunction with Pacifica SB nourishment, nourish 100' beach as part of Pacifica State Beach alternative.</p> <p><b>Future:</b> Nourish 100' beach when beach width falls below the minimum beach width, increasing frequency as SLR accelerates, timing TBD via shore response modeling. Raise buildings above coastal flooding elevation.</p>
<b>3 Retreat</b>	Managed removal/relocation of assets	<p><b>Now:</b> Option to private property owners to remove or abandon existing armoring structures protecting property once it is damaged or no longer effective and to allow erosion.</p> <p><b>Future:</b> Remove or relocate public structures and infrastructure only when no longer necessary to support existing development.</p>

## 4.3 Cost-Benefit Analysis of Alternative Adaptation Strategies

*The Final Draft Adaptation Plan will include an economic analysis consistent with the methodology described in the Economic Analysis Methodology Memo (ESA and Phil King 2018; Appendix E) in this section.*

## CHAPTER 5

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# Pacifica's Sea-Level Rise Adaptation Plan

*The Final Draft Adaptation Plan will provide in this section a general set of City and public preferred adaptation measures for each sub-area with a focus on the immediate and near-term to address existing vulnerabilities, while also leaving options open in the future.*

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