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Memorandum

To: Community Work Group, Technical Work Group, and the General Public
From: Tina Wehrmeister, Planning Director
Date: April 20, 2018
Subject: Cover letter to the Adaptation Strategies Memorandum

Attached please find the Adaptation Strategies Memorandum. The Adaptation Strategy Memo identifies and defines various adaptation strategies or "tools" that are commonly used to address sea level rise impacts. The memo describes each adaptation strategy and identifies which strategies may work well in each subarea within Pacifica. This memo does not finalize the selection of adaptation strategies. A **Public/CWG meeting** will be held on **Thursday, April 26, 2018 at the Community Center (6:00pm to 9:00pm)** to discuss the memo.

The City of Pacifica has already prepared an Asset Inventory Memo, Existing Conditions Memo, and a Draft Vulnerability Assessment (with Appendices) to analyze what areas and assets may be vulnerable to sea level rise. All of these documents are available at www.cityofpacifica.org/sealevelrise for public review. The comment period on the Draft Vulnerability Assessment closed on March 14, 2018 and hundreds of comment letters were received. While staff is still preparing individual responses to specific comments, repeating comments were identified and responses to those have been provided at the end of this memo.

Please visit www.cityofpacifica.org/sealevelrise to understand what future steps, deliverables, and public outreach events will be held to support Pacifica's Sea Level Rise/ Draft Local Coastal Plan Update process.

Repeating Comments on the Draft Vulnerability Assessment

City needs to protect property and assets. Do not pursue managed retreat.

Many comments were received urging the protection of property and assets and opposing managed retreat adaptation strategies. The purpose of the Vulnerability Assessment document was to identify what areas may be vulnerable to sea level rise. The scope of the document was not intended to include consideration of adaptation strategies to the vulnerabilities. The discussion of adaptation strategies options will be included in the Adaptation Plan document. No decisions on adaptation strategies have been made or proposed as part of the Draft Vulnerability Assessment.

Nonetheless, your comment is on record.

Additionally, please note that on March 26, 2018 the Pacifica City Council formalized the Goals for the Draft Local Coastal Land Use Plan Update and Adaptation Planning. Goal No. 3 is to Preserve Existing Neighborhoods and Promote Environmental Justice and Local Economic Vitality and states that the Adaptation Plan shall protect existing homes, businesses, and infrastructure in Pacifica.

The vulnerability zone will make it impossible to get insurance or a loan.

Many commenters were concerned with the impacts that may result from the City creating a Coastal Hazard Zone (red line) on the Asset Vulnerability Maps shown at the public outreach meetings. The Coastal Hazard Zone represented the most inland extent of the modeled Coastal Hazard Exposure (i.e., wave run up, storm flood, flood prone area, coastal erosion) along the coast of Pacifica as shown in Appendices B through D of the Vulnerability Assessment. Modeled Coastal Hazard Exposure extents were produced by agencies such as the Federal Emergency Management Agency (FEMA) and State of California Ocean Protection Council. The City of Pacifica is using the agencies' publicly available data to understand what areas and assets in Pacifica may be vulnerable to sea level rise. The City of Pacifica has not created any hazard data. It is not known if or how third parties will use the maps in the Vulnerability Assessment, Adaptation Plan, or the update to the City's Local Coastal Plan.

Questions on sea level rise models.

Many comments were received questioning the coastal hazard models the City used and the assumptions or science supporting the models. The City of Pacifica has not created any hazard data and does not have the budget or resources to create hazard data, therefore the City must rely on existing publicly available data. Section 2 of the Draft Vulnerability Assessment discusses the planning horizons and sea level rise scenarios selected for this sea level rise planning effort. The selected data sources and models are consistent with the State of California 2018 Sea Level Rise Guidance for best available science for sea level rise in California. Questions regarding assumptions or methodology for the sources should be directed to the agencies that created the models.

Cost/benefit analysis has not occurred.

Several comments were received that the City has not considered the cost/benefit analysis of adaptation strategies. The City will be conducting a cost/benefit analysis for adaptation strategies as part of the Adaptation Plan. Prior to the release of the Adaptation Plan, a memo will be released and a public meeting will be held on May 10, 2018 (Pacifica Community Center at 6:00pm) to discuss the methodology of the cost/benefit analysis that will be used for the Adaptation Plan.

ESA supports managed retreat.

Many commenters have stated that ESA has expressed publicly opposition to sea walls and that Pacifica should pursue managed retreat. ESA does not have a predetermined opinion concerning various solutions for sea level rise. Additionally, the City Council will determine what adaptation policies go into the LCP Update for Coastal Commission certification.

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memorandum

date	April 18, 2018
to	Bonny O'Connor, AICP
cc	Tina Wehrmeister
from	James Jackson, PE; Bob Battalio, PE
subject	Pacifica Sea Level Rise Adaptation Background and Example Strategies

This memorandum is an interim deliverable specified in the Pacifica Sea Level Rise LCP Update Project work plan for Task 3 Adaptation Plan. The purpose of this memo is to start an informed conversation of adapting to coastal hazards and sea level rise with the City, workgroup members and public. The memo includes the following:

- Summary of recent coastal hazard issues and actions taken in the City.
- General background information on various approaches to coastal adaptation to enable informed discussions.
- Examples of possible adaptation strategies for each City sub-area to be discussed with the public, workgroups and City staff, and further evaluated. Recommended strategies will be presented in subsequent meetings and decided by the City.

This memo does not determine which adaptation strategies will be analyzed in the project, but rather presents ESA's preliminary framing of options, based on comments received during the Vulnerability Assessment, Coastal Commission guidance, and ESA's professional experience and knowledge of Pacifica and its values. The initially identified adaptation strategies also are consistent with the project goals adopted by the City Council on March 26, 2018[1].

To set the context for discussing adaptation alternatives going forward, we first discuss past coastal hazard experiences in Pacifica and associated actions taken to mitigate impacts. Next, we present general examples for a range of adaptation strategies that may be appropriate in Pacifica to provide a background on the subject of coastal adaptation. Example adaptation strategies are then presented for each of the nine analysis sub-areas in Pacifica to be discussed with the City, workgroups and public in the upcoming public meeting on April 26, 2018. As a preliminary analytic step, several example adaptation strategies have been identified and tailored based on an technical understanding of the physical setting in each sub-area, and also rely heavily on comments received

[1] Adopted project goals can be viewed here: http://www.cityofpacifica.org/civicax/filebank/blobdload.aspx?BlobID=14019

from workgroup members and the public during the draft Vulnerability Assessment engagement meetings and subsequent comment period. Recommended adaptation strategies will be refined further with the City following the discussion of this memo with the aforementioned groups and additional analysis. The final adaptation strategies will be selected by the City and then analyzed in more detail by the ESA team and presented in the draft Adaptation Plan.

1. 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).

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[2] 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 development encroaches on the beach (Figure 1). 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.

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SOURCE: Adelman & Adelman 2013

Figure 1
SF RV Resort showing fill on beach and armoring in 1972

Most of the existing shore protection structures are in various stages of degradation and the most robust have been frequently augmented with new rock and other actions (e.g. Beach Boulevard and Land's End seawall repairs). The seawalls at Beach Boulevard and Rockaway are overtopped by waves and damage landward of these structures has occurred (Figure 2) and can be expected in the future. More recently, the Land's End seawall failed

[2] 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.

(Figure 3) and the vertical public access is currently unavailable. Much of the armoring has been 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 at the Pacifica State Beach[3,4], where the natural shore was restored and built assets were reconstructed about 50 feet farther landward (Figure 4). This project is hugely successful, with almost no costs 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 and seawall damage (center); Rockaway on November 30, 2017 (right)

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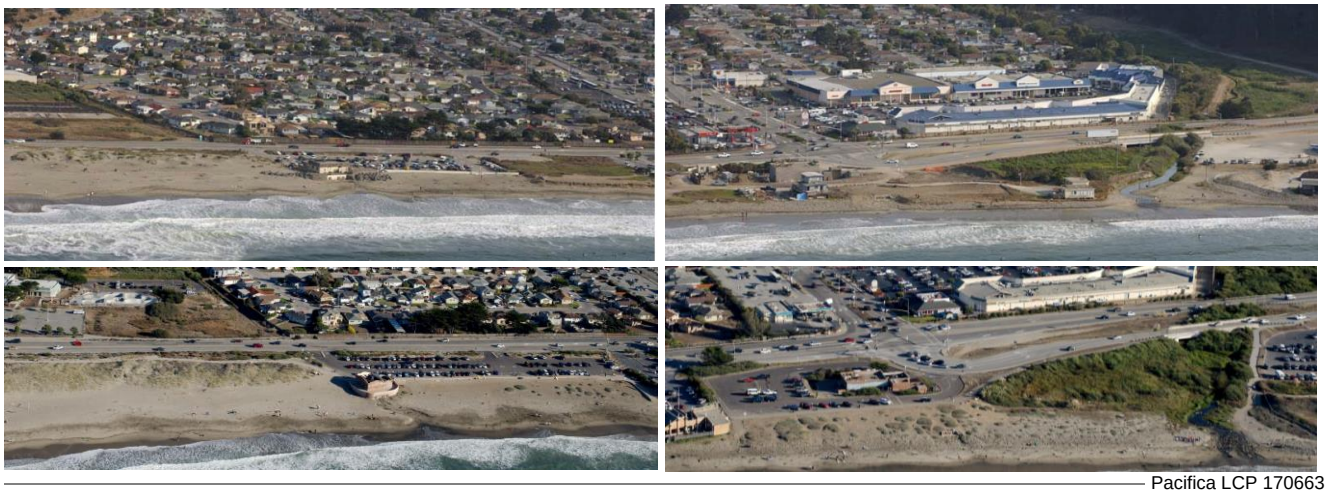
SOURCE: J. Jackson

Figure 3

Structural failure of Land's End Seawall (left) and erosion beyond end (right)

[3] 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.

[4] 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



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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 (Figure 5), a good example of a hybrid approach to shoreline adaptation. The project was funded by public sources and 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.

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SOURCE: Adelman & Adelman 2013

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 been lost where the armoring has occurred (Figure 6), as shoreline erosion continues seaward of armoring. 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. This type of hybrid approach is proposed as the baseline for comparing adaptation alternatives, discussed in Section 3 below.

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SOURCE: Geomatrix Consultants 1987 (left); B. Battalio 2010 (right)

Figure 6

Beach Blvd seawall in 1985 (left) after construction and in 2010 (right) showing no beach at high tide.

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

- Land's End – seawall failure, loss of vertical access
- Manor Apartments – demolition of apartments after failure of seawall construction at the apartments (shotcrete wall was not completed, loss of beach area
- The Bluffs Apartments – loss of lateral access along rock revetment due to beach erosion
- Esplanade Ave – remaining two homes demolished, and prior bluff top trail endangered despite 1998 rock revetment which was designed to save the road.
- West Avalon Drive at Esplanade Ave – loss of lateral access along rock revetment due to beach erosion

- SF RV Park – emergency rock revetment after bluff erosion; storm drain failure just south of the RV park at the public parking lot and marginal vertical access
- Pacific Skies Estates to Beach Boulevard – loss of lateral access along revetments and seawalls
- Beach Boulevard – seawall failures (1/11/2001 and 1/22/2016) and regular overtopping
- Rockaway – wave overtopping of seawall caused hotel damage (1/21/2017), loss of lateral access along seawall from beach erosion

2. General Examples of Adaptation Measures

Adaptation measures are types of actions that can be considered to mitigate coastal hazards. Not all measures are appropriate for a particular location. A selected suite of measures for a project or area can be considered an alternative adaptation strategy. Often, it is beneficial to consider a range of adaptation strategies to form scenarios for evaluation[5]. To further help the City identify appropriate adaptation strategies, ESA has developed descriptions of various adaptation measures that are applicable to Pacifica. The descriptions include the functionality, feasibility, and relative cost of adaptation measures and are divided into the following categories: Land Use Planning, Non-Structural, Structural, and Hybrid. Again, these potential measures may not be applicable or appropriate in all situations.

2.1. Hazard Avoidance Measures

The approaches in this category primarily focus on allowing the natural coastal processes to operate unimpeded, and using planning or other legal mechanisms to avoid hazardous conditions for development and other resources. These mechanisms may include building setbacks, conservation easements, fee simple acquisition, managed realignment (relocation / removal), rolling easements, , and transferable development rights or credits. Depending on the circumstances, these measures may have higher initial costs (e.g. property acquisition costs). Some, such as new development setbacks, have limited application due to shortage of undeveloped parcels or limited space to setback from the bluff.

Setbacks for Development

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 should be removed or whether it should 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

[5] SPUR, 2011 SPUR, AECOM, ESA PWA, Nelson\Nygaard, Sherwood Design Engineers, Phil D. King, PhD, 2012, Ocean Beach Master Plan, Prepared for State of California Coastal Conservancy, San Francisco Public Utilities Commission, and the National Park Service, Available online [1/9/14]: http://www.spur.org/publications/spur-report/2012-05-21/ocean-beach-master-plan .

calculate the setback distance. Also, there may be significant administrative costs to implementing/enforcing setbacks if and when developments become endangered, including potential litigation costs depending on the terms of the original development approval and possible challenges to it (see below). 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.

Deed Restrictions and Conservation Easements

A deed restriction or conservation easement is a legally enforceable agreement attached to the property deed between a landowner and a government agency or a non-profit organization that restricts substantial structural development for some period of time, often "for perpetuity," but that allows the landowner to retain ownership and otherwise use the land. Deed restrictions and conservation easements can be applied to any coastal parcel, but typically are used where a large and/or valuable parcel with environmentally sensitive resources exists, such as habitat or scenic views. Conservation easements and sometimes deed restrictions are often voluntary, but may also be agreed to or required as part of a larger development approval on the parcel(s) in question.

The cost of a deed restriction or conservation easements depends on willingness of seller, costs associated with maintenance and monitoring of the restriction, as well as the implementing mechanism. With easements, someone has to file, hold, and enforce the terms of conservation easement, which all have their own costs. The deed restriction has the same burdens, minus the need for a third party to hold it. There could also be lost property tax revenue and altered property values depending on the scope of the restriction. The benefits of easements and deed restrictions include those flowing from the protection of the resources being conserved, such as open space and natural shoreline and beach protection, or an important public viewshed.

Rolling Easements

Rolling Easements are open space or conservation easements or other restrictions that allow for the shoreline to naturally retreat, usually in relation to an identified reference feature, such as the Mean High Water line (MHW) for coastal properties. As the coast retreats the easement line migrates along with it, inland on a parcel,. When it appears likely that a development will soon encroach into the easement, it may be removed, allowing the easement to continue moving inland. This approach ensures maintenance of beach width and protection of the natural shoreline by requiring humans to yield the right of way to naturally migrating shores. Rolling easements may be implemented by statute or, more typically, by specifying that a conservation easement or other restriction "roll" or move landward as the shore erodes. The Coastal Commission has long-implemented a form of rolling easement through its use of the "no future seawall" deed restriction on new shoreline development. This restriction prohibits the future construction of a seawall to protect newly-approved development, thereby requiring the removal of the development if and when it becomes endangered.

Rolling easements have both costs and benefits. More transaction costs can be anticipated in densely developed coastal areas. Like all easements, Rolling Easements will require some regular inspection and potential enforcement. Ultimately, the rolling easement could result in lost property tax revenue and decreased property values. Also, one can assume there will be administrative costs associated with enforcing a rolling easement. On the other hand, rolling easements allow for the private economic use of land and development for a significant period of time, with clear expectations, and protect public beach, recreational and natural resources, potentially far-outweighing the lost tax revenue.

Fee Simple Acquisition

Fee Simple Acquisition is the purchase of vacant or developed land. As an erosion avoidance measure, this technique would transfer the erosion risks from the current property owner to the group or entity willing to acquire the property. Normally, the Fee Simple Acquisition is done to remove the property from being developed and prevent the construction of buildings or other capital improvements that would eventually be in danger from erosion. Experience shows that not all private property owners are interested in participation in a Fee simple acquisition program. However, one hybrid approach to consider is a fee simple purchase followed by a lease or rent back option to the former owners until the property becomes uninhabitable. This hybrid both allows continued use of the property and may enable public investment to recover some of the initial purchase cost.

Cost of Fee Simple Acquisition is potentially high based on land value and any demolition costs and potential loss of tax revenues. For this alternative, it is typically assumed that parcels are purchased at Fair Market Value. Conceptually this measure is likely to require the highest upfront costs although the cost may be less when a parcel and improvements are threatened by erosion. However, like rolling easements and other avoidance measures, fee acquisition may have significant long run economic benefits for the City and public, particularly as it could allow the maintenance of natural shorelines and beaches.

Managed Realignment or Relocation of Buildings and Facilities (Managed Retreat)

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 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[6,7,8,9]. The cost of these managed retreat projects ranged from about $4.5 Million per acre of beach to $45 Million per acre: 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. The costs for retreat in areas consisting of private property are not well defined by this project data, but could be approximately estimated by assessing the value of the property, and the compensation mechanism (e.g. purchase, easement, etc.). One of the most difficult elements of this measure is uncertainty over who pays and who benefits, and quantification of benefits. Typically, this measure is part of a strategy that includes public cost to rebuild public infrastructure and compensate private property owners for their property net the costs associated with shore armoring. But again, there also may be significant public benefits from a managed retreat strategy that should be weighed against the costs.

Although this may be the most straightforward method for protecting development that is under imminent or long-term threat of being damaged or destroyed, it is often assumed to be technically or financially infeasible.

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[6] 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

[7] 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.

[8] 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

[9] 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

Often there is not sufficient space or land available for the structure to be relocated. Many planned retreat efforts, therefore, often use property acquisition to remove development from inherently hazardous places. Planned retreat is easier to implement on public lands and by government agencies such as the California Department of Parks and Recreation.

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 taken away) 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, 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.

TDR programs do, however, require extensive planning and sustained implementation and enforcement over the long termOther 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.

2.2. Non-structural Protection Measures

The alternatives in this category tend to be focused either on enhancing sediment supply and accretion processes or reducing sediment losses, and reducing or limiting flooding. Implementing mechanisms for these types of alternatives may require the involvement of a regional planning entity. In general, these measures replace eroded sand frequently and repeatedly.

Beach 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 (generally considered a short term negative effect), 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.

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.

Dune Restoration / Nourishment (Sand and Vegetation)

Dune restoration would include placement of sand, graded and planted to form back beach dunes. Beach 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[10] below beaches in California. This strategy includes the dune enhancement activities below:

- Dune augmentation (adding sand to dunes to provide protection during storm events), especially to raise low-lying beach access paths to prevent flood waters from flowing into the neighborhoods behind the dunes.
- Ceasing any activity that adversely affects the sediment supply of the dunes.
- Ceasing beach grooming. This would encourage dune vegetation establishment and dune formation. Beach grooming removes driftwood and wrack and reduces vegetative growth and dune formation.
- Planting vegetation. Planting native dune vegetation, together with wind action, will help build up and stabilize dunes.
- Fencing off sensitive areas and creating dune walkways
- Informational signs and other outreach activities to educate about the importance of maintaining stable sand dunes.

Wetland / Shoreline Vegetation

In areas that were previously wetland habitat, the conversion back to wetlands through restoration and revegetation may provide additional buffering of storm surges as well as improve habitat and water quality. Combined with managed retreat of the shoreline, transgression of wetlands upland would maintain valuable habitat.

Horizontal Levee (Ecotone Levee)

The horizontal 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.

ESA previously worked on The South Bay Shoreline Study (USACE 2015) with the purpose to decrease tidal flood risk that exists for large areas of low-lying terrain protected by non-engineered dikes, restore tidal marsh habitat that was lost in the past creation of the salt ponds and maintain recreational opportunities. USACE

[10] 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.

provided costs for building an ecotone over an existing ground surface of about 0-2 feet NAVD. The slope extended from EL 5 to EL 16 at 30:1 to accommodate 5' of sea level rise and extending down to below the vegetation colonization elevation. Prior successful implementations of this concept have occurred at Warm Springs Marsh (south San Francisco Bay) and the Hamilton Wetlands Restoration Project (Novato, Marin County)[11].

2.3. Structural Protection and Accommodation Measures

Measures that fall into this category involve the design and construction of structures to protect the coastline, or the use of structural design to accommodate hazards. These alternatives include seawalls, revetments, groins, breakwaters, perched beaches, low crested structures, artificial reefs, elevation and/or strengthening of structures, or designing structures to facilitate future relocation. However, not all of these measures are allowed or favored by regulatory authorities and stakeholders that prioritize natural assets such as beaches and wetlands. Implementing these strategies will likely follow a relatively traditional permitting process involving the local permitting agencies, California Coastal Commission, California State Lands Commission, and for those located below Mean High Water (MHW) the U.S. Army Corps of Engineers (USACE).

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.

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

[11] ESA PWA, 2013. Hamilton Wetland Restoration Project Breach and Completion Contract, Supplemental Design Documentation Report, Prepared for the US Army Corps of Engineers, April 19, 2013, ESA project number DWO1764.08.

design elements that allow the structure to resemble the natural environment in that area, in order to blend in with the existing geologic conditions.

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 as the erosion continues 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 breakwaters are considered the most effective because wave sheltering and diffraction reduces sand transport directly. Offshore Breakwaters consist of fill in the surf zone, typically quarry stone arranged in a mound that penetrates the water surface. The breakwaters dissipate incident wave energy and change the pattern of sand transport in their lee, thereby reducing the transport of sand from the nourished area. These structures are generally applicable where there is a firm seabed and the need to create a calm area free from wave energy.

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. Offshore reefs are considered less effective than offshore breakwaters because the wave sheltering is reduced by the low crest height which allows wave overtopping. 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).

Groins are structures that extend seaward from the shore. Groins are generally considered along stretches of coast with high net longshore sediment transport. In application, the groins are located to segment the beach and nourishments into compartments, thereby reducing the loss of sand to adjacent shores. Groins are considered the least effective because wave climate is not reduced and rip current formation causes offshore transport, bypassing and edge effects near the structures.

ESA developed a concept for a large scale coastal engineering solution to manage erosion and maintain beaches along northern Pacifica. The sand retention structure includes a series of engineered rock headlands to segment the coast into smaller cells that would be nourished with sand. This concept is shown in Figure 7 below.

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SOURCE: ESA

Figure 7
Engineered headlands and beach nourishment concept for north Pacifica

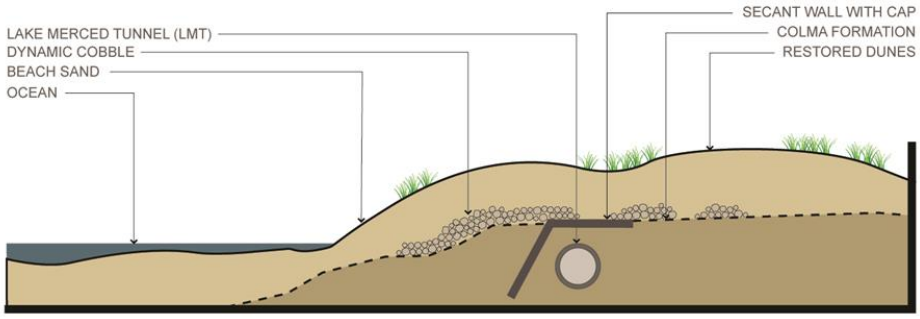
Traditional Levee

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 waves.

2.4. Hybrid Measures

Hybrid Shore Protection

Recent experience indicates that hybrid approaches that include a mix of adaptation measures may be the most practical in some situations. For example, San Francisco's Ocean Beach Master Plan includes a hybrid approach in south Ocean Beach where prior development and erosion have resulted in an acute hazard to both built and natural assets (ESA PWA 2015). At this location, a low-height seawall is proposed but at a location established as far landward as possible which requires removal of roadway and parking within a managed retreat framework (Figure 8). The plan also includes beach nourishment and dune construction, and includes adaptive management with revisions anticipated for higher sea level rises after 2050. Another hybrid example is to combine beach nourishment with a traditional armoring structure such as a seawall or revetment; by adding sand in front of the structure, the frequency and intensity of wave action on the structure is reduced (as long as the beach persists), thereby reducing the maintenance of the armoring structure.



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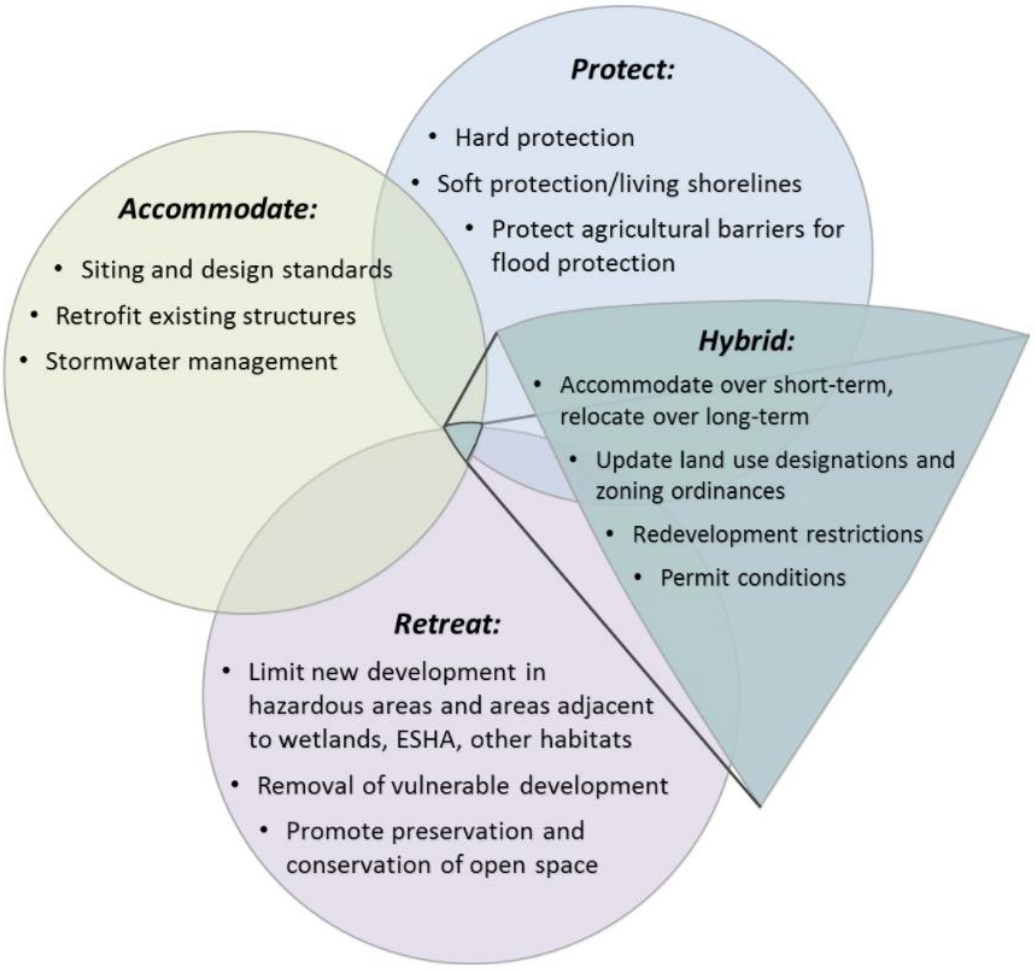
SOURCE: ESA PWA 2015

Figure 8
Conceptual cross section of hybrid adaptation strategy that includes low-profile armoring, beach nourishment and dune construction

3. Adaptation Strategy Examples for Pacifica Sub-areas

Ultimately, a range of adaptation strategies will be analyzed for each sub-area in terms of costs and benefits so that the City can create informed policy that guides adaptation to sea level rise in the future. This section discusses example adaptation strategies for each sub-area in Pacifica that address projected coastal erosion and flooding impacts identified in the Vulnerability Assessment, based on an initial consideration of each area, technical feasibility concerns, and issues raised by stakeholders and the public. These examples were developed considering the public's desire and City resolution to protect existing development and infrastructure as well as Coastal Commission guidance (and public input) to maintain coastal access and recreation. The example strategies in this section focus on different combinations of traditional engineering measures to maintain the backshore, coastal access and the beach that mostly fall under the protect and hybrid approaches listed in the Coastal Commission guidance (Figure 9). At this stage, we have not focused on undeveloped areas in the City where other measures such as hazard avoidance may be appropriate.



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SOURCE: CA Coastal Commission

Figure 9
Adaptation strategies as defined by the Coastal Commission

For reference, Pacifica sub-areas are shown in Figure 10. The sub-area adaptation strategies are meant to serve as a starting point for discussion with the City, workgroups and public. A selection of preferred adaptation strategies for each sub-area will ultimately be decided by the City and will be compared against the baseline scenario.

Baseline and Alternative Adaptation Strategies for Pacifica

Typically, the costs and benefits of various adaptation strategies are evaluated and compared with a baseline such as no action, allow erosion etc. For example, the Coastal Regional Sediment Management Plan baseline strategy consisted of "No Action" where erosion and flooding proceed without human intervention. Given Pacifica's past experience with emergency, ad hoc response to erosion, a "No Action" scenario was determined to be inappropriate for the City. A new baseline is proposed to consist of a continuation of recent hazard mitigation practices in Pacifica through more deliberate planning. Specifically, armoring is presumed to be the preferred adaptation strategy for most of Pacifica with the exception of Linda Mar. We presume that public funding will be used to maintain the existing public armor at Esplanade, Beach Boulevard and Rockaway. We also presume that the City of San Francisco will armor the levee fronting the golf course in south Sharp Park. We will assume that the remainder of the armoring funded privately will be maintained. At Linda Mar, we presume that shore migration will be allowed to progress on public lands but that armoring will occur on private lands. Of course, with the presumption of armoring, it must also be presumed that most of Pacifica's beaches will disappear over time, especially with sea level rise. This is one of the trade-offs that the City must consider in its consideration of the LCP update.

Specific adaptation strategies preliminarily deemed appropriate for each Sub-area are presented in the following sections. The example adaptation strategies combine multiple adaptation measures listed in Section 2 of this memo, and are further explained for the respective Sub-areas. These example adaptation strategies are influenced by feedback from community and technical work group members during the CWG and TWG meetings as well as from Pacifica residents during the Public Workshop on the draft Vulnerability Assessment. The adaptation strategies examples will be reviewed and refined in collaboration with the City, working groups and public. The preferred adaptation strategies, selected by the City, will be evaluated in a cost-benefit analysis and presented in the Adaptation Plan.

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SOURCE: ESA, Pacifica, San Mateo County

Figure 10
Pacifica Sub-areas

3.1. Fairmont West (Figure 11)

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

- Tobin's Folly photographic spot
- Manmade historic spot
- GGNRA Mussel Rock trail hiking and dog walking
- Parking/trail access
- Hang gliding area
- TWG: California State Lands Commission has lease rock revetment adjacent to 528-572 Esplanade Avenue
- USACE started FID on Esplanade Avenue erosion. Status of study is uncertain

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, example adaptation strategies for this area include the following:

1. **Baseline** – Maintain existing armoring structures, erosion continues elsewhere.
2. **Hybrid** – Maintain existing armor structures, place sand elsewhere to reduce erosion.
3. **Armor** – Maintain existing armor, build new armor everywhere else. 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 beach width modeling.
4. **Sand Retention Structures** – build sand retention structures and place sand (see artificial headlands concept in Figure 7 above).

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SOURCE: ESA, Pacifica, San Mateo County

Figure 11
Fairmont West Sub-area and existing coastal armor

3.2. West Edgemar and Pacific Manor (Figure 12)

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:

- Trailheads for Milagra Ridge Trail
- Bluff/gateway to Pacifica
- Economic center
- Structures hang over bluffs
- Coastal trail loss

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, example adaptation strategies for this area include the following:

1. **Baseline** – Maintain existing armoring structures, erosion continues elsewhere.
2. **Hybrid** – Maintain existing armor structures, place sand elsewhere to reduce erosion.
3. **Armor** – Maintain existing armor, build new armor everywhere else and maintain. 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 beach width modeling.
4. **Sand Retention Structures** – build sand retention structures and place sand (see artificial headlands concept in Figure 7 above).

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SOURCE: ESA, Pacifica, San Mateo County

Figure 12

West Edgemar and Pacific Manor Sub-area and existing coastal armor

3.3. Northwest Sharp Park (Figure 13)

Community values and concerns were identified in the draft Vulnerability Assessment public engagement meetings for the Northwest Sharp Park sub-area 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. Example adaptation strategies for this area include the following:

1. **Baseline** – Maintain existing armoring structures, erosion continues elsewhere.
2. **Hybrid** – Maintain existing armor structures, place sand elsewhere to reduce erosion.
3. **Armor** – Maintain existing armor, build new armor everywhere else and maintain. 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 beach width modeling.
4. **Sand Retention Structures** – build sand retention structures and place sand (see artificial headlands concept in Figure 7 above).

Pacifica LCP 170663

SOURCE: ESA, Pacifica, San Mateo County

Figure 13
Northwest Sharp Park Sub-area and existing coastal armor

3.4. Sharp Park, West Fairway Park and Mori Point (Figure 16)

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:

- Old Wastewater Treatment Plant 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 due to pumping limitations. As a result the City storm drains can no longer use the outfall to Laguna Salada, which in turn overloads the Clarendon Outfall that was not designed for such capacity. To address the coastal erosion and flooding hazards with SLR while addressing the above values and concerns, the example adaptation strategies include the following:

1. **Baseline** – Maintain existing armoring structures, including new revetment extension along SPGC levee.
2. **Armor** – Maintain existing armor, build new armor everywhere else and maintain (similar to Beach Blvd seawall). Does not include armoring around Mori Point. 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 beach width modeling. Build interior levees along Clarendon Rd and Lakeside Ave as well as Fairway Drive to protect neighboring homes and businesses from flooding (fluvial and coastal) around Laguna Salada and install pump stations on inboard side of levees (see Figure 15).
3. **Sand Retention Structures** – Build sand retention structures and place sand (see artificial headlands concept in Figure 7 above). This option may also include pumps and levees to manage flooding around Laguna Salada.

Additional adaptation measures that address coastal flooding include the following:

- Elevate Assets – elevate roads, homes and buildings behind Beach Blvd seawall and adjacent to SPGC.
- Upgrade Coastal Structures, Add Pumps – raise the Beach Blvd seawall and the Levee along SPGC to limit wave run-up and overtopping and close the gap between the two. Add pumps to manage rain flooding around Laguna Salada. Portable pump stations are already used to manage rainfall-caused flooding along Clarendon.

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SOURCE: ESA, Pacifica, San Mateo County

Figure 14
Sharp Park, West Fairway Park and Mori Point Sub-area and existing coastal armor

Pacifica LCP 170663

SOURCE: ESA

Figure 15
Sharp Park, West Fairway Park and Mori Point Sub-area
interior levees and pump stations concept

3.5. Rockaway Beach, Quarry and Headlands (Figure 16)

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:

- Highway 1
- Lack of data for potential restoration of historical wildlife corridors along Highway 1 (Mori Point, Rockaway, San Pedro Creek)
- Quarry has an accessible trail
- Could city purchase quarry to keep it open as a barrier?
- North Coastal trail provides beach access
- Viewpoint
- Fishing
- What current open space areas can we use for flood mitigation?
- TWG: flood mitigation bank potential for quarry

Adaptation alternatives in this sub-area focus on development along Rockaway Beach and do not address the Quarry or Headlands. To address coastal erosion and flooding hazards with SLR while addressing the above values and concerns, adaptation strategies examples that mitigate erosion impacts in this sub-area include the following:

1. **Baseline** – Maintain existing armoring structures.
2. **Armor** – Maintain existing armor, build new armor along Rockaway Cove (not including Quarry or Headlands). 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 beach width modeling.
3. **Sand Placement** – Place sand along Rockaway Cove. (this option could include artificial reefs)
4. **Hybrid** – hold line at seawalls and revetments, allow erosion elsewhere (south end) and remove/relocate parks facilities. Simply maintaining coastal structures at their current elevation would only address erosion; wave run-up and overtopping of the structure would still occur during storms and would damage assets.

Additional adaptation measures that address coastal flooding include the following:

- Upgrade Coastal Structures – raise the seawalls/revetments to eliminate wave run-up and overtopping during storm events.
- Elevate Assets – elevate roads, homes and other buildings in Rockaway above the flood hazard elevation.
- Remove/Relocate Assets

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SOURCE: ESA, Pacifica, San Mateo County

Figure 16
Rockaway Beach, Quarry and Headlands Sub-area and existing coastal armor

3.6. Pacifica State Beach (Figure 17)

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

- 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 examples for this Sub-area take this into account along with the above values and concerns, and include the following:

1. **Baseline** – maintain existing armoring structures on private lands, allow erosion of public lands.
2. **Hybrid** – Allow erosion in meantime, then raise and armor Highway 1 (part of West Linda Mar hybrid strategy) to counteract erosion and wave overtopping exposure.
3. **Sand Placement** – nourish beach with sand placements
4. **Armor** – Maintain existing armor, build armor elsewhere to protect assets at south end of beach and raise/armor Highway 1. 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 beach width modeling.

Additional adaptation strategies that address coastal flooding include the following:

- Elevate Assets – elevate roads, homes and other buildings above the flood hazard elevation.
- Remove/Relocate Assets (this strategy has been previously employed at Pacifica State Beach with successful results, PWA 2002)

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SOURCE: ESA, Pacifica, San Mateo County

Figure 17
Pacifica State Beach Sub-area and existing coastal armor

3.7. West Linda Mar (Figure 18)

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

- 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 and is currently susceptible to high groundwater levels and is vulnerable to flooding from San Pedro Creek. Future SLR will further expose this sub-area to flooding from wave run-up and overtopping. To address coastal flooding hazards with SLR while addressing the above values and concerns, example adaptation strategies for this sub-area focus on reducing flood risks and include the following:

1. **Baseline** – Erosion management at Pacifica State Beach subarea affects hazards at Linda Mar in the future. Existing flood exposure from San Pedro Creek remains.
2. **Armor/Flood Protect** – Raise and armor Highway 1 to prevent coastal flood exposure from future SLR. Improve flood protection along San Pedro Creek to prevent exacerbated future fluvial flooding from sea level rise (potentially similar to recent USACE project). Add pump station to drain lowest area of neighborhood (manage future high ground water as well as respond to coastal/fluvial storm event flooding).
3. **Accommodate** – Raise homes above flood hazard elevation, install pump station to manage rising groundwater and drain neighborhood after flood events.

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SOURCE: ESA, Pacifica, San Mateo County

Figure 18
West Linda Mar Sub-area and existing coastal armor

3.8. Pedro Point and Shelter Cove (Figure 19)

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:

- Adaptation requirements 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 following adaptation alternatives examples were developed:

1. **Baseline** – maintain existing structures along waterfront, allow erosion elsewhere.
2. **Sand Placement** – place sand along waterfront (100' first year and every time beach falls below minimum width, backshore erodes) – can be applied to Shoreside Drive waterfront homes and Shelter Cove.
3. **Armor** – build/upgrade structures along waterfront homes, at bluff toe along Shelter Cove access road, and Shelter Cove homes.
4. **Remove/relocate** – allow erosion of shoreline at waterfront homes and Shelter Cove, allow erosion of bluffs.

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SOURCE: Multiple

Figure 19
Pedro Point and Shelter Cove Sub-area and existing coastal armor

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