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Coyote Point

Sea-Level Rise Vulnerability Assessment

PRODUCED FOR THE COUNTY OF SAN MATEO

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Acknowledgements

This project was a collaboration between the County of San Mateo's Parks Department and Office of Sustainability to meet the requirements of California Assembly Bill (AB) 691.

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Glossary

ABM	Articulated Block Mat {revetment}
CDFW	California Department of Fish and Wildlife
CSLC	California State Lands Commission
CSM	City of San Mateo
GHG	Greenhouse Gas {emissions}
M&N	Moffatt & Nichol
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
OCOF	Our Coast Our Future
OPC	Ocean Protection Council
PG&E	Pacific Gas & Electric {Company}
ROM	Rough Order of Magnitude
SCC	{California} State Coastal Conservancy
SLR	Sea-Level Rise
SMC	San Mateo County
SMCP	San Mateo County Parks Department
SMCSO	San Mateo County Sheriff's Office

Executive Summary

The Coyote Point Recreation Area is managed by the San Mateo County Parks Department and is a popular destination with more than 500,000 visitors annually. The park features spectacular panoramic views of San Francisco Bay along the shoreline and from bluff trails and elevated viewpoints up on the Knoll, and access to natural habitat and marshlands. Key attractions of the Recreation Area include the park itself, the Coyote Point Marina, the Coyote Point Yacht Club, and the Coyote Point CuriOdyssey Museum. The Recreation Area is located on 691.65 acres of sovereign land, tidelands, and submerged lands granted to the County of San Mateo by the State of California in 1965. The present report provides a sea-level rise vulnerability assessment for the State Grant Area in compliance with Assembly Bill (AB) 691 requirements.

AB 691 requires trustees to assess sea-level rise impacts to granted lands. The first step was to inventory vulnerable natural and built resources and facilities. The second was to consider the impacts of sea-level rise itself and other dynamic coastal processes and climatic events that are projected to be exacerbated by sea-level rise such as coastal erosion, storms, and high tides on the vulnerable assets identified. This information was used to inform adaptation strategies for Coyote Point.

The sea-level rise projection adopted for this analysis was the California Ocean Protection Council, *OPC (2018),* medium to high risk aversion, high emissions scenario, which projects 0.8 feet of sea-level rise by 2030, 1.9 feet by 2050, and 6.9 feet by 2100.

Shoreline levees managed by the City of San Mateo provide flood protection for the greater area, including Coyote Point. A significant portion of the City of San Mateo is low-lying and located within the FEMA 1% annual chance floodplain. These include the Coyote Point Levee along the Peninsula Beach west of the Knoll at Coyote Point, and the Bayfront Levee extending southeast from the Coyote Point Marina along the shoreline of the North Shoreview area. These two levee systems provide protection for San Mateo County Parks facilities west of the Knoll as well as roadways and access to facilities on the Knoll.

Because portions of the two levee systems are freeboard-deficient they are currently not meeting FEMA requirements. The City of San Mateo in partnership with the County of San Mateo is in the process of upgrading the shoreline levees and other flood protection infrastructure in order to meet FEMA requirements for flood protection. These flood control improvements are to meet FEMA requirements for flood protection of residences in San Mateo. FEMA flood protection requirements are expressed as the 1% annual chance event (or a 100-year storm). Meeting FEMA requirements will protect the greater area from coastal flooding and increase resiliency against sea-level rise. The estimated cost of planned Capital Improvement Projects to improve flood protection in the area is approximately $36M.

The present assessment estimates that the area west of the Knoll is protected from sea-level rise related hazards out to approximately 2050, and with the above improvements to flood protection per FEMA requirements would be protected in the event of a 100-year storm. However, FEMA requirements do not include an allowance for sea-level rise and protection against future sea-level rise would therefore need to be implemented via additional Capital Improvement Projects. A regional

solution would be needed to protect the area west of the Knoll with improvements to the East Promenade (planning completed and funding for construction approved), West Promenade, and shoreline levee along the Coyote Point Pump Station (construction scheduled for completion by 2021).

The above-mentioned Capital Improvement Projects would provide protection for public trust resources and values in this area, including public access and recreational values and commercial activity in this area, which includes the Peninsula Humane Society & SPCA, the Boardsports Kite- and Windsurfing Center and School, and the Siebel Firearms Range. Facilities on the Knoll are on high ground and would only be affected by sea-level rise and flood hazards to the extent that access to the area is impacted.

The Coyote Point Marina and Coyote Point Yacht Club reside outside of the existing levee system and this area is therefore sensitive to sea-level rise. The most immediately impacted area is the parking area at the Coyote Point Yacht Club which is projected to be impacted by flooding associated with king tides by around 2020. Flooding in this area may initially be limited and infrequent, but flood impacts will gradually increase in terms of extent, flood depth, and frequency of flooding with sea-level rise.

Parking areas along the west side of the marina are on relatively high ground and are not projected to be impacted until after 2050. The first impacts will be in the form of shallow flooding during king tides of parking areas on the center mole, and in the area of the Harbormaster Office and the boat launch ramps. Park Offices located along the west side of the marina are not projected to be impacted until 2090.

Areas of coastal habitat include a small freshwater marsh and seasonal wetland in the area west of the Coyote Point Pump Station, and the saltmarsh and mudflats along the eastern fringe of the Coyote Point Marina. These areas are projected to be gradually impacted by sea-level rise, but preservation and expansion of the habitat would be possible with beneficial reuse of dredge material from the marina.

The Parks Department and City of San Mateo are currently in the process implementing the Eastern Promenade project and pump and levee upgrades to protect the area from sea level rise impacts. Additional activities needed to protect the Recreation Area include enhancing the tidal marsh and raise the trail along the marina and implement stormwater backflow prevention devices. To prepare for 2100, regional shoreline protection measures would need to be put in place, including raising levees, trails, portions of the marina, and breakwaters and expanding the tidal marsh to protect the marina from wave action. The County of San Mateo has already partnered with UC Davis to monitor real time changes in sea level rise and will continue to monitor flooding and sea level rise impacts associated with future projects. An order of magnitude estimate places the cost of adaptation strategies to prepare for sea level rise impacts at ~ $360 million in today's dollars. Implementing these strategies will require regional coordination and implementation support from state and federal agencies.

Maps of 2030, 2050, and 2100 impacts are provided in Appendix A. Options for mitigation/adaptation measures to protect trustee facilities and natural resources by 2050 and by 2100 are also included in Appendix A.

1. Introduction

San Mateo County's location between the San Francisco Bay and the Pacific Coast makes it especially vulnerable to sea level rise and flooding. Under the leadership of Supervisor Dave Pine, the Office of Sustainability launched the "Sea Change SMC" initiative in 2015 with the goal of increasing coordination and collaboration on sea level rise planning across the County, and improving awareness and understanding of the issue. In 2018, the County finalized a Sea Level Rise Vulnerability Assessment in coordination with cities, agencies, businesses, community groups, and others.

As part of the County's Climate Change Preparedness Action Plan the County's goal is to continue to prepare for the impacts of sea level rise, and to evaluate risks from other climate change impacts. This includes leading by example to prepare County-owned facilities for the future impacts of climate change. This report takes the first step to developing a set of adaptation strategies for one of these facilities, the Coyote Point Recreation Area.

1.1. Background Information

The Coyote Point Recreation Area is managed by the San Mateo County Parks Department and is a popular destination with more than 500,000 visitors annually. The park features spectacular panoramic views of San Francisco Bay along the shoreline and from bluff trails and elevated viewpoints up on the Knoll, and access to natural habitat and marshlands. Key attractions of the Recreation Area include the park itself, the Coyote Point Marina, and the Coyote Point CuriOdyssey Museum.

Use varies with the season. During the peak periods of warmer and summer months, often spanning from April to September, visitations range from 50,000 to over 80,000 per month. Based on summaries of attendance figures, the most popular areas are the playgrounds and picnic areas. Boating is among the top three popular uses, rotating with museum visitation and family picnicking according to the season. CuriOdyssey serves over 100,000 visitors annually.

The greater vision for the park is to retain the natural Bayfront character of the site and keep new development to a minimum, with an emphasis on:

- Recreation - Updating and maintaining the existing recreation facilities to meet current safety and disability requirements, improving trails and playgrounds and upgrading/improving existing green areas used for informal play.
- Infrastructure - Making improvements to landscape and infrastructure, including but not limited to, repairing/replacing as required the park water system, realigning the sewer line, improving beach area drainage, replacing turf irrigation, enhancing existing windbreaks, repairing eroded areas, providing new and upgrading existing restrooms, developing indoor and outdoor showers, improving flood resilience, and incorporating flood protection measures and levee improvements to the Peninsula Beach Shoreline.
- Stewardship and Education - Enhancing the natural wetlands of the area, coastal upland and riparian systems and increasing opportunities for visitors to learn about the Bay shoreline, its

biotic resources and cultural resources, and provide ways for visitors to become active stewards in the natural landscape and its education programs.

1.2. Historical Background

The present day park setting is firmly rooted in history. The Coyote Point area was originally a marshland inhabited by Ohlone Indian tribes. At this time the knoll was an island in the bay surrounded by marshland covered in grassland and oak trees. Settlement of the area commenced around 1776 when the Juan Bautista de Anza Historic Trail came through the area, which lead to establishment of a missionary outpost at San Mateo Creek around 1793. The area was then known as Rancho San Mateo. In 1850 the Howard family bought the Rancho San Mateo property to house their home and for import of high-grade cattle. Development of the area included filling the marshlands and construction of a road across the marsh that surrounds Coyote Point Knoll. A wharf was established at the end of this road to support freight transported on barges. In the 1860's to 1870's the Southern Pacific Railroad was built through the region, which supported population growth in the region.

Early recreational activities in the area were affirmed with a bathhouse and a short pier for bathing constructed sometime in the 1880's to early 1890's. The bathhouse and pier were located in the sheltered cove, which today forms part of the Peninsula Shoreline Beach. See Plate 1 for an overview of the Coyote Point Recreation Area. Other recreational use of the area involved hunting for game birds.

In 1921, the Pacific City Corporation purchased 90 acres of the site in the vicinity of the old wharf and bathing pier to be developed into an amusement park, which opened in 1922. Sand was brought in from Monterey Bay to create a bathing beach. Public access to the park was improved with a new road, buses from the train station, and chartered ferryboats from San Francisco.

In 1932 the inland marsh began to be filled in for the current golf course. What comprised the original Rancho San Mateo area was acquired by the Federal government in the 1940's. The Merchant Marines acquired the Knoll in 1942 and established a Merchant Marine Cadet School to train officers for the World War II merchant fleet. The Captain's House was located on the Knoll and still remains, and today functions as a conference center (see Plate 1).

1.3. State of California Granted Lands

Transfer of the land to the County for public recreation began in 1963 and in 1965, the State of California granted the County of San Mateo (SMC) sovereign tidelands and submerged lands at Coyote Point to hold in trust for:

- The establishment, improvement and conduct of a harbor and associated facilities;
- For the construction, reconstruction, repair, maintenance and operation of public buildings, public assembly and meeting places, convention centers, parks, playgrounds, bathhouses and bathing facilities, recreation and fishing piers, and public recreation facilities; and

- For establishment, improvement and conduct of a small boat harbor and marina, including launching ramps, storage sheds, boat repair facilities, administration buildings, public restrooms, service stations and fuel docks, yacht club buildings, and associated parking areas, roadways, pedestrian ways and landscaped areas. Several easements and leases enable other public jurisdictions and private parties to operate in park boundaries.

The total area of the State Grant Area is 691.65 acres of which approximately 66 acres are beaches, wetland, and mudflat areas (tidelands), 477 acres are seabed (submerged) areas, and 149 acres are upland areas. Figure 1-1 depicts the boundaries of this area.

Features of the Coyote Point Recreation Area are shown on Plate 1 and include public access to the Bay Trail, beach areas, windsurfing, kiteboarding and kite flying, swimming areas, coastal cliffs with overlook areas, hiking trails, bicycle and walking paths, picnic and playground areas, public amenities, shower facilities and general parking, and RV camping. The Recreation Area hosts large family, employer and non-profit gatherings, a number of different running and bicycling events for health, a kids' obstacle event, weddings, and a series of Coyote Point Nights as put on by County Park Foundation.

The recreation area also houses the CuriOdyssey museum and wildlife center, located on the Knoll, which is operated by CuriOdyssey, which hosts numerous school visits and provides recreation and educational opportunities for over 100,000 visitors annually. Additional facilities include the Captain's House Conference Center, Boardsports kite- and windsurfing retailer and school, the Siebel Firearms Range which is operated by the San Mateo County Sheriff's Office, and utilized by the privately owned Coyote Point Rifle and Pistol Club, as well as 13 local law enforcement agencies for certification and training, and the Peninsula Humane Society & SPCA Center which is on a lease of County owned land, but not operated by the County. A number of PG&E power lines go through the northwestern part of the Recreation Area across the Golf Course to the PG&E substation located at the southeast end of the golf course.

The Coyote Point Marina is a special enterprise zone, and operations and management of this area are overseen by the Harbormaster. All revenue generated by the marina is utilized for funding of the marina facilities. The marina is located on the east side of the Knoll and features two main basins. A third basin was considered for expansion in the 1970's and 1980's and concrete rubble left over from demolition of the old San Mateo Bridge was subsequently placed in the water to define the east property line of the recreation area and the limits of the potential third marina basin. In the meantime, saltmarsh habitat has established in this area and current plans are to preserve and support this habitat.

The marina provides 544 berths for 20 to 60 feet sailboats, powerboats, and multi-hull boats, including a visitor dock, boat ramp, fuel dock, pump-out station, gated security, and the Coyote Point Yacht Club with bar and dining facilities, which offers boating opportunities ranging from motor boating, and sailing, to kayaking. The marina area also features a fishing area, trails, picnic areas, and a shoreline trail through the saltwater marsh along the eastern portion of the marina.

Activities hosted at the marina include weekly sailboat races, club cruises, a summer youth sailing program, and annual lighted boat parade.

Figure 1-1: Coyote Point State Grant Area Boundary.

1.4. Scope of Work

The present report is a complete sea-level rise (SLR) vulnerability assessment for Coyote Point, as required in response to Assembly Bill 691. The vulnerability assessment covers the State Grant Area delineated on the California State Lands Commission (CSLC) grant plat, which includes the sovereign tidelands and submerged lands of the Coyote Point Recreation Area. The boundary of the State Grant Area is indicated by the yellow outline in Figure 1-1.

The AB 691 Assessment includes:

1. Assessment of Impacts of Sea-Level Rise

    - Impacts of storms and extreme events, changing shorelines, and trends in relative local sea level on vulnerable natural and built resources and facilities, including public trust resources and values such as public access, commerce, recreation, coastal habitats, and navigability.

2. Maps of 2030, 2050, and 2100 impacts

3. Estimate of financial costs to address the impacts of sea-level rise

    - Replacement or repair costs of resources and facilities that could be impacted by sea-level rise, and non-market values of recreation and ecosystem services, and public trust resources that could be impacted by sea-level rise.

    - Costs of 2030, 2050, and 2100 high sea-level rise projection, including anticipated costs of adaptation/mitigation measures, and potential benefits of such strategies and structures. In this case, the medium-high risk scenario is most appropriate given the nature of the resources.

4. Description of how trustee proposes to protect and preserve resources and structures that would be impacted by sea-level rise.

    - Proposed mitigation/adaptation measures, timeframe for implementation, plans to monitor impacts of sea-level rise and climate change, and regional partnerships that address sea-level rise vulnerability or increase resiliency.

2. Assessment of Impacts of Sea-Level Rise

2.1. Historical Erosion/Flooding

The Peninsula Shoreline has been subject to continued erosion which has undercut the adjacent paved promenade trail. Erosion has impacted the beach along the Eastern Promenade and removed most of the imported sand from the 1920's leaving a base of pea gravel along much of the shoreline. Along the Western Promenade, erosion progressively undercut the rock riprap and collapsed the shoreline Armor Flex Articulated Block Mats, which caused the adjacent pavement to fail. Improvements to shore protection in this area to mitigate erosion and provide improved access for were completed in 2014.

Where there is not shoreline protection the impact has been the greatest along the Eastern Promenade. As noted later in the report, the Eastern Promenade restoration and climate adaptation project will realign infrastructure, improve shoreline resilience and access to recreation, and increase shoreline elevation to protect properties inland from flooding. The Bay side of the Knoll is very steep, and barren areas of the slope are experiencing severe erosion as result of the nature of the soils and the slope's exposure to the harsh bay winds and tidal action.

A significant portion of the region at Coyote Point is low-lying and vulnerable to flooding. The effective FEMA Flood Insurance Rate Maps (FIRMs) indicate the extent of flooding associated with a 1% annual chance storm event. Affected areas include the entire region shown on Plate 1, which includes the majority of the Coyote Point Recreation Area (apart from the Knoll which is high ground), portions of the Coyote Point Marina, the adjoining marshlands, the Poplar Creek Golf Course, the North Shoreview neighborhood and schools, the Bayshore Freeway, Bowie Estate and the area of the San Mateo High School. Portions of Burlingame would also be subject to flooding.

These areas are protected to an extent by the shoreline levee along the Peninsula Beach promenade west of the Knoll and the shoreline levee along North Shoreview southeast of the Knoll. These levees are not FEMA accredited, and therefore freeboard deficient. The lowest elevation along the Peninsula Beach shoreline levee is around El. +10 feet NAVD88 and the crest of the North Shoreview levee is around +13.6 feet NAVD88.

The 1% annual chance flood Still Water Elevation (SWEL) is +10.35 feet NAVD88 per *AECOM (2016)*, and the progressive risk levels that could unfold under this scenario are:

- Coastal flooding associated with wave action overtopping the levee(s). The extent of this type of flood exposure may be limited to some hours in duration over the peak of one or more high tides. Floodwaters under this scenario will be collected and routed via the existing stormwater infrastructure to the Coyote Point Pump Station and/or the Poplar Avenue Pump Station.

- Coastal flooding due to the still water level overtopping along the Peninsula Beach shoreline levee. The extent of this type of flood exposure may be limited to several hours in duration over the peak of one or more high tides, likely with wave action and wave overtopping. The amount of flooding under this scenario would be much more substantial than the above

scenario. It is conceivable that the floodwaters could be collected and routed via the existing stormwater infrastructure to the Coyote Point Pump Station and/or the Poplar Avenue Pump Station. The stormwater infrastructure and pump stations would need to remain functional during the critical time frame where floodwaters need to be captured and returned to the Bay. Schaaf & Wheeler, *S&W (2015)*, studied the stormwater infrastructure pump station capacities as part of the North Shoreview Flood Hazard Mitigation Plan and proposed to increase the capacities of the two pump stations to address this scenario. It should be noted that potential risks could be that overflowing water and wave action causes the levee to fail which would lead to catastrophic flooding. In this case the pump system would not keep up with tidal flooding and the system would be overwhelmed.

- Coastal flooding associated with a levee breach either because of storm action or seismic activity. An event that would result in breaching of the levee could result in catastrophic flooding of the region. In a scenario such as this, the actual extent of flooding would rely heavily on the capacity of existing stormwater infrastructure to convey flood waters to the pump stations, and the capacity of the pumps to return the flood waters to the Bay.

The Trustee facilities and structures located within the FEMA 1% annual chance storm floodplain are therefore classified as vulnerable to sea-level rise.

Although, the shore levees protecting the region at Coyote Point are not meeting FEMA standards, they have served to protect the region from coastal flooding since they were established, and the levees have never been breached.

Historically, flooding due to fluvial sources has occurred several times in areas throughout the City of San Mateo with the most impacted areas on the eastern side of San Mateo. Major flood events in the historical record occurred in the 1970's where the Laurel Creek Dam was overtopped and flooded a substantial portion of the San Mateo Village neighborhood. In the 1980's, the East Laurel Creek Dam was overtopped and homes immediately downstream were damaged. San Mateo Village has experienced recurring flooding in 1955, 1966, and 1982. San Mateo Creek flooded in 1955 and 1958, which affected a number of homes and businesses downstream including a number of downtown businesses. These areas are located in the south-east portion of the City of San Mateo and are not in proximity to the Coyote Point Recreation Area.

2.2. Land Use

The Coyote Point Recreation Area (Coyote Point) is located in the County of San Mateo between the cities of Burlingame and San Mateo (Figure 1-1, Project Site Location). The park comprises approximately 149 land acres and 543 water acres of the San Francisco Bay. Coyote Point is a popular destination with annual visitation estimated at 500,000 visitors. Popular recreation activities include picnicking, windsurfing, swimming, informal turf play, playground activities, special events, boating, fishing, and sightseeing. The Marina area, which includes a private Yacht Club, offers boating opportunities ranging from motor boating, and sailing, to kayaking.

The Siebel Firearms Range, operated by the San Mateo County Sheriff's Department, and CuriOdyssey located on the Knoll provide additional recreation and educational opportunities. The

regional Bay Trail (the recreational trail route for the Juan Bautista de Anza National Historic Trail overlays on the Bay Trail in this location) and various internal trails within the recreation area provide linear corridors for walking, running, skating, bicycling, and observing shoreline aquatic life.

Table 2-1 and Table 2-2 list natural and built resources and facilities potentially vulnerable to sea-level rise. Locations of the respective facilities and resources are shown on the Coyote Point Recreation Area Map, Appendix A, Plate 1.

These facilities and resources are potentially vulnerable to one or more of the following Sea-Level Rise related hazards that could impact them directly or indirectly:

- Sea-Level Rise, causing dry land and intertidal areas to become permanently submerged.
- Rising tides, which encroach on low-lying land areas and increase the frequency and duration of flooding.
- Erosion, which encroaches on shorelines and land areas and potentially increases impacts from flooding.
- Rising groundwater tables which could contribute to saltwater intrusion, and enhanced flooding.
- Storm events and associated coastal flooding inundating low-lying areas.

Table 2-1: Inventory of Vulnerable Facilities and Assets

#	**Facility**
1	Coyote Point Pump station
2	Bay Trail, paved bike and walking paths
3	Magic Mountain Playground and other playground areas
4	Picnic areas
5	Parking areas
6	Public amenities, including restrooms, shower facilities, view points, and benches.
7	Marina, including Harbormaster Office, Park Offices, Yacht Club, and associated parking areas, breakwater, and shoreline trail.
8	Peninsula Humane Society & SPCA
9	Boardsports Kite- and Windsurfing Center and School
10	Siebel Firearms Range
11	PG&E power lines

Table 2-2: Inventory of Vulnerable Natural Resources

#	Resource
1	Freshwater marsh and seasonal wetland
2	Beach area
3	Salt Marsh
4	Mudflat areas

2.3. Public Access

Coyote Point and its surrounding area includes several public beaches, coastal trails, public parks, camp grounds, and boating. Figure 2-1 highlights the main public access routes, the Bay Trail (pink), the Promenade Trail and Marina Trail (orange) which are considered spurs of the Bay Trail, other paved trail and roadways (blue), and parking areas indicated with P. The yellow line indicates the California State Lands Commission (CSLC) Grant Boundary.

Figure 2-1: Public Access Routes.

2.4. Habitat

Habitat within the Coyote Point Recreation Area encompasses a diverse ecosystem that includes plant species (trees, shrubs, herbs, eelgrass, and algae), birds, mammals, marine life (fish, shellfish, oysters, mollusks and other invertebrates), amphibians, and reptiles.

2.4.1. Vegetation

Most of the park is landscaped with non-native species and no rare plant species are known to exist within the park. Plant species categorized by the *(number of individual species)* observed at Coyote Point include trees (23), shrubs (12), herbs (44), and algae (2). No protective status applies to the principal vegetation types.

Areas supporting sensitive and protected species are described in the following section.

2.4.2. Freshwater Marsh and Seasonal Wetland

A small freshwater marsh and seasonal wetland exists at the western end of the park near the pump station and the Peninsula Humane Society. Freshwater marsh and wetland habitat creates valuable habitat for a diverse group of wildlife and is considered sensitive habitat by the County of San Mateo and CDFW. Freshwater marsh needs freshwater input to maintain soil moisture and can endure periods of seasonal flooding. In the winter months, freshwater input to the marsh is from precipitation and runoff. Over the summer months, the marsh is sustained by irrigation passing through the park's drainage system. This area includes arroyo willows, weeping willow, prairie bulrush, spearscale, common reed, brass buttons, pickleweed and salt grass per the San Mateo County Parks Vegetation Resources document prepared by Rana Creek Habitat Restoration, *RCHR (2002).*

Coastal salt marsh habitat exists along the east side of the marina and adjacent to the Yacht Club. This area east of the marina was considered for expansion of the marina with a third basin in the 1970's and 1980's. The area since has seen the resurgence of coastal salt marsh habitat, which is expanding naturally in an easterly direction as a result of the configuration of the marina breakwaters and levees. This configuration has produced an eddying effect that brings in natural deposits of silt, sand and seashells, allowing cordgrass and pickleweed to take root in this area. The resulting tidal mudflats adjacent to the shoreline provide important foraging habitat for migrating and wintering birds, including waterfowl, shorebirds, wading birds, gulls and terns.

A small remnant Coastal Salt Marsh is also located south of the Marina and is expanding naturally in an easterly direction. The emerging salt marsh at the edge of the San Francisco Bay provides important wintering and foraging habitat for migratory waterfowl, and breeding habitat for shorebirds. Where grassland is found adjacent to pickleweed salt marsh, it can create habitat for the burrowing owl, the endangered salt marsh harvest mouse, endangered snowy plovers and other species.

Salt marsh habitat has high biological quality and is considered sensitive habitat by the County of San Mateo and CDFW. Salt marsh vegetation is capable of thriving within the upper zone of tidal inundation and can endure periods of submergence. Native plant species in this area includes California cord grass, pickleweed, alkali heath, fleshly jaumea, salt grass, gum plant, salsola, brass buttons, radish,

and fennel per the San Mateo County Parks Vegetation Resources document prepared by Rana Creek Habitat Restoration, *RCHR (2002)*. Non-native plant species include radish, fennel, salsola, brass buttons, smooth cord grass, and ice plant. The latter two are highly invasive.

2.4.3. Wildlife

Species of wildlife categorized by the *(number of individual species)* observed at Coyote Point includes mammals (10) nine of which species are land-based and one is marine (harbor seal), birds (69), fish (7), invertebrates (43), amphibians (3) including frogs, salamanders and toads, and reptiles (3) including snakes and lizards.

2.4.3.1. Special Status Species

The San Francisco Garter Snake which is a State- and Federally Endangered species has purportedly been observed in one instance at Coyote Point in the area of the salt marsh, *RCHR (2002)*. It is not known if this species still resides in the area. In addition, Monarch butterflies have been reported wintering in the eucalyptus grove, *RCHR (2002)*. When the City of San Mateo Flood Control project goes through it will replace a damaged culvert draining to the creek area that has been causing the ponding that could create habitat. This habitat will likely disappear.

Harbor Seals, which are protected under the Federal Marine Mammal Protection Act, have been observed at Coyote Point, *RCHR (2002)*.

The salt marsh provides habitat potentially capable of supporting Salt-marsh Harvest Mouse, which is a State- and Federally Endangered Species; California Clapper Rail, which is also a State- and Federally Endangered Species, and California Black Rail, which is a State Threatened Species, *RCHR (2002)*.

2.5. Social Equity and Community Vulnerability

Sea-level rise related impacts to social equity and community vulnerability can be expressed via impacts to: beach access, displacement, contamination risk, emergency service and disaster response, and also social and economic implications of adaptation options.

Social vulnerability to sea-level rise and climate change hazards in general can be evaluated by identifying social groups who may be particularly impacted by sea-level rise. Categories considered in this regard can include: People over 65 living alone, the extent of the population under 18 years of age, renters, households speaking little English, people of color, low income areas, population without high school education, residents living in group quarters, unemployed, women who have recently given birth, outdoor workers, foreign born residents, residents with lack of access to grocery stores, overweight/obese youth, households without a vehicle, and households without air conditioning.

Figure 2-2 provides an overview of the geographic extent of some of the primary social groups potentially impacted by sea-level rise related hazards. These include areas renters and owners with severe housing cost burden (red), areas with 33% or more low income households (green), areas with 68% or more people of color (orange), concentration (8% and greater) of population under 5 years old (pink), and areas with a concentration (9% and greater) of population over 75 years and over (orange).

The Coyote Point Recreation Area does not encompass any residential development, and none of the above social groups reside within the State Grant Area. However, it is apparent that region wide flooding associated with sea-level rise could significantly impact residential areas with low income households and areas with a severe housing cost burden. The Recreation Area also serves as a regional attraction for a broad diversity of residents living in the area.

Table 2-3 shows social vulnerability index scoring for census blocks in the vicinity of the Coyote Point Recreation Area from *PI (2012)*. The data indicates that social vulnerability in most of the region is near medium, slightly above or below neutral (census blocks 6054, 6060, and 6061), and points to census block 6062 as an area that could be more significantly impacted. As noted here, a high proportion of renters, people of color, and people without high school diplomas live near Coyote Point. Implementing projects that protect Coyote Point assets from sea level rise and flooding has the potential to protect these vulnerable people, while also supporting equitable access to open space.

Figure 2-2: Overview of Social Vulnerability to Sea-Level Rise Hazards.

Table 2-3: Factors Affecting Social Vulnerability to Sea-Level Rise and Climate Change Hazards

Factors	Census Block Group			
	6054	6060	6061	6062
Living Alone over 65	8%	15%	3%	7%
Population under 18	21%	17%	27%	24%
Renters	57%	54%	38%	69%
Households speaking little English	13%	23%	29%	47%
People of Color	42%	51%	65%	88%
Low Income	20%	20%	30%	42%
Population w/o High School Diploma	93%	87%	84%	63%
Living in Group Quarters	0%	0%	0%	0%
Unemployed	6%	2%	3%	5%
Women giving birth within last 12 months	9%	1%	12%	1%
Outdoor Workers	7%	11%	4%	12%
Foreign Born	28%	41%	37%	55%
Lack Access to Grocery Stores	9%	0%	0%	0%
Overweight/Obese Youth	24%	28%	47%	40%
Impervious Land Cover	51%	60%	48%	62%
Treeless Area	4%	1%	2%	0%
Households without a Vehicle	6%	12%	9%	10%
Pre-term Birth Rate	9%	9%	9%	9%
Households without Air conditioning	26%	24%	24%	24%
Vulnerability Index Score	**-0.14**	**-0.09**	**+0.07**	**+0.38**
Range (less vulnerable ↔ more vulnerable)				
	-2	-1	0	+1 +2

2.6. Sea-Level Rise

Current guidance for California recommends evaluation of SLR impacts using a scenario-based analysis. This method is founded on the approach by the Intergovernmental Panel on Climate Change (IPCC) to understand how SLR and other drivers interact to threaten health, safety, and resources of coastal communities. Comprehensive SLR guidance for California was first developed by the National Research Council, *NRC (2012).* The guidance relied on the best available science at the time to identify a range of sea-level rise scenarios including high, low, and intermediate projections, taking

into account regional factors such as El Niño and extreme storm events that affect ocean levels, precipitation, and storm surge. This approach allows planners to understand the full range of possible impacts that can be reasonably expected based on the best available science and build an understanding of the overall risk posed by potential future SLR.

The best available science and most recent guidance is provided by the California Ocean Protection Council in *OPC (2018)* and has been adopted for this vulnerability assessment. Table 2-5 summarizes SLR scenarios adopted from *OPC (2018)* for time horizons out to 2150. The columns outlined in dark blue reflects the OPC guidance for risk levels, which include low risk aversion, medium to high risk aversion, and extreme risk aversion.

The SLR scenario adopted for this vulnerability assessment is the *Medium – High Risk Aversion* scenario, assuming high greenhouse gas (GHG) emissions. The CSLC AB 691 Assessment requires planning horizons of 2030, 2050, and 2100 to be considered. Table 2-4 summarizes the sea-level rise projected for these specific planning horizons.

Table 2-4: SLR for CLSC Planning Horizons.

		1-IN-200 CHANCE
		0.5% probability sea-level rise meets or exceeds…
Greenhouse Gas (GHG) Emissions	Plan Horizon	**Medium - High Risk Aversion**
High emissions	**2030**	0.8
High emissions	**2050**	1.9
High emissions	**2100**	6.9

Figure 2-3 depicts the *OPC (2018)* SLR projections from Table 2-1 in graphical form, where the *Medium to High Risk Aversion* scenario with high emissions is indicated by the red line. The projected sea-level rise for planning horizons 2030, 2050, and 2100 is indicated by the red circles. Present day conditions for 2019 is indicated by the black circle (E) denoting existing conditions.

The horizontal blue bands provide an indication of when the adopted levels of sea-level rise could be experienced under the other *OPC (2018)* scenarios, e.g. low risk aversion under a low or high GHG emissions scenario or extreme risk aversion indicated by the purple line for the H++ scenario.

Table 2-5: Sea-Level Rise Projections for San Francisco Bay Area, *OPC (2018)*.

		Probabilistic Projections (in feet) (based on Kopp et al. 2014)					*H++ scenario (Sweet et al. 2017) *Single scenario*
		MEDIAN	**LIKELY RANGE**		**1-IN-20 CHANCE**	**1-IN-200 CHANCE**	
		50% probability sea-level rise meets or exceeds...	*66% probability sea-level rise is between...*		*5% probability sea-level rise meets or exceeds...*	*0.5% probability sea-level rise meets or exceeds...*	
				Low Risk Aversion		**Medium - High Risk Aversion**	**Extreme Risk Aversion**
High emissions	2030	0.4	0.3 -	0.5	0.6	0.8	1.0
	2040	0.6	0.5 -	0.8	1.0	1.3	1.8
	2050	0.9	0.6 -	1.1	1.4	1.9	2.7
Low emissions	2060	1.0	0.6 -	1.3	1.6	2.4	
High emissions	2060	1.1	0.8 -	1.5	1.8	2.6	3.9
Low emissions	2070	1.1	0.8 -	1.5	1.9	3.1	
High emissions	2070	1.4	1.0 -	1.9	2.4	3.5	5.2
Low emissions	2080	1.3	0.9 -	1.8	2.3	3.9	
High emissions	2080	1.7	1.2 -	2.4	3.0	4.5	6.6
Low emissions	2090	1.4	1.0 -	2.1	2.8	4.7	
High emissions	2090	2.1	1.4 -	2.9	3.6	5.6	8.3
Low emissions	2100	1.6	1.0 -	2.4	3.2	5.7	
High emissions	2100	2.5	1.6 -	3.4	4.4	6.9	10.2
Low emissions	2110*	1.7	1.2 -	2.5	3.4	6.3	
High emissions	2110*	2.6	1.9 -	3.5	4.5	7.3	11.9
Low emissions	2120	1.9	1.2 -	2.8	3.9	7.4	
High emissions	2120	3	2.2 -	4.1	5.2	8.6	14.2
Low emissions	2130	2.1	1.3 -	3.1	4.4	8.5	
High emissions	2130	3.3	2.4 -	4.6	6.0	10.0	16.6
Low emissions	2140	2.2	1.3 -	3.4	4.9	9.7	
High emissions	2140	3.7	2.6 -	5.2	6.8	11.4	19.1
Low emissions	2150	2.4	1.3 -	3.8	5.5	11.0	
High emissions	2150	4.1	2.8 -	5.8	5.7	13.0	21.9

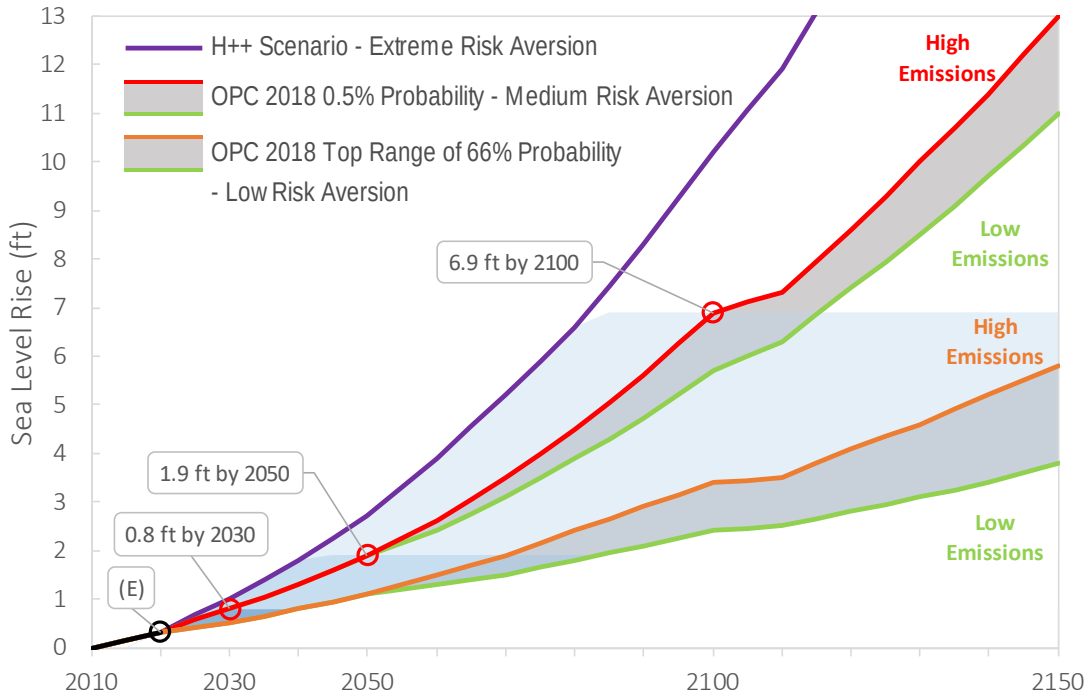

Figure 2-3: OPC Sea-Level Rise Projections.

2.7. Trends in Local Relative Sea Level

Local relative sea-level rise reflects the change in sea-level due to climate change and vertical movement of the land. Vertical land motion can occur due to tectonic activity, isostatic rebound which is adjustment of the earth due to compression from the ice masses during the last ice age, and due to subsidence, which is the primary factor at Coyote Point.

Figure 2-4 shows estimates of vertical land motion (VLM) for California and Nevada from *JGR (2016)*. GPS imaging was employed to track vertical land motion data over a period of five years, accounting for groundwater withdrawal, elastic bedrock uplift and tectonic uplift. Red colors indicate uplift and blue colors indicate subsidence. The intersection of the black horizontal and vertical lines reflects the location of Coyote Point. Land is subsiding by 1.4 mm per year. At this rate the land will sink by 4.5 inches by 2100.

The vertical land motion in this case adds to the relative sea level rise at Coyote Point, but the effect is limited as the projected rise in ocean level is an order of magnitude larger than the VLM.

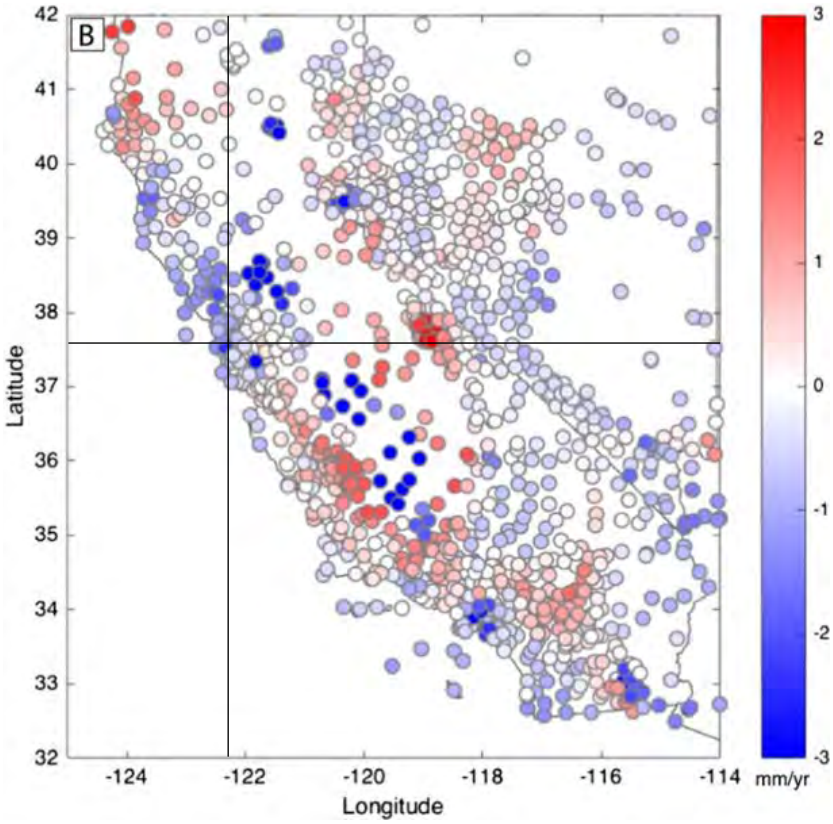

Figure 2-4: Rates of Vertical Land Motion, CA and NV, *JGR (2016)*.

2.8. Sea-Level Rise Scenarios

Coastal flooding is projected to increase with sea-level rise. Additional factors that can exacerbate coastal flooding events include high tides, storm surge, El Niño effects, and elevated groundwater tables. These elements can increase the severity and frequency of flooding.

- Tides occur regularly with about two high tides and two low tides each day. The highest tides (spring tides) occur twice a month during the full moon and the new moon. Around December and January when a new or full moon occurs at the same time as the moon is at its closest to the earth, the tides run higher. These higher perigean spring tides are commonly known as King Tides.

- Storm surge can occur as a combination of wind shear over the water and low atmospheric pressure. Strong northerly wind can produce storm surge in the South Bay, but it doesn't manifest as much at Coyote Point, which is located more centrally in the South Bay.

- El Niño (and La Niña) are cycles of warming and cooling of the ocean, typically lasting 9 to 12 months. They often commence in June or August and reach their peak during December through April, and subsequently decay over May through July of the following year. Their

periodicity is irregular, occurring every 3 to 5 years on average. The warming associated with El Niño produces a rise of the ocean level, which can be on the order of 6 to 13 inches. The period of elevated (or lowered) ocean levels can be on the order of months, while the peak highs and lows occur on a scale of days to weeks.

- Elevated Groundwater Tables. Sea-level rise can cause seawater intrusion into coastal aquifer systems and can raise shallow groundwater tables. These can short circuit levee systems and contribute to inland flooding and/or impacts to buried infrastructure.

The historically highest water levels recorded in the South Bay occurred in January of 1983 and were due to a combination of King Tides and rise of the ocean level due to a pronounced El Niño episode. The estimated water level at Coyote Point was around +9.8 feet NAVD88.

Table 2-6 provides a breakdown of tidal datums and extreme water levels for existing conditions, and estimated water levels with SLR projected for 2030, 2050, and 2100. The sea-level rise projection reflects the *Medium to High Risk Aversion* OPC Scenario, assuming *High Emissions*.

The conditions adopted for mapping of sea-level rise related flood impacts are highlighted in yellow. In terms of frequency, these reflect flooding as follows:

- Daily inundation of areas below the Mean High Water (MHW) line.
- Annual inundation of areas flooded by king tides.
- Extreme inundation in the event of a 100-year (1% annual chance) storm.

These can be described further as follows:

- Mean High Water. The Mean High Water (MHW) tide level is an average of all of the high tides occurring over a tidal epoch (19-year cycle). In coastal areas, the MHW tide line defines the shoreline, and in terms of sea-level rise sets the threshold above which daily tides will result in coastal flooding. High tides occur twice daily.
- King Tides. Extreme high tides (perigean spring tides) which occur annually in January and December when a new or full moon occurs at the same time as the moon is at its closest to the earth. King tides produce temporary flooding, but can be envisaged as a precursor to future, permanent rise of the sea level.
- 1% Annual Chance Storm. Representative of an extreme tide or storm event with an average recurrence interval of 100 years. This scenario reflects the FEMA 1% annual chance event. The extreme water level associated with this scenario accounts for storm surge, tides, El Niño effects, and wave action.

Table 2-6: Tidal and Extreme Water Level Datums, SLR Scenarios.

Condition [2]	Existing	Sea Level Rise (feet) by [1]		
		2030	2050	2100
		0.8	1.9	6.9
	Water Level (feet NAVD88)			
1% Annual Chance Storm	+10.35	+11.2	+12.3	+17.3
King Tides	+8.39	+9.2	+10.3	+15.3
MHHW	+6.86	+7.7	+8.8	+13.8
MHW (Shoreline)	+6.24	+7.0	+8.1	+13.1
MSL	+3.32	+4.1	+5.2	+10.2
MTL	+3.31	+4.1	+5.2	+10.2
MLW	+0.39	+1.2	+2.3	+7.3
MLLW	-0.81	-0.0	+1.1	+6.1

[1] State of California Sea-Level Rise Guidance, OPC (2018) Update.

[2] San Francisco Bay Tidal Datums and Extreme Tides Study, AECOM (2016).

3. Maps of 2030, 2050, and 2100 Impacts

San Mateo County acquired countywide LiDAR topographic data in 2017. An excerpt of the County LiDAR is shown on Appendix A, Plate 2. The topographic data is referenced to the California State Plane Coordinate System, Zone III (FIPS 0403), with elevations referenced to the North American Vertical Datum of 1988 (NAVD88). The LiDAR data was acquired by the County in April to May of 2017. The DEM data consists of bare earth elevations gridded to 1 meter (3.28 feet) resolution.

Note that the topographic data portrayed on Plate 2 focuses on elevations that are within the tidal range and potential range of flood stages with future sea level rise. Elevations below +8.0 feet NAVD88 are therefore greyed out, and high ground above elevation +15.0 feet NAVD88 is shaded brown.

3.1. Guide to Flood Maps

Maps of existing conditions and 2030, 2050, and 2100 sea-level rise impacts were developed using the San Mateo County LiDAR Digital Elevation Model (DEM). The flood maps included in Appendix A provide information on flood extents and flood depths. Areas subject to inundation associated directly with coastal flooding are shaded in blue colors. Hues from light blue to dark blue indicate flood depths from 0.5 to 5.0 feet at one foot increments (see Figure 3-1). Shallow flooding less than ½ feet deep is indicated in yellow. Depths of detached low-lying areas area are indicated by orange colors (Figure 3-1) ranging from light to dark for depths ranging from 0.5 to 5.0 feet at one foot increments. Aquamarine indicates shallow areas with depths within ½ foot. The low-lying areas are detached and not subject to direct overland flooding but indicate areas that may become flooded due to precipitation runoff, seepage, a high groundwater table, or at or near failure of the levee(s).

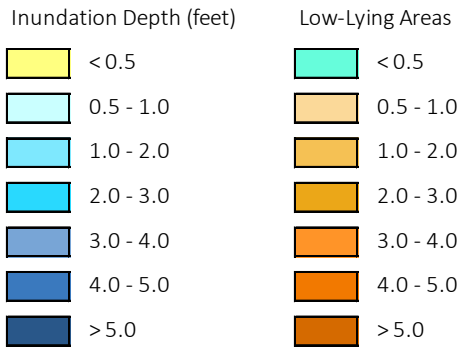

Figure 3-1: Flood Map Information

It should be noted that the mapping reflects current day conditions with sea level rise projections out to 2100. Flood mitigation projects that have already been implemented are thus reflected in the mapping effort, but ongoing and future planned project elements are not considered in the mapping effort. Planned Capital Improvement Projects (CIPs) are described and discussed in Section 5 on Sea-Level Rise Mitigation and Adaptation Measures.

3.2. Changing Shorelines

There are several different ways sea-level rise can affect shorelines. Along shorelines subject to wave action, the typical response of the shoreline to sea-level rise is to recede inland. This happens as the shoreline profile rebalances itself around the new higher mean sea level. This effect was described in 1962 by Per Bruun and is known as the *Bruun Rule*. In order to maintain the same beach slope, upland material is eroded and shifted to the below water portion of the profile. In undeveloped areas the effect may be pronounced recession of the shoreline. If there is an insufficient supply of sediment available to raise the shoreline profile in tow with sea-level rise, the result can be accelerated erosion and deepening of the coastal waters. This in turn allows larger waves to impact the shore which further exacerbates erosion. These effects are the reason why shorelines often experience a higher degree of erosion during strong El Niño episodes occurring over the winter months. The El Niño conditions cause the ocean level to be higher which manifests as a temporary sea-level rise.

3.2.1. Historical Setting

The Coyote Point area was originally marshland with the Knoll as a separate feature. Use of the land can be traced back to before 1850.

Aerial photography from the area shows that the regional shoreline and marsh edge has been managed since before the 1930's. Historical shoreline locations are shown on Plate 3. The marina area was built out in the 1930's and the yacht club incorporated in 1941. The present day shoreline, much of which is riprapped and leveed runs approximately where the edge of the marsh originally was. The only portion of shoreline that is not currently protected with riprap is the approximately 800 feet long Pebble Beach area on the west side of the Knoll. This area shows a trend of progressive erosion since the 1930's. For comparison, Plate 4 provides an aerial view of the area from 1965 when the shoreline was substantially wider along Pebble Beach and out around the Knoll. The estimated average rate of erosion is approximately 8 inches per year. However, the observed rate of erosion is likely not due to natural causes as the area was subject to sand mining for many years.

The present day Pebble Beach area is retained between the Knoll and the riprap further west and future shoreline change is therefore expected to be primarily due to rising tides as a result of sea-level rise.

Drainage channels and stormwater infrastructure is in place to route interior drainage captured within the Recreation Area. Pumping with sewer pumps to discharge stormwater takes place regularly. Locations of sewer pumps within the Recreation Area are indicated on Plate 5 through Plate 16. Additional sewer pump locations (not shown) are in place on the Coyote Point Golf Course, which is a low-lying area adjacent to the Coyote Point Recreation Area. The Coyote Point Pump Station, which is a larger pump station facility utilized to return flood waters to the Bay, is located at the west end of the Recreation Area by the area indicated as Freshwater Marsh & Seasonal Wetland.

3.2.2. Daily Inundation Levels

A map of the present day MHW shoreline impacts from sea-level rise is shown on Plate 5. Projected future shoreline locations are defined as areas below the MHW line that would be subject to daily

inundation as a result of sea-level rise. Projections for sea-level rise by 2030, 2050, and 2100 are shown on Plate 6, Plate 7, and Plate 8.

The primary areas that will be affected by rising tides are:

- **Freshwater Marsh:** The area with freshwater marsh and seasonal wetland west of the pump station will progressively become submerged and is likely to transition to a saltmarsh environment.
- **Pebble Beach:** Rising sea levels will encroach upon the beach area and gradually reduce the dry beach area.
- **Saltmarsh Habitat:** The saltmarsh habitat along the east side of the marina will progressively become submerged if sea level rise outcompetes supply of sediment to the area.
- **Mudflat Areas**: This area adjoining the saltmarsh will become submerged, which is projected to impact birdlife and marine life in this area.
- **Marina Basin II:** As the saltmarsh becomes submerged, wave overtopping may begin to impact boat slips and users of Marina Basin II.
- **Isolated Shoreline and Parking Areas:** Tides will not directly flood these areas, but low-lying portions of the terrain and yacht club parking lot may pond due to rainfall and/or a high groundwater table.
- **Facilities on the Knoll:** Although facilities up on the Knoll won't be directly impacted by flooding, they will be impacted (no access/egress) when the surrounding park areas are subject to flooding.

High tides in themselves are not projected to substantially flood any of the upland areas of the park or marina out to around 2070. If no adaptive measures are incorporated, by 2100 sea level could have risen to the point where the entire Coyote Point Recreation Area except the Knoll would be submerged during daily high tides.

3.3. King Tides

Flood maps showing inundation associated with king tides are shown on Plate 9 for existing conditions, and on Plate 10, Plate 11, and Plate 12 for impacts associated with sea-level rise by 2030, 2050, and 2100. Note storm sewer pump locations indicated by yellow diamond symbols on flood maps, Plate 5 to Plate 16, and Coyote Point Pump Station indicated by the red dot to the west at the Freshwater Marsh & Seasonal Wetland.

The primary areas that are projected to be impacted by king tides are:

- The Freshwater marsh and seasonal wetland west of the pump station. King tides will progressively encroach on this area and temporarily raise the groundwater table when present.

The higher tides and greater exposure to the open water of the Bay may lead to increased shoreline erosion in this area and impact the marsh vegetation.

- With rising sea level, the saltmarsh habitat along the east side of the marina will become subject to longer durations of submergence when king tides occur. The marsh vegetation may prove resilient to rises in tide level up to about 2030 or so, but additional research is necessary.

- Isolated shoreline areas and parking area in front of the yacht club. Tides will not inundate these areas, but low-lying portions of the terrain and yacht club parking lot may pond due to rainfall and/or high groundwater table.

- By 2030, king tides will flood the trail along the salt marsh and flood the low-lying shoreline areas and parking areas in front of the yacht club. Flood depths in the parking areas may be up to 1-2 feet during king tides.

- Pebble Beach area, which will be impacted by king tides as rising sea-level progressively reduces the accessible area of dry beach.

- By 2050, if no Capital Improvement Projects are implemented rising sea levels would enable king tides to reach the elevation of the levees protecting the park and nearby city areas. The crest elevation of the existing levees is approximately +10 feet NAVD88, and king tides could reach and possibly slightly overtop the levees in areas where the crest elevation is low. Because the peak of the tides would be limited in terms of duration, flooding due to overtopping would be limited, assuming that the levee would not fail. Consequently, the region is mapped as low-lying on Plate 11 for sea-level rise by 2050. Beyond this point, king tides are projected to substantially overtop the levee, which could lead to the levee being breached. Flood impacts could potentially impact the majority of the Recreation Area west of the Knoll. Impacted facilities include the Peninsula Humane Society & SPCA, general parking, picnic, and play structure areas, and parking by the Siebel Firearms Range. The Boardsports Kite- and Windsurfing Center and School and Siebel Firearms Range are on slightly higher ground and would not be directly impacted by flooding, but access to these facilities and access throughout the Recreation Area would be impacted. Construction of the Eastern Promenade Project will incorporate a sea-level rise allowance of approximately 4 feet above the existing grade and is estimated to provide flood protection out to around 2080.
- By 2050, flooding during king tides would also more fully impact the parking area in front of the yacht club where tides would inundate these areas. The Harbormaster Office would also be impacted by shallow flooding. Facilities along the west side of the marina, including Park Offices, Ranger Station and Maintenance Yard would not be impacted.

- Facilities on the Knoll would not be directly impacted by flooding, but would experience downtime when general access to the park recreation area is impacted.

By 2100, the ocean level would have risen to the point where the entire region would be submerged during high tides. It should be noted that the above only addresses inundation, not FEMA compliance. Most of the areas are already in a FEMA Flood Zone and would continue as such unless improvements are made soon.

Improvements to protect the area west of the Knoll from flooding associated with sea-level rise would include improvements to the Coyote Point shoreline levee, which would encompass upgrades to the East Promenade, West Promenade, and the shoreline levee along the Coyote Point Pump Station. Improvements to the marina area on the east side of the Knoll would encompass raising grades along the west side parking areas, Park Offices, Maintenance Yard, and Harbormaster's Office, raising grades along the center mole, along with improvements to the shoreline levee/trail along the east side of the marina and the breakwaters protecting the marina.

3.4. Storms and Extreme Tides

Flood maps showing inundation due to 100-year storms and extreme water levels are shown on Plate 13 for existing conditions, and on Plate 14, Plate 15, and Plate 16 for sea-level rise by 2030, 2050, and 2100.

The inundation mapping shown on Plate 13 for existing conditions corresponds approximately to the inundation extents delineated on FEMA Flood Insurance Rate Maps (FIRMs) for the area. Small differences may be due to the FEMA analysis including both coastal and fluvial flooding, and/or the use of differing topographic data for flood mapping.

The crest elevation of the existing levees is around +10 feet NAVD88. This elevation does not meet FEMA requirements to withstand the 1% annual chance storm/extreme tide condition. The levees are therefore freeboard-deficient and consequently not FEMA accredited.

Flooding associated with a 100-year storm event is therefore projected to affect most of the region.

Potential impacts to areas can be categorized as follows:

- In the existing condition, most of the marina parking areas and center mole are not projected to be flooded or would be subject to shallow flooding. Facilities on the Knoll would remain unaffected. The area around the yacht club would flood substantially with depths of inundation ranging from shallow to 2-3 feet. The trail along the saltmarsh would be overwashed. A portion of the shoreline perimeter around the harbor basin would be subject to shallow flooding. The area around the boat launch ramps and Harbormaster Office would be also be subject to flooding. The majority of the park area on the west side of the Knoll could flood due to the levee being overtopped or breached. All parking and picnic areas would be impacted by flooding. The pump station and Humane Society buildings would also be impacted by flooding. The Boardsports Kite- and Windsurfing Center and Siebel Firearms Range are located on higher ground and would not be significantly impacted.

- By 2030 flooding associated with a 100-year storm event would be widespread. The saltmarsh and adjoining trail would be flooded, as would the entire area around the yacht club. Flooding would also affect a portion of the parking areas on the center mole between marina basins I and II. Flooding would also affect a larger area around the boat launch ramps and Harbormaster Office. Facilities on the Knoll would remain unaffected. In the park area west of the Knoll, all facilities would be impacted by significant flooding. Some of the buildings at the Siebel Firearms Range would be subject to shallow flooding.

- By 2050, a 100-year storm event would impact nearly all park facilities as the entire region would be subject to significant flooding. Only facilities up on the Knoll would remain unaffected. The Siebel Firearms Range would be partially flooded, and the areas around the Harbormasters Office and the area of the yacht club would be substantially flooded. Park offices are on higher ground and would not be impacted.

- By 2100, the mean sea level would have risen to the point where high tides would overtop the levees throughout the region. A 100-year storm at this point in time would have the potential to devastate the entire region. In such an extreme scenario all park facilities would be impacted.

3.5. Impacts to Public Trust Resources and Values

Potential impacts to public trust resources and values are considered in the following, including public access, commercial activities, recreation, coastal habitats, and navigation.

Assets potentially impacted by future sea-level rise are identified in the following along with the type(s) of sea-level rise related hazard, and approximate impact threshold, which gives an idea about the planning horizon within which to incorporate adaptations and mitigations to address sea-level rise related hazards.

3.5.1. Public Access

Potential impacts to public access are summarized in Table 3-1. The primary elements include the Bay Trail, shoreline promenade trail and beach access west of the Knoll, and east of the Knoll, the trails, marshland, and access in and around the Coyote Point Marina and Yacht Club.

Table 3-1: Potential Impacts to Public Access

Asset/Area	Description	Hazard, Impact	Impact Threshold	Impacts
Promenade Trail	Paved trail along shore	King tides, overtopping	2050	Trail impacted by wave overtopping Trail flooded during King tides
San Francisco Bay Trail	Paved trail along shore	King tides, overtopping	2050	Trail impacted by wave overtopping Trail flooded during King tides
San Francisco Bay Trail	Paved trail through park	King tides, flooding	2050	Bay Trail flooded during King tides
Pebble Beach	Public beach area	King tides, flooding	2030 (gradual)	SLR encroaches on beach area
Parking areas	Paved parking areas throughout park	King tides, flooding	2050	Parking areas flooded during king tides
Coyote Point Drive	Paved Road	King tides, flooding	2050	Road access to Coyote Point flooded during king tides
Yacht club parking lot	Paved parking areas	King tides, flooding	2020	Parking areas flooded during king tides
Overlook points near yacht club	Benches along shoreline trail	King tides, flooding	2030	Low-lying shoreline areas flooded during king tides
Saltmarsh shoreline trail	Compacted gravel trail	King tides, overtopping	2030	Trail impacted by wave overtopping Trail flooded during King tides
Fishing area	Marina breakwater	King tides, overtopping	2080	Hazardous conditions on breakwater due to wave overtopping Crest submerged during King tides

3.5.2. Commerce

Potential sea-level rise related hazards and impact thresholds for facilities that support commercial activities are summarized in Table 3-2.

Table 3-2: Potential Impacts to Commercial Assets

Asset/Area	Description	Hazard, Impact	Impact Threshold	Impacts
Peninsula Humane Society & SPCA	Lease	King tides, flooding	2050	Facilities impacted by shallow flooding during King tides. Flooding will impact access and usage. Facilities with outfall pipes may experience flooding unless outlets are outfitted with backflow prevention, e.g. duckbill valves.
Coyote Point Pump Station	Adjacent to site but drains floodwaters from site.	King tides, flooding	2050	
Boardsports Kite- and Windsurfing Center and School	Lease	King tides, flooding	2070	
Siebel Firearms Range	Lease [a)]	King tides, flooding	2060	
Coyote Point Yacht Club	Lease [b)]	King tides, flooding	2020 [1)]	
Coyote Point Marina	Enterprise [c)]	King tides, flooding	2050 [2)]	
Harbormaster Office	At the marina near the boat launch ramps	King tides, flooding	2050	
Park Offices and Maintenance Yard	Located on the west side of the marina	King tides, flooding	2090	
Park Admission	Gatehouse at park entrance	King tides, flooding	2050	

[a)] Facility operated by the County of San Mateo Police Chief's and Sheriff's Association/South Bay Safety Training Consortium.

[b)] Facility operated by Coyote Point Yacht Club.

[c)] Operated by Harbormaster.

[1)] Impacts to yacht club parking areas. Yacht club building is elevated and not subject to impacts.

[2)] Initial impacts to 300 feet of parking areas near entrance to center mole, shallow flooding around boat launch ramps and Harbormaster Office.

Adjacent facilities that could be impacted by flooding include the Poplar Creek Golf Course and PG&E substation located south of the Knoll. PG&E power lines cross the golf course and the west end of the Recreation Area. The transmission towers consist of steel structures with concrete foundations. Three

such towers are located at the west end of the Recreation Area near the Freshwater Marsh & Seasonal Wetland area. One tower is on the beach (foundation footing subject to tidal action), and the other two towers slightly further inland. The tower footings could potentially be subject to sea-level rise related impacts and future remediation could include wrapping the footing with a protective material or coating or relocating the towers. The golf course and PG&E substation would benefit from the planned San Mateo Flood Control Northern Levee and Poplar Avenue Pump Station Improvements but would need additional protection against flood hazards associated with future sea-level rise.

3.5.3. Recreation

Recreational assets, sea-level rise related hazards and impacts thresholds for these assets are listed in Table 3-3.

Table 3-3: Potential Impacts to Recreational Assets

Asset/Area	Description	Hazard, Impact	Impact Threshold	Impacts
Park	Recreational area west of the Knoll	King tides, flooding	2050	Recreational Assets impacted by flooding during King Tides. Shallow flooding in most areas will impact access and usage. Structures may tolerate shallow flooding to an extent.
Picnic areas	Within park area west of the Knoll	King tides, flooding	2050	
Magic Mountain Playground	Within park area	King tides, flooding	2050	
RV campsites	RV overnight parking areas	King tides, flooding	2050	
Public amenities	Restrooms and shower facilities, drinking fountains, benches	King tides, flooding	2050	
Boardsports Kite- and Windsurfing Center and School	Sporting goods retail store	King tides, flooding	2070	

3.5.4. Coastal Habitats

Areas of coastal habitat affected by sea-level rise are summarized in Table 3-4. Habitats along the shoreline can protect inland property from increased wave action and flooding. These habitat areas are low-lying and will be gradually impacted by sea-level rise. The main hazard is that the rate of sea-level rise may outcompete the ability of marsh and mudflat areas to grow vertically, which will cause these areas to transition from being intertidal to permanently submerged. With sea-level rise, the

freshwater marsh may undergo a transition to saltmarsh habitat. Impacts to these areas will be gradual.

Table 3-4: Potential Impacts to Coastal Habitats

Asset/Area	Description	Hazard, Impact	Impact Threshold	Impacts
Freshwater marsh and seasonal wetland	Marsh area west of pump station and Peninsula Humane Society & SPCA	Rising tides, Submergence	2030 (gradual)	Conversion to saltwater marsh
Saltmarsh	Marsh area along eastern side of marina	Rising tides, Submergence	2030 (gradual)	Conversion to low marsh/mudflat
Mudflats	Bordering saltmarsh	Rising tides, Submergence	2030 (gradual)	Conversion to subtidal habitat

3.5.5. Navigability

Navigability will not be significantly impacted by sea-level rise as the water depth increases with sea level rise and the marina docks float and will follow the water level elevation. However, docks may be impacted structurally at the landside abutment where the structural connection can become damaged if the vertical angle is extended beyond what the connection permits. Also, if guide pile top elevations are not sufficient to restrain docks during extreme events, the docks may float up over the top of the guide piles.

Sea-level rise may bring about other indirect impacts to navigability. This includes overtopping of the breakwater which could lead to damaging wave penetration within the marina basins resulting in vessels unable to remain in the harbor. Wave overtopping of the breakwater could occur during a 100-year storm starting from around 2050 and onwards. King tides would not overtop the breakwater until around 2080.

4. Financial Costs of Sea-Level Rise

Financial costs of sea-level rise are assessed in the following sections. This includes potential impacts to public access, commercial facilities, recreation, coastal habitat, and navigation.

Elements that don't have a specific market value are termed non-market. These include recreational and habitat values. For these elements, their economic value is assessed based on non-market valuation methods, one being how much people would be willing to pay for them, e.g. beach visits, swimming, wildlife viewing, and fishing.

Cost estimates reflect present value of future cost with price escalation based on the U.S. Average Consumer Price Index (CPI) and index base period (1982-84 = 100), *BLS (2019)*.

4.1. Non-Market Losses

In this section, potential non-market losses due to sea-level rise are estimated for recreational activities. To determine the non-market values, economists suggest using the concept of willingness to pay, which is defined as the value of an individually consumed non-market good as the amount that an individual consumer would be willing to pay to consume the good or use the service (*Raheem et al., 2009*). These values are identified through empirical research (e.g., *Costanza et al., 2006*; *Raheem et al., 2009, 2012*). Resources from Center for the Blue Economy Library and Duke Marine Ecosystem Services Partnership, as well as the California Department of Boating and Waterways *CDWB (2011)* and *EPA (2009)* were drawn into consideration.

Recreational activities involving wind- and kite surfing and trail access will not be immediately impacted by sea-level rise or will be protected with the implementation of planned adaptation projects. The primary non-market element potentially affected by sea-level rise is recreational use of the beach.

Beaches can be attributed to a range of non-market economic values, which include recreational value, storm-buffering capacity, and provision of biological and ecological diversity *(CDBW, 2011)*. In California, beaches below the high-water line are in public trust, and there is no market value for them. One of the recommended methods to determine the non-market values of a beach is to divide its value into use and non-use values. The use values include direct use benefits such as recreation (boating, birding, fishing, bathing), while indirect use benefits include flood control, shoreline protection, and groundwater discharge. The non-use values include biodiversity, cultural, and heritage existence benefits.

In practice it is challenging to assess non-market values. The Environmental Protection Agency provides guidance for the economic value of coastal ecosystems in California. EPA (2009) estimates a value of $16,946 per acre per year for activities associated with recreation and ecotourism.

The California Department of Boating and Waterways, *CDBW (2011)* also provide guidance on economic costs of sea-level rise to California beach communities. CDBW (2011) recommends a non-market value of $1,620 (present value of $2,000) per acre per year for beaches, which accounts for biodiversity and environmental values, and flood control benefits. The recreational value is estimated to be $16,200 per acre per year ($20,000 present value), i.e. 10 times the non-market ecological value.

The estimated aggregate non-market losses based on these values is summarized in Table 4-1.

Table 4-1: Aggregate Non-Market Loss due to SLR impacts to the Peninsula Beach.

Year	Beach Loss (acres)	*CDBW (2011)*	*EPA (2009)*
2030	0.08	$10,000	$11,000
2050	0.29	$100,000	$115,000
2100	1.20	$1,500,000	$1,600,000

4.2. Habitat Losses

Economists classify coastal habitat as non-market. Estimates of habitat value for wetland and marsh areas vary hugely by area and use. Coastal habitat can contribute to value in many ways including: recreational access, birdwatching, aesthetic value, fisheries, flood protection, improving water quality, and general ecological sustainability. At Coyote Point, a key function of the coastal habitat areas is to support wildlife habitat and endangered species. In California where existing wetland areas are sensitive and in rapid decline, an assessment value of $20,000 to $85,000 per acre *(CDBW, 2011)* is adopted to estimate sea-level rise related losses. This cost range corresponds to 10-40 times the base ecological value of $2,000 per acre. For comparison, the typical replacement cost of wetland habitat in the Bay Area can range from $50,000 to $100,000 per acre. The CDBW (2011) high estimate in Table 4-2 is therefore likely a better estimate of the true value of the coastal habitat areas at Coyote Point.

Table 4-2: Aggregate Non-Market Loss due to SLR impacts to Coastal habitat.

Year	Coastal Habitat Loss (acres)	*CDBW (2011) Low Estimate*	*CDBW (2011) High Estimate*
2030	2.3	$10,000	$43,000
2050	8.3	$100,000	$440,000
2100	12.6 [a)]	$1,500,000	$6,100,000

[a)] Loss of entire habitat area.

4.3. Commercial Assets

Two facilities, the Peninsula Humane Society & SPCA and the Siebel Firearms Range, are housed on the State Granted lands. These facilities are non-profit and maintained for the good of the public. The County has a lease with these facilities but is not involved in their operation. The San Mateo County Parks Department does therefore not collect revenue from these facilities.

Facilities within the Recreation Area from which the County collects revenue includes the Boardsports Kite- and Windsurfing Center and School and the Coyote Point Yacht Club.

The Coyote Point Marina is categorized as an enterprise and revenue is dedicated to upkeep of the facilities at the marina. The annual revenue of the marina is on the order of $1.4M.

4.4. Park Operations

A significant portion of Park revenues are from admission fees, reservations, and the Coyote Point Marina slip fees. Because general access to the Recreation Area for these revenue categories is by car, impacts to parking areas are an indicator of potential revenue losses.

Table 4-3 summarizes the percentage of available parking space in the areas of the Park, the Siebel Firearms Range, the Knoll, the Coyote Point Marina, and the Coyote Point Yacht Club.

Because the park in general is protected by the Eastern and Western Promenade and the Coyote Point Levee, impacts to park operations are associated with a scenario where the promenade and levee is overtopped or breached resulting in region wide flooding. It is unlikely that sea level rise would progress to the point where this type of scenario could unfold without prior projects to enhance or upgrade flood protection of the greater area. In fact, Park facilities will benefit from already planned Capital Improvement Projects (CIP's) aimed at flood protection improvements. These are discussed further in Section 5 on sea-level rise mitigation and adaptation measures. Funding for improvements to the Eastern Promenade has been approved and this project is scheduled for construction in 2020. This project features a seatwall with a crest elevation of +14 feet NAVD88, which is estimated to mitigate sea-level rise related flood hazards out to around 2080. The Eastern Promenade project also includes relocation of utilities under the parking lot, so they won't be subject to flooding.

If the planned Capital Improvement Projects for Coyote Point are not constructed, flood hazards associated with rising tides and storms would significantly impact the Recreation Area. For example, by 2030 flooding associated with a 100-year storm event would be widespread and the park area west of the Knoll and all facilities within would be impacted by significant flooding.

Without improvements by 2050, rising sea level would enable king tides to overtop the Coyote Point shoreline levee. Flood impacts could potentially impact the majority of the Recreation Area west of the Knoll. Impacted facilities include the Peninsula Humane Society & SPCA, general parking, picnic, and play structure areas, and parking by the Siebel Firearms Range. The Boardsports Kite- and Windsurfing Center and School and Siebel Firearms Range are on slightly higher ground and would not be directly impacted by flooding, but access to these facilities and access throughout the Recreation Area would be impacted. There would also be impacts to facilities on the east side of the

Knoll, where flooding on king tides would inundate the parking area in front of the yacht club. The Harbormaster Office would also be impacted by shallow flooding. Facilities along the west side of the marina, including Park Offices, Ranger Station and Maintenance Yard would not be impacted. Facilities on the Knoll would not be directly impacted by flooding but would experience downtime when general access to the park recreation area is impacted.

One facility in Table 4-3 which stands out as being sensitive to sea-level rise related impacts in the near term is the Coyote Point Yacht Club. Although the Yacht Club building is elevated and as such won't be directly impacted by high water levels, the adjoining area is low and will be prone to shallow flooding and ponding in the near future within improvements to flood protection. It is estimated that 97% of the parking space at the Yacht Club could be impacted by flooding on high tides by 2030, and from thereon, all parking areas at the Yacht Club would be affected.

Table 4-3: Potential Sea-Level Rise Related Parking Area Impacts.

Area	**Parking Spaces (percent of area total) Impacted by:**		
	2030	**2050**	**2100**
Park	0%	100% [a)]	100% [a)]
Knoll	0%	100% [b)]	0% [b)]
Coyote Point Marina	0%	6%	100%
Coyote Point Yacht Club	97%	100%	100%
Recreation Area Total	**10%**	**56%**	**75%**

[a)] Assumes region wide flooding due to overtopping of or breach of the shoreline levee.

[b)] Facilities on the Knoll would not be directly impacted by sea-level rise related hazards, but would be indirectly impacted in the case of region wide flooding as the Knoll would be rendered inaccessible.

It is relatively difficult to assess indirect revenue losses associated with flooding due to tidal action as the flooding is transient and initially episodic. Impacts by 2030 would be centered on the Yacht Club. Impacts thereafter would be broader and involve impacts to the general parking, picnic, and other Park recreational areas.

It is estimated that losses in Park revenue due to impacts to parking areas could be on the order of $10,000/day by 2050 and $20,000/day by 2100.

5. Sea-Level Rise Mitigation and Adaptation Measures

The following sections summarize efforts to protect and preserve trustee resources and structures, and provides estimates of anticipated costs for these measures.

5.1. Planned and Completed Capital Improvement Projects

Planned Capital Improvement Projects (CIPs) and projects completed in recent years are summarized on Plate 17, and measures to protect and preserve trustee resources and structures are outlined in the following. Table 5-1 summarizes these projects and provides reference to locations indicated on Plate 17.

5.1.1. Coyote Point Recreation Area Shoreline Promenade Improvement Project

This improvement project is planned as the first two out of five phases of the Coyote Point Recreation Area Master Plan, *SMCP (2008)*. The Phase I project, consisting of improvements to the western portion of the promenade was completed in 2014. The Phase II project will incorporate improvements to the eastern portion of the promenade. The County Manager's Office has approved funding for the Coyote Point Eastern Promenade. It is being turned over to the County Department of Public Works as a Capital Improvement Project and will be constructed summer 2020. Amongst other things this will benefit the Siebel Firearms Range. The purpose of the proposed project is to develop a sustainable solution to the coastal erosion problem along the San Francisco Bay at the park shoreline while facilitating good public access to the beach and water for a variety of users, particularly swimmers and windsurfers.

The two project areas are indicated as (I) and (II) in Appendix A, Plate 17. An outline of the main improvements is provided in the following.

5.1.1.1. Phase I – Western Promenade Shoreline Project

This project was carried out as Phase 1 of the Coyote Point Recreation Area Shoreline Promenade Improvement Project. This project was completed in 2014 and addresses SLR-related hazards out to around 2050 as summarized below:

1. Addressed coastal erosion and coastal flood hazards by construction of rock revetment along the western section of shoreline to protect the existing promenade and shoreline levee.

2. Provided improvements to public access by construction of three Articulated Block Mat (ABM) revetment access ramps for non-motorized recreational use by windsurfers, kayakers and standup paddlers; reconstruction of the promenade, preserving public access via the Bay Trail to a wide range of users, including walkers, joggers, roller skaters with ADA compliant pathways.

5.1.1.2. Phase II – Eastern Promenade Rejuvenation Project

This project is Phase 2 of the Coyote Point Recreation Area Shoreline Promenade Improvement Project. Environmental documentation and design has already been completed for this project. Funding for this project has been approved and construction planned for 2020. It is estimated that this project will provide mitigation against sea-level rise related flood hazards along the Eastern Promenade out to around 2080.

Figure 5-1: Erosion along the Eastern Promenade trail.

Table 5-1: Recently Completed and Planned Projects to Protect and Preserve Assets from SLR

#	Project	SLR-Related Hazards Addressed	Mitigation, Adaptation and Improvements	Lead Agency	Status
I	Coyote Point Recreation Area Shoreline Promenade Improvement Project. Western Shoreline Project.	Erosion, Flood	Public Access	SMC Parks Department	Construction completed in 2014.
II	Coyote Point Recreation Area Shoreline Promenade Improvement Project. Eastern Promenade Rejuvenation Project.	SLR, Erosion, Flood	Public Access Public Amenities Vegetation	SMC Parks Department	CEQA Determination: IS/MND. Detailed design completed. Funding approved, and construction scheduled for 2020.
V NLI P_C P_P	North Shoreview Flood Hazard Mitigation. Northern Levee Improvement Project, incl. Coyote Point Pump Station, and Poplar Avenue Pump Station.	SLR, Flood (Coastal and Fluvial)	Levee, raise crest to El. +14.1 feet NAVD88.	City of San Mateo Public Works Department	Planning and design completed. Awaiting permitting and FEMA accreditation. Construction scheduled for completion in 2021.
BP	Burlingame Point Project	SLR, Flood	Public Access Raise shore perimeter to El. +16 feet NAVD88.	City of Burlingame (Private Developer led)	Planning, design and permitting completed. Construction ongoing, scheduled for completion in 2019.
BL	Bayfront Levee Project. Improvement to the Bayfront Levee along the City of San Mateo North Shoreview Community.	SLR, Flood	Levee, raise crest to El. +14 feet NAVD88.	City of San Mateo Public Works Department	Construction completed.

The Eastern Promenade has been designed to accommodate a 4 foot rise in sea level. The proposed project raises the Promenade Trail by 3 feet, from +10 feet to +13 feet NAVD88, includes a seatwall that will be at an elevation of +14 feet NAVD88, and adds an additional volume of sand to raise the beach from the current elevation of +7 feet NAVD88 to +12 to +12.5 feet NAVD88. In addition, the current beach will be converted into a perched beach, which will be at an elevation of +12 to +12.5 feet NAVD88. Towards the shoreline, the beach will slope back down to the current graded area of mostly compacted mud that is only exposed during low tide.

In addition to the raised, perched, sandy beach, raised Promenade Trail, and seatwall, the current restroom facilities and parking area will be moved back away from the Bay to enable the expansion of the sandy beach, and the managed retreat from rising tides. The project design therefore accounts for sea level rise and also acts as a flood protection measure for the parking areas.

This project will address SLR-related hazards and provide improvements as summarized below:

1. Addresses SLR-related coastal flood hazards by raising the promenade to El. +13 feet NAVD88 and seatwall to +14 feet NAVD88. This will provide protection of the landside area from daily inundation due to rising tides out to 2100, defer coastal flooding associated with king tides out to 2080, and provide protection against flooding associated with the 1% annual chance storm out to 2060.

2. Addresses coastal erosion hazards by incorporation of 1,800 feet of new beach area and riprap protection at the toe of the Knoll. A monitoring program will be implemented that defines trigger points for replenishment of the beach to address future SLR.

3. Provides improvements to public access by construction of a new promenade, reconfigured and new parking areas, 15 additional parking spaces, new restrooms. Preserves public access via the Bay Trail to a wide range of users, swimmers, windsurfers, hikers and cyclists, ADA compliant facilities.

4. Improves public amenities by construction of new restrooms, installation of benches, bike racks, trash receptacles and signage.

5. Provides habitat improvements by introduction of new landscaping, planting of 120 replacement trees, irrigation systems to support plantings, and construction of bioswales.

5.1.1.3. Phases III and IV (not relevant to flood hazard mitigation)

Phase III of the *CMSP (2008)* master plan, focuses on landscape improvements. Phase IV includes focus studies, and improvements to public access and amenities.

5.1.1.4. Phase V – Flood Protection Improvements

Work under this phase was originally planned as Phase V in *SMCP (2008)*. The originally planned area of flood protection improvements is indicated on Plate 17 as (V). The most recent plans include implementation of flood protection improvements led by the City of San Mateo Public Works Department, including various improvements to public access, a new concessionaire building to

incorporate food service at the Peninsula Beach, potential relocation of the park maintenance yard to the current Peninsula Humane Society location, and planning for development of a parking structure at the Siebel Firearms Range. Flood hazard improvements to this area are described further in the following section.

5.1.2. North Shoreview Flood Hazard Mitigation Project

5.1.2.1. Northern Levee Improvements

This project, *S&W (2015)*, will incorporate a portion of the originally planned Phase V Flood Protection Improvements described above. The most recent planning for the Northern Levee Improvements (NLI) consider a wider range of expansion and upgrades to flood protection infrastructure. The main flood hazard mitigation elements are indicated on Plate 17, and include levee improvements to raise a 1,300 foot portion of the Coyote Point Levee (CPL), upgrades to the Coyote Point Pump Station (P_C) and the Poplar Avenue Pump Station (P_P), and incorporation of a new levee south of the Coyote Point Yacht Club near the corner of the PG&E substation.

This project will address SLR-related hazards and provide improvements as summarized below:

1. Addresses SLR-related coastal flood hazards by raising a 1,300 feet portion of the Coyote Point shoreline levee (CPL) to El. +14.1 feet NAVD88. The levee improvements are at the west end of the Coyote Point Recreation Area at the Coyote Point Pump Station Peninsula Humane Society. This will provide protection of the landside area from rising tides out to 2110, defer coastal flooding associated with king tides out to 2088, and provide protection against flooding associated with the 1% annual chance storm out to 2050.

2. Addresses SLR-related coastal flood hazards by incorporation of a new levee south of the Coyote Point Yacht Club near the PG&E substation. This upgrade is anticipated to provide protection of the landside area from daily inundation due to rising tides out to 2110, defer coastal flooding associated with king tides out to 2088, and provide protection against flooding associated with the 1% annual chance storm out to 2050.

3. Mitigates flooding by upgrading the Coyote Point Pump Station to 340 cfs pump capacity. This increase will help maintain minimum pump station capacity of 310 cfs needed to prevent overflow toward Coyote Point Drive and the Poplar Avenue Pump Station.

1. Mitigates flooding by upgrading the Poplar Avenue Pump Station to 360 cfs pump capacity which exceeds the 336 cfs needed to adapt to 5.5 feet of SLR.

5.1.3. Burlingame Point Project

The Burlingame Point project indicated by (BP) on Plate 17 focuses on redevelopment of the area and is planned to house the Facebook Willow Campus. The site and building facilities are currently under construction with completion scheduled for 2019.

This project will address SLR-related hazards by:

1. Raising the site perimeter to El. +16 feet NAVD88. This will provide protection of the landside area from daily inundation due to rising tides and king tides out past 2100 and defer coastal flood impacts associated with the 1% annual chance storm out to about 2090.

5.1.4. Living Shoreline Project and Tidal Elevation Monitoring

The California State Coastal Conservancy (SCC) is conducting a living shoreline project to assess whether conditions are appropriate to support eelgrass, native oysters, Pacific cordgrass, and marsh gumplant. San Mateo County Parks has issued a Scientific Collection Permit for this ongoing research. The project is in partnership with University of California Davis who is conducting a real time tide monitoring project to monitor tidal elevations at 15-minute intervals during daylight hours for the next 3 years and beyond as funding and permitting allow. This information will be used to analyze effects of sea-level rise on infrastructure and tidal marsh habitats along the shoreline of San Francisco Bay and along Coyote Point.

5.1.5. Capital Improvement Project Costs

Anticipated costs of Capital Improvement Projects that will incorporate elements of flood protection and adaptation to sea-level rise are summarized in Table 5-2.

Table 5-2: Anticipated Costs of Planned Capital Improvement Projects.

Project	Lead Agency	Cost	Timeframe	Status
Coyote Point Promenade Eastern Improvement Project	County of San Mateo	$6.2M	Est. 1 to 2 years for construction.	Funded. Construction by summer of 2020.
Northern Levee Improvements	City of San Mateo	$9.9M	Est. 1 to 2 years for design and permitting followed by 1 to 2 years for construction.	Not funded, Seeking funding
Coyote Point Pump Station Improvements		$8.9M		
Poplar Avenue Pump Station Improvements		$10.8M		

A description of proposed mitigation/adaptation measures and associated costs is provided in the following.

5.2. Adaptation and Mitigation Measures

Adaptation measures proposed to be incorporated by 2050 are summarized in Table 5-3. An overview of these adaptation measures is provided on Plate 18. Recommendations for adaptation by 2100 are summarized in Table 5-4. Areas of improvements are indicated on Plate 18. Rough Order of Magnitude (ROM) soft costs are provided in 2019 dollars.

Table 5-3: Potential Adaptation Measures By 2050.

	Segment	Adaptation Measure	Description	Cost	Status	Responsible Organizations
(by 2050, the 1% water level would be about +12' with wave runup due to wave action reaching higher) Refer to Plate 18 for overview of areas where adaptation is proposed						
Bay Trail/Levee	P-0	Not required	Burlingame Point Development project is building adequate protection.	n/a	In construction	City of Burlingame
	P-3	Phase 1: Raise Bay Trail along shoreline levee to +14' Phase 2: Raise in place or install seat wall at crest to +16'	Current trail elevation is about +10' which overtops during extreme storms. Phase 1 improvements by City (North Shoreview project) would raise this to +14'. An additional 2-ft seat wall by 2050 would provide continued flood protection and include an allowance for future SLR	$14M	Planned CIP	City of San Mateo (Northern Levee Improvement Project)
	P-2	Similar to P-3	Current promenade elevation is about +10' which overtops during extreme storms. Improvements similar to above would be needed along this reach.	$11M	-	County of San Mateo, City of San Mateo
	P-1	Construct Eastern Promenade project OR Improve trail/levee to +16'.	The beach is currently at about +10'. Options include constructing the Eastern Promenade project (designed and permitted, and funding for construction approved) with minor adaptations to the seat walls in future OR make improvements similar to P-3 which would remove beach use.	$8M	Funding for construction approved. Construction scheduled for 2020	County of San Mateo, City of San Mateo
Marina	M-1	Close off public access on breakwater during high tides OR install short seawall above crest of existing structure.	The marina trail ranges in elevation between +11' and +14'. With SLR, increased wave overtopping would make it unsafe for public access. Controlled access is possible but would require active management OR a short seawall on top of the breakwater could be constructed.	$50k $1M	-	County of San Mateo
	M-6	For most of this reach (except southeast segment), place material dredged from marina to expand the existing tidal marsh and improve flood protection. At southeast segment, raise shoreline trail to +14'.	*Reach fronted by tidal marsh:* Beneficially reuse mechanically dredged material from marina basins for marsh enhancement. Place a thin lift of material over existing marsh, expand the marsh eastward into the 3rd basin, and raise the trail. *Southeast segment:* Raise this section of trail to provide continued public access, parking for the Yacht Club, and to reduce nuisance flooding (flooding at extreme high tides).	$1M $2M	-	County of San Mateo
	M-7	Raise shoreline trails along southern edge of basins to +14'	Elevations in the area around the Yacht Club range from +9' to +10'. To prevent nuisance flooding from the southern edge of the marina basins, the trails could be raised in place.	$9M	- Planned CIP (partial protection)	County of San Mateo, Coyote Point Yacht Club. City of San Mateo (Northern Levee Improvement Project)
	M-9	Raise the northern portion of parking lot to same elevation as other areas of parking lot. Elevate or move harbormaster's office away from the shoreline to the west.	The northern portion of the parking lot (north of the County office buildings) has subsided and would be flooded at extreme high tides. This would affect the harbormasters building, launch ramp operations, and access to the breakwater trail. Adaptations would include raising this area and relocating the harbormaster's office farther to the west (to the back edge of the parking lot).	$6M	-	County of San Mateo
General	Marina	Upgrade and reconfigure marina, *TSC (2007).*	Plan E: Improvements to three areas of the marina to incorporate larger berths in Basins I and II and improve Guest Dock and Fuel Dock areas. Plan C: Dock reconfiguration of entire marina.	$10M $29M	Concept Planning, Estimates and Financial Analysis Completed	County of San Mateo, Coyote Point Yacht Club.
	Underground Stormwater Systems	Incorporate backflow prevention devices.	Prevent flooding associated with backflow through existing stormwater outlets by outfitting stormwater infrastructure with backflow prevention devices such as check valves, pinch valves, and/or outfit outlet pipe ends with duckbill valves. Pump systems may be needed if discharge has to counter a static head.	$200k	-	County of San Mateo, Humane Society & SPCA Boardsports store Coyote Point Yacht Club

Table 5-4: Potential Adaptation Measures By 2100.

(by 2100, the 1% water level would be about +17' with wave runup due to wave action reaching higher)

Refer to Plate 18 for overview of areas where adaptation is recommended

Notes:

1. Even after implementation of the adaptation measures summarized in Table 5-3, flood hazards from other adjacent parcels would become significant enough by about 2050 (see Plate 10) that a regional flood protection solution would have to be implemented. Flooding from the Golf Course, Airport Blvd, and Hwy 101 would occur during annual King Tides, which would happen several times each year.
2. If regional flood protection projects are not implemented by then, and if the County and other stakeholders make a decision to continue using the Coyote Point Recreation Area (including the marina) in its current form over the long term, Airport Blvd and Coyote Point Drive up to the marina would have to be raised. This would effectively make the CPRA a leveed asset.

The adaptation measures described below assume that the above described regional flood protection measures are not implemented.

	Segment	Adaptation Measure	Description	Cost	Status	Responsible Organizations
Promenade	P-0	Raise southern portion of Airport Blvd OR Install flood gates/barriers	Given the relatively high Bay trail elevations proposed by the Burlingame Point project, only minor adaptation measures would be needed along their shoreline; these which would be implemented by the City of Burlingame as described in their BCDC permit. South of the Burlingame Point project, flooding is via the southern portion of Airport Blvd which could be addressed by raising Airport Blvd.	$8.4M $2.5M	-	Caltrans, City of Burlingame, City of San Mateo
	P-3	Raise trail/levee to +21' OR A combination of raising grades and seawall at crest	Assuming the North Shoreview project is constructed (to +14' as proposed), additional flood protection to +21' will be needed. The promenade could be raised by 7-ft, which would be a significant amount of new fill, or could be raised to +18' with a 3-ft seawall on the Bayside.	$25M	-	City of San Mateo County of San Mateo
	P-2	Similar to P-3	Similar to P-3	$20M	-	County of San Mateo, City of San Mateo
	P-1			$15M	-	County of San Mateo, City of San Mateo
Marina	M-1	Raise elevation of breakwater to about +24'	This would be a substantial reconfiguration of the breakwater in place using similar armoring components	$46M	-	County of San Mateo
	M-2	Raise elevation of southern breakwater to about +19'	Raise the southern leg of the breakwater to provide continued protection from waves. Elevate buildings potentially affected by flooding such as the Harbormaster Office, Maintenance Yard, and Ranger Office.	$5M	-	County of San Mateo
	M-6	Continue placing material dredged from marina to expand the existing tidal marsh and improve flood protection. At southeast segment, raise shoreline trail to +18'	Expand the areal extent of marsh eastwards to encompass the entire 3rd basin	$30M	-	County of San Mateo
	M-7	Raise shoreline trails along southern edge of basins to +18'	This would protect the Yacht Club building and parking lot in place	$40M	-	County of San Mateo, Coyote Point Yacht Club.
	M-8	Raise the mole between the two basins to +18'	The parking lot, access areas, and restrooms could be raised using material dredged from the marina	$50M	-	County of San Mateo
	M-9	Raise the parking lot and trail to +18'	The parking lot, access areas, and restrooms could be raised using material dredged from the marina	$30M	-	County of San Mateo

5.3. Additional SLR Mitigation Measures

5.3.1. Marsh Resilience

Marshes, wetland, and mudflat areas are very flat in profile by nature and may be significantly impacted by sea-level rise. Marsh vegetation and shorebird habitat on mudflats typically exists within a fairly narrow vertical range. Mudflats are typically below mean sea level and exposed on low tides. Low marsh to high marsh vegetation typically exists within the range from mean sea level to mean higher high water.

Small changes in sea level can equate to a large areal extent of impacted marsh and mudflat areas. Provided that there is a continuous supply of sediment and the vegetation is capable of growing vertically and/or retreat to neighboring areas, marshes and mudflat areas may be able to adapt to sea-level rise. In many cases sea-level rise is projected to outcompete the ability of the vegetation to grow or migrate, and marsh edges are often along areas where retreat is not possible.

One method that supports vertical migration of marsh and mudflat areas is thin lift placement of dredge material. This is a method that enables beneficial reuse of dredge material. Figure 5-2 shows an example of thin lift placement of dredge material.

Figure 5-2: Example thin-lift placement of dredge material for marsh adaptation to SLR.

This type of method could apply to the area of the Coyote Point Marina and adjoining saltmarsh with the following benefits:

1. Improved resiliency for marsh vegetation and shorebird habitat.
2. Long term retention of sediment and survivability of marsh vegetation.
3. Beneficial reuse of dredge material.

4. Marsh vegetation can tolerate thin lift placement, but to avoid potential impacts to existing habitat, the thin lift placement can be done in the mudflat areas (elevating these areas expands mudflat habitat and supports marsh migration/expansion). Time dredging and thin lift placement to environmental windows.

5. Dredge material is likely suitable as a growth medium for marsh vegetation.

6. Short pumping distance from marina basins to marsh/mudflat area east of the marina.

7. Limits use of heavy construction equipment in marsh areas (otherwise needed for marsh creation).

8. The existing L-shaped remnant breakwater could aid in retaining a saltmarsh edge near the east State Grant Boundary. The segment near the marina entrance might need to be reconfigured to reduce migration of material into the marina.

This type of approach could support long term sustainability of the saltmarsh and beneficial reuse of dredge material from the marina. A further enhancement that would facilitate recurring dredge episodes and thin lift placement could be to incorporate a sediment trap at the entrance to the marina. This could achieve the following:

a) Promote siltation in the sediment trap area.

b) Reduce siltation within the marina where docks and moored vessels interfere with access for dredge equipment.

c) Reduce the pumping distance between the sediment trap and the marsh/mudflat area.

d) Material dredged from sediment trap is likely to be cleaner in general than material dredged from within marina basins.

5.3.2. Navigation

Navigability will not be significantly impacted by sea-level rise as the water depth increases with sea level rise and the marina docks float will follow the water level elevation. However, there are limitations to the range of movement floats and finger piers can accommodate in the vertical as the landside abutment is typically fixed. Figure 5-3 shows an example where king tide conditions cause flooding at the landside abutment although the outer float section is able to rise with the tide level. A solution to this type of impact can be to rebuild the abutment with a higher hinge point for the float or install a new abutment structure that allows vertical adjustments to be made over time. In addition, the guide pile top elevations may need to be raised to restrain floats.

Adaptation can also include issuance of warnings to boaters in advance of high tide conditions as the date and times of tides will be known in advance and published in tide tables. Another measure could be to highlight such events in the annual tide tables provided at the Harbormasters Office.

Figure 5-3: Flooding around float abutment due to king tide, *CCC (2019)*.

With future sea-level rise, overtopping of the breakwater could lead to damaging wave penetration within the marina basins resulting in vessels unable to remain in the harbor. Wave overtopping of the breakwater could occur during a 100-year storm starting from around 2050 and onwards. King tides would not overtop the breakwater until around 2080.

5.3.3. Stormwater Outlets

Existing underground stormwater infrastructure is typically designed to gravity drain back to the Bay. Sea-level rise may produce enough hydraulic head that the underground utilities become a conduit for flooding from the Bay.

One method of resolving this type of flood hazard is to outfit the stormwater system with backflow prevention devices. These may be in the form of siphons, check valves, pinch valves, or duckbill valves mounted at the pipe outlets. Figure 5-4 shows an example of rubber duckbill valves mounted on outlets. The valves permit discharge but prevent backflow.

This type of solution works well in situations when the flooding is temporary in nature, i.e. governed by tidal action or storm surge. If discharge needs to remain continuous and oppose a hydraulic head, then additional pumping systems would need to be incorporated.

Figure 5-4: Example backflow prevention with duckbill valves.

5.4. Plans to Monitor Sea-Level Rise

5.4.1. Sea-Level Rise Monitoring

Monitoring of sea-level rise nationwide and locally is conducted by NOAA and NASA under Federal Government programs with status and findings available via online resources. Sea-level rise projections are regularly updated and adjusted globally by the IPCC, and statewide by agencies such as the National Research Council (NRC) and Ocean Protection Council (OPC).

5.4.2. Monitoring of Sea-Level Rise Impacts

Monitoring of sea-level rise related impacts in areas with manmade facilities can be conducted as part of regularly scheduled monitoring conducted as part of maintenance operations. As part of the Eastern Promenade project, a monitoring program will be implemented that defines trigger points for replenishment of the beach to address future SLR.

In more dynamic environments such as beaches and coastal habitat areas, time lapse photography systems exist which can conduct imagery analysis on regularly acquired imagery to monitor shoreline changes, the progress of adaptive measures, and the rate of sea level rise. These systems use cameras placed at strategic locations and require regular monitoring and maintenance. Such systems

are currently in place and used for studies and monitoring throughout the San Francisco Bay Area, *NCST (2017)*. University of California, Davis (UC Davis) has successfully employed time lapse photography to monitor shoreline changes in response to sea-level rise and found that the method was sensitive to vertical changes in sea level within about 1/3rd of an inch (< 1 cm). A rise of the mean sea level of 1/3rd inch corresponds to approximately 1-2 years of sea-level rise at the current rate, which means this method may be a useful tool to determine when certain conditions are met for planning purposes and triggers for action with respect to adaptation and mitigation efforts. Researchers at UC Davis have investigated complementary shoreline monitoring methods including image analysis of drone-based LiDAR terrain-mapping and historical, opportunistic and satellite photographs.

5.5. Regional Partnerships to Address Sea-Level Rise

Regional partnerships to reduce flood risk and increase resiliency to sea-level rise are summarized in the following.

5.5.1. Lessee Roles and Responsibilities

Recreation facilities and programs in the Coyote Point Recreation Area are operated and maintained by the County Parks Department and a number of other County agencies, lessees and concessionaires. These recreation and infrastructure providers include the County Sheriff, the Harbormaster, CuriOdyssey, Peninsula Humane Society, the Yacht Club, PG&E, and the City of San Mateo. Full implementation of the facility and programming recommendations in this Master Plan will be contingent in part upon future partnership agreements with these providers. A summary of the roles and responsibilities these stakeholders will have in the future development of this recreation area is provided in Table 5-5 adopted from *SMCP (2008)*. The County of San Mateo currently partners with the City of San Mateo on shoreline improvement projects. The County has also launched Climate Ready SMC (www.climatereadysmc.org) to bring state and local government, non-profits, and businesses together to coordinate on climate resiliency efforts.

Table 5-5: Overview of Lessee Roles and Responsibilities.

Potential Partner Collaborations	Roles and Responsibilities	Implementation Opportunities
Association of Bay Area Governments – The Bay Trail Project	• Oversees implementation of the Bay Trail	• Potential funding source for the Bay trail recently awarded grant monies to develop design of the Bay Trail in Coyote Point Recreation Area
Bay Development and Conservation Commission	• Jurisdiction over San Francisco Bay submerged lands, tidelands, marshlands, and 100-foot wide strip shoreline band – requires “maximum feasible public access”	• Can require/promote increasing public access to and along the Bay shoreline • The Adapting to Rising Tides program can support data needs • BCDC is requiring incorporation of sea level rise and monitoring in permits

Potential Partner Collaborations	Roles and Responsibilities	Implementation Opportunities
		• Continued discussion regarding dredging and habitat creation for protection and adaptation to sea level rise is needed • If San Mateo Flood Control improvements are made north and south of Coyote Point, the Bay Trail would need to be rerouted during construction
California Department of Boats and Waterways	• Fund boat ramps and fishing piers	• Continuation of boating and fishing • Grant and loan programs have previously supported improvements to the Marina and could support future work • Fund transient mooring facilities • Fund abandoned vessel abatement
California Department of Transportation	• Highway 101/Peninsula Ave. interchange	• Provide pedestrian/bicycle access to recreation area in association with highway improvements • Coordinate on climate resiliency projects via SB1 and other efforts
City of Burlingame	• Shared circulation	• Integration of Burlingame trails with Coyote Point trails • Coordination of regional sea level rise adaptation planning
City of San Mateo	• Shared circulation, recreation, and public works functions	• Integration of San Mateo Shoreline Park trails with Coyote Point trails • Flood control protection improvements • Pedestrian access between the recreation area and City golf course • Coordination on the use of dredged materials
County of San Mateo Police Chief's and Sheriff's Association, South Bay Safety Training Consortium	• Operates the shooting range • Operates a regional Law Enforcement Training Center	• Conduct a noise and safety study to evaluate options for reducing noise • Adding safety improvements and limiting hours at the range to conform to the findings of the study • Monitor flooding and address as needed in coordination with County Parks
Harbormaster	• Marina Enterprise Zone – develops and manages facilities within the Marina	• Develop more boating programs such as kayaking, outrigger canoes, Sea Scouts, sailing • Upgrade the new restroom to include indoor showers • Provide a storage area for kayaks and rowing shells on floating docks within the Marina across from the Harbormaster's office • Relocate Harbormaster's office building • Support sea level rise education through king tides events, signage and by monitoring impacts • Remove storage area for kayaks.

Potential Partner Collaborations	Roles and Responsibilities	Implementation Opportunities
		• Provide hoist and dry storage facility for trailer able sailboats. • Expand boat trailer storage capacity. • Provide retail sales of bait, ice, and other amenities at Harbormaster's Office. • Improvements to docks to adapt to sea-level rise • Replace docks as needed • Reuse of future dredge spoils for levee protection • Enhance tidal marsh habitat
Sam Trans	• County bus service	• Provide shuttle/public transit into park to increase visitation
PG&E Easements	• Operates and maintains utility towers and transmission lines that run through the recreation area • Utility provider	• Share PG&E easement with recreation providers
CuriOdyssey	• Lessee/Non-profit Organization – Operates the museum, museum store and animal habitat areas	• Partner with County Parks Department to create interpretive programs • Collaborate with the County Parks Department to improve transportation options to meet visitor needs
Coyote Point Rod and Gun Club	• Private Club utilizing the Siebel Firearms Range	• Support education, where possible
Coyote Point Yacht Club	• Own and maintain yacht club building on land leased from the County • Rent dock space from the County	• Educate public about SLR • Address flooding and stormwater concerns as needed • Coordinate to ensure flood protection • Provide informal sailboat racing program open to the public. • Provide competitive sailboat racing program for members. • Provide organized cruising program for members.
Peninsula Humane Society	• Lessee/Non-profit Org. – Operates and maintains animal shelter and associated site improvements	• Address flooding and stormwater concerns related to environmental health as needed • Coordinate with City of San Mateo and County Parks to ensure protection
Point of View	• Public telescope concession	• Partner with the County Parks Department and Museum in development of rest areas/interpretive exhibits and interpretive programs

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Appendix A: Plates

Coyote Point Recreation Area Map
Area Topography
Historical Shorelines
1965 Shoreline
Existing, 2030, 2050, and 2100 Maps of Tidal Inundation
Existing, 2030, 2050, and 2100 Maps of King Tide Inundation
Existing, 2030, 2050, and 2100 Maps of 100-Year Storm Flooding
Capital Improvement Projects
Sea-Level Rise Adaptation/Mitigation

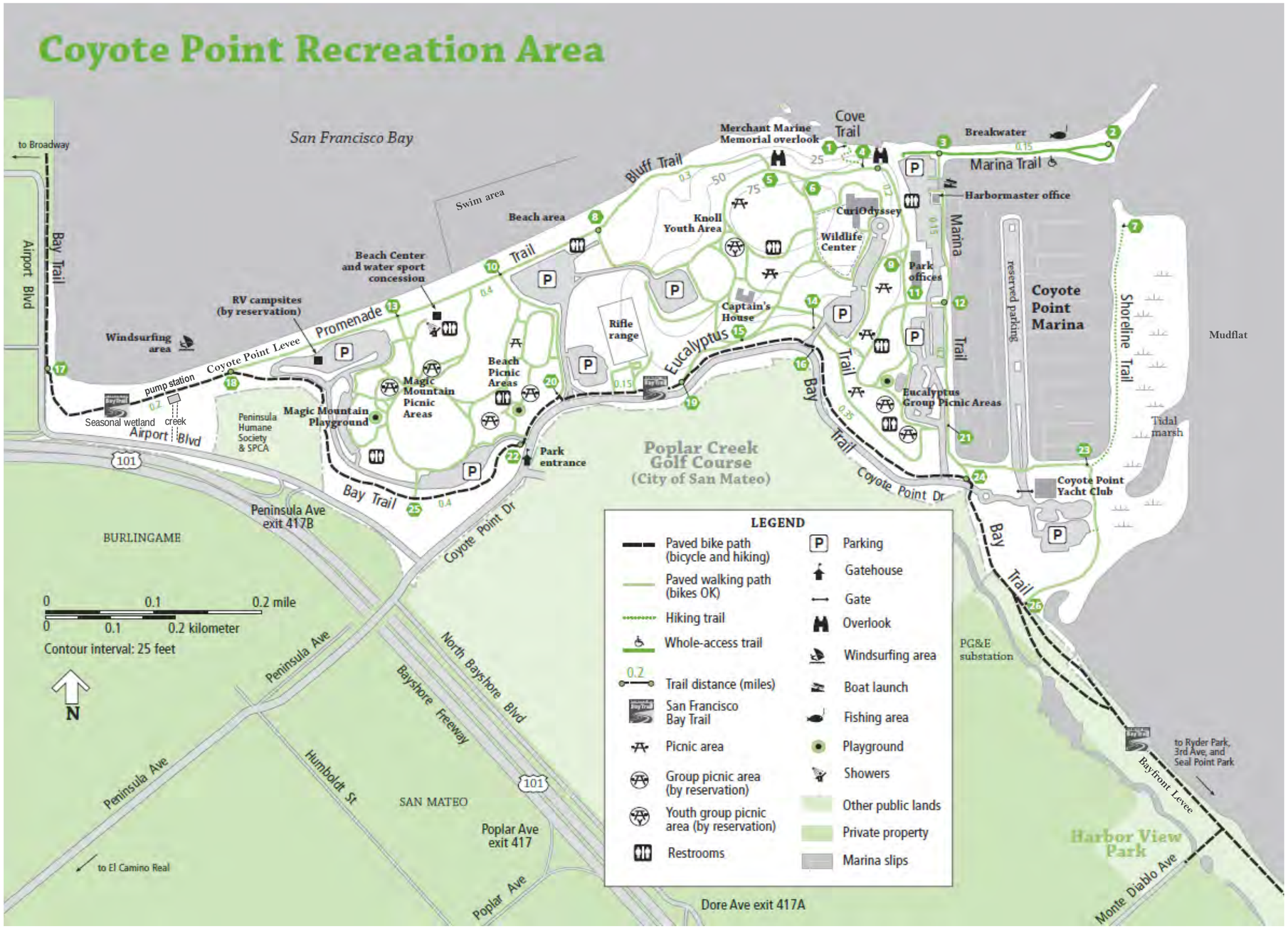

Plate 1: Coyote Point Recreation Area Map

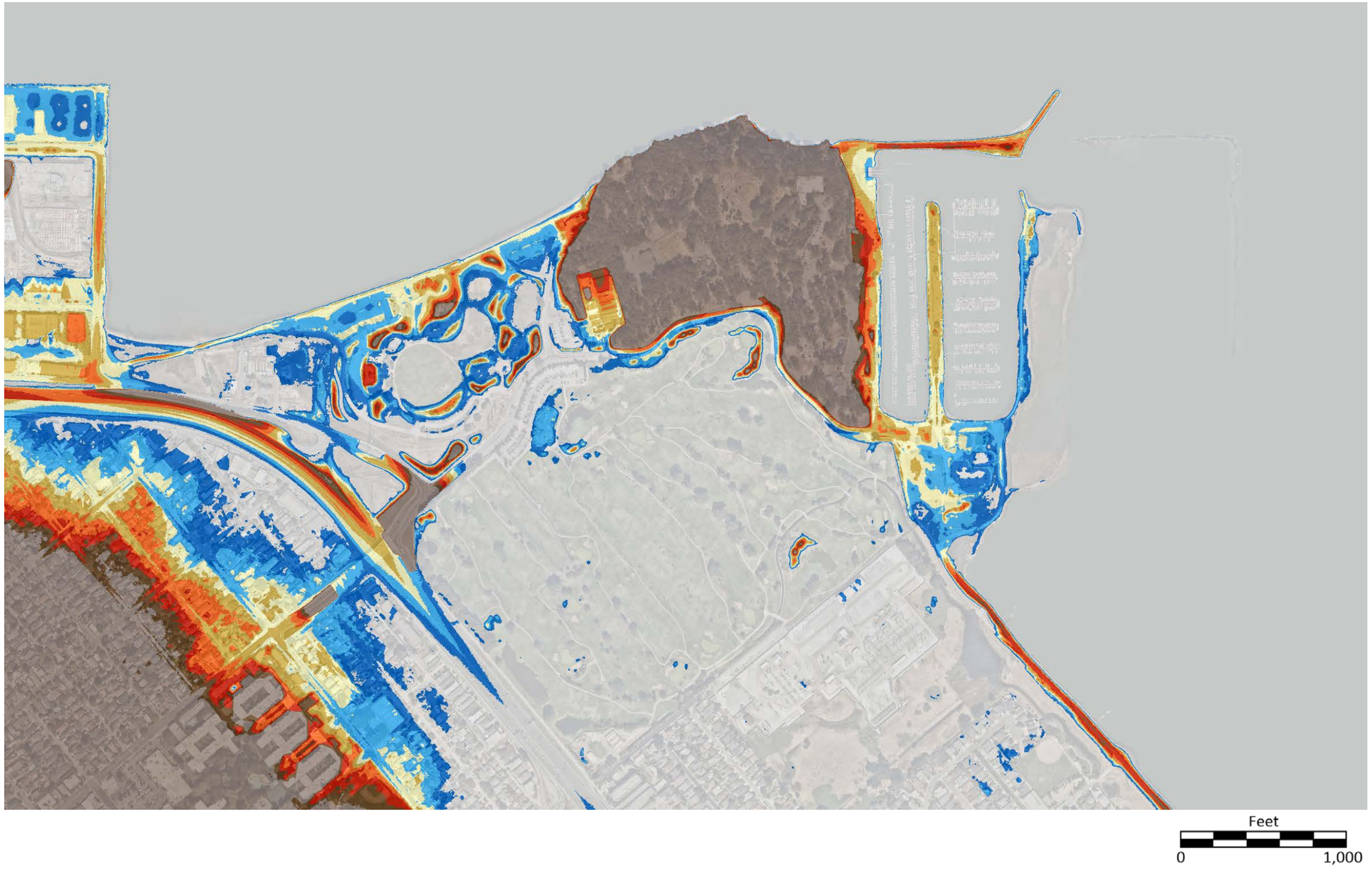

Plate 2: Area Topography, San Mateo County 2017 LiDAR

Plate 3: Historical Shorelines, 1930 – 2018

Plate 4: Coyote Point 1965 Shoreline

Plate 5: Flood Hazard Zones associated with Daily Inundation due to Rising Tides for Existing Conditions

Plate 6: Flood Hazard Zones associated with Daily Inundation due to Rising Tides and 0.8 feet of SLR by 2030

Plate 7: Flood Hazard Zones associated with Daily Inundation due to Rising Tides and 1.9 feet of SLR by 2050

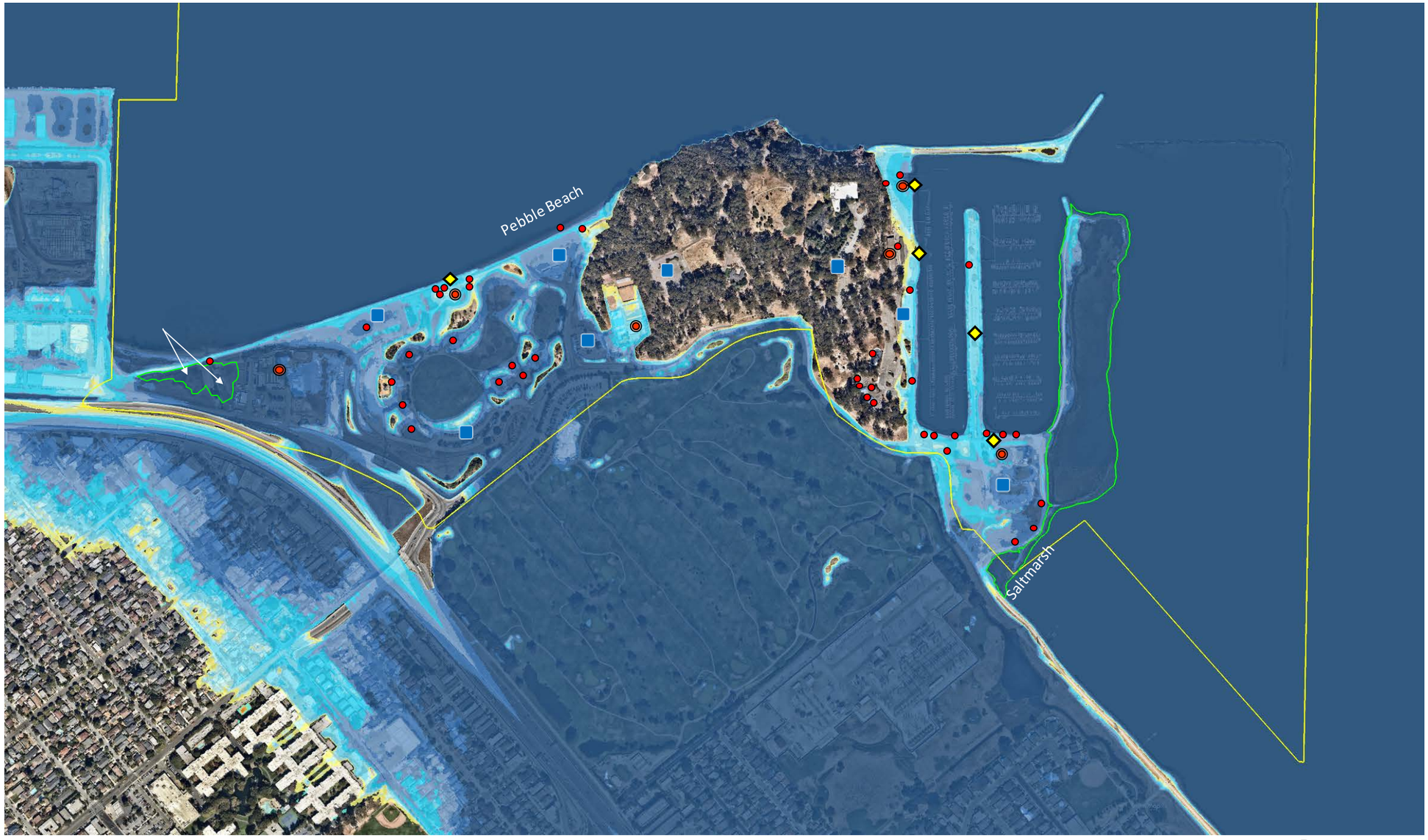

Plate 8: Flood Hazard Zones associated with Daily Inundation due to Rising Tides and 6.9 feet of SLR by 2100

Plate 9: Flood Hazard Zones associated with King Tides for Existing Conditions

Plate 10: Flood Hazard Zones associated with King Tides and 0.8 feet of SLR by 2030

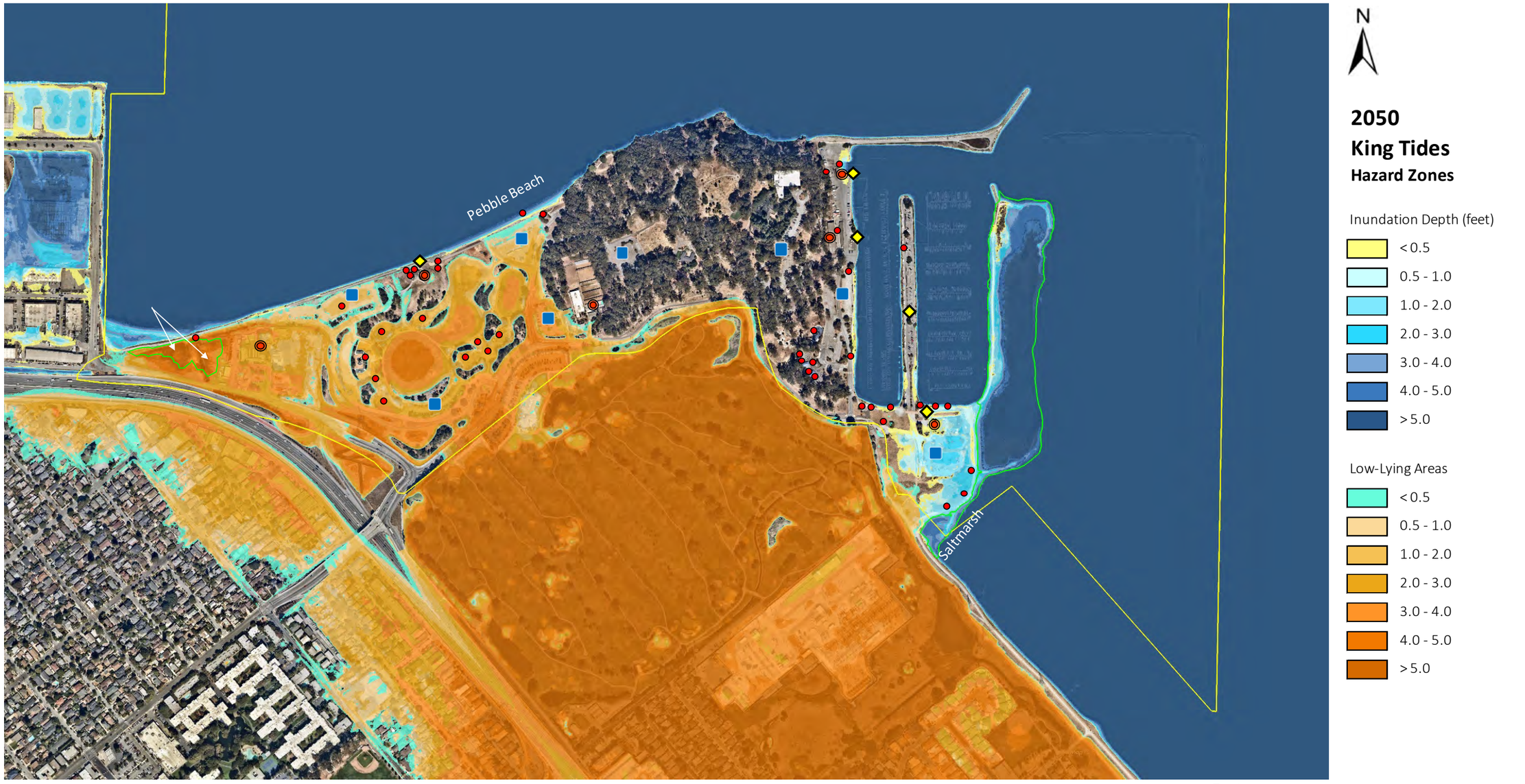

Plate 11: Flood Hazard Zones associated with King Tides and 1.9 feet of SLR by 2050

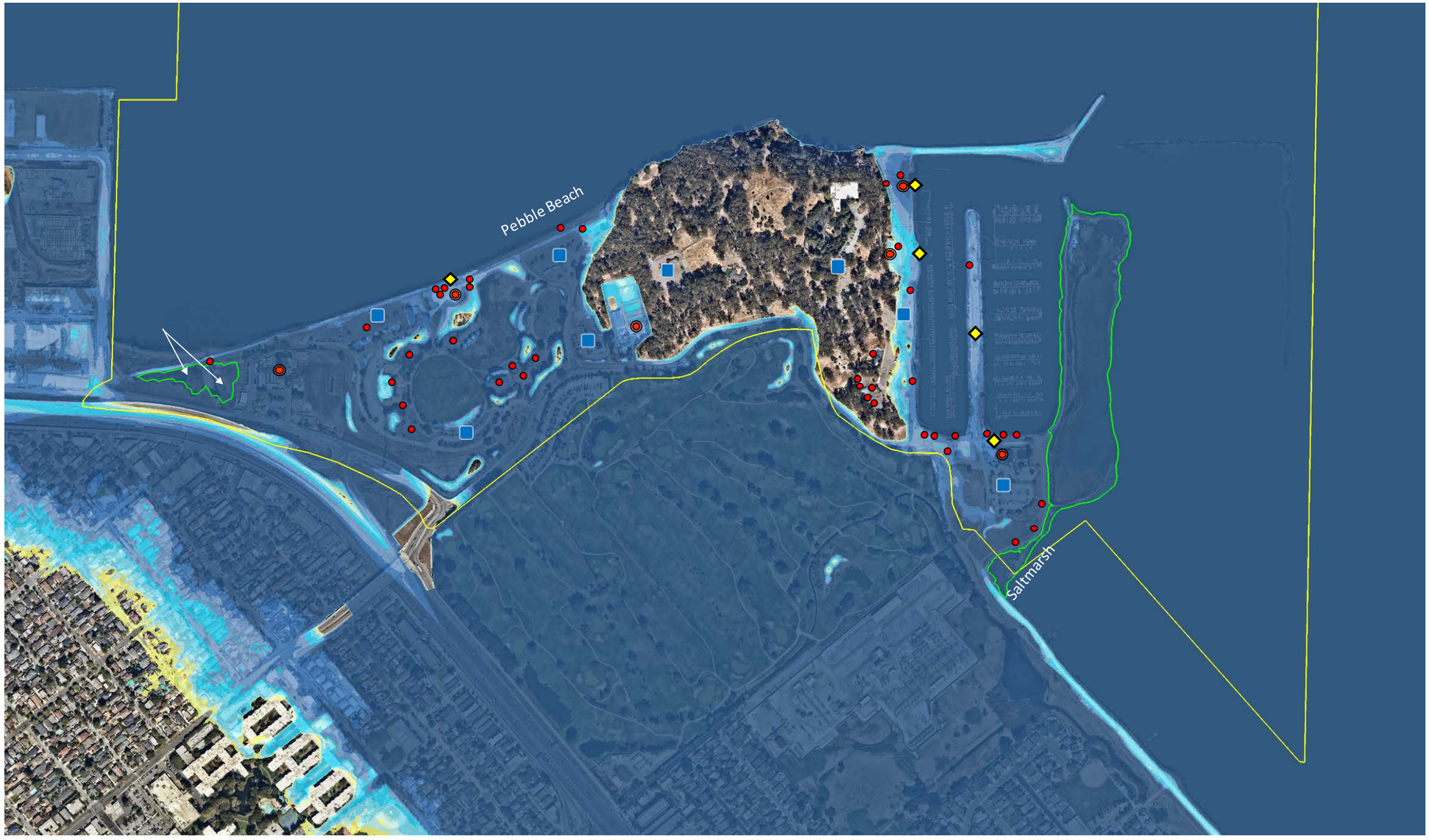

Plate 12: Flood Hazard Zones associated with King Tides and 6.9 feet of SLR by 2100

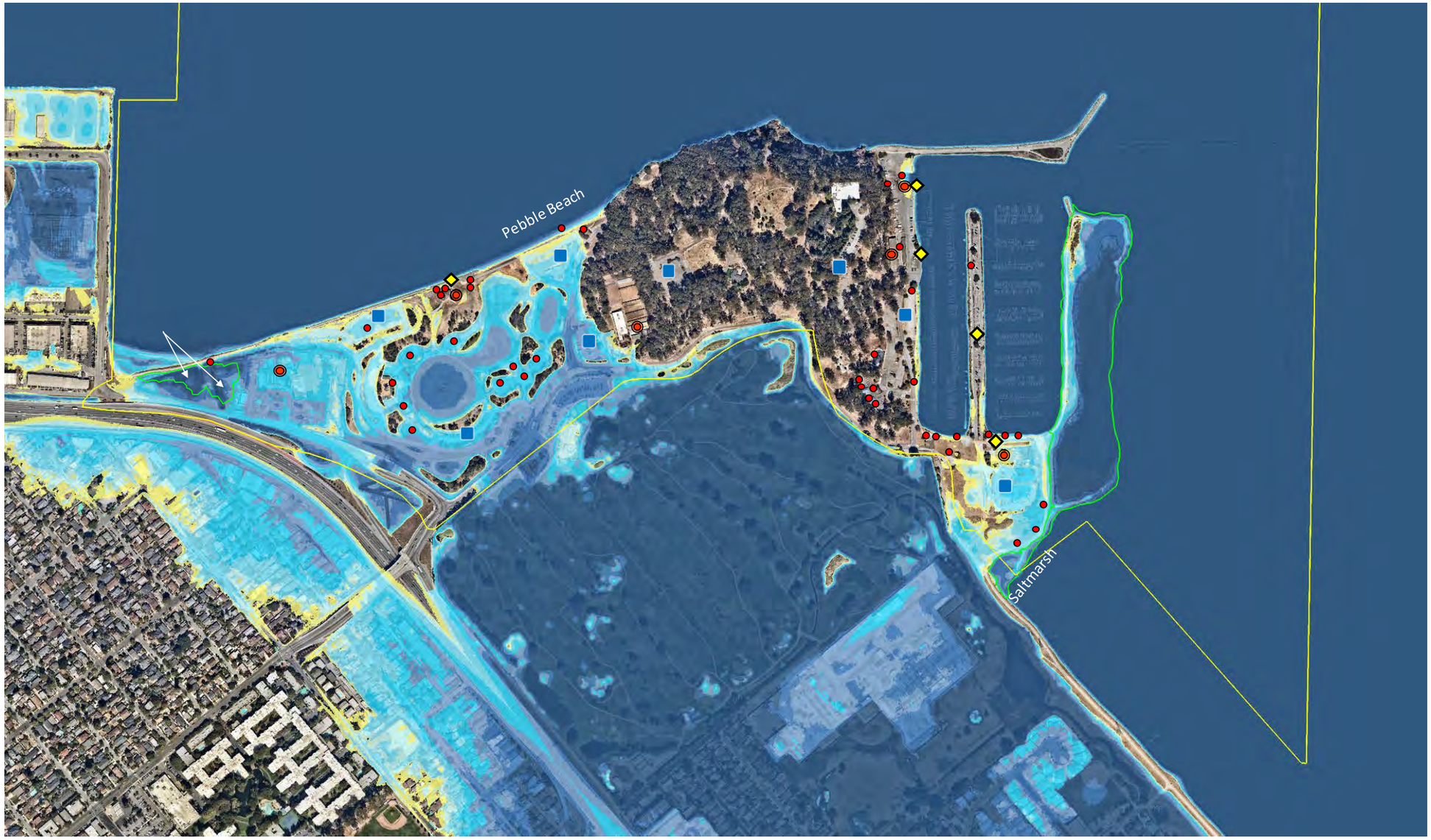

Plate 13: Flood Hazard Zones associated with 100-Year Storm for Existing Conditions

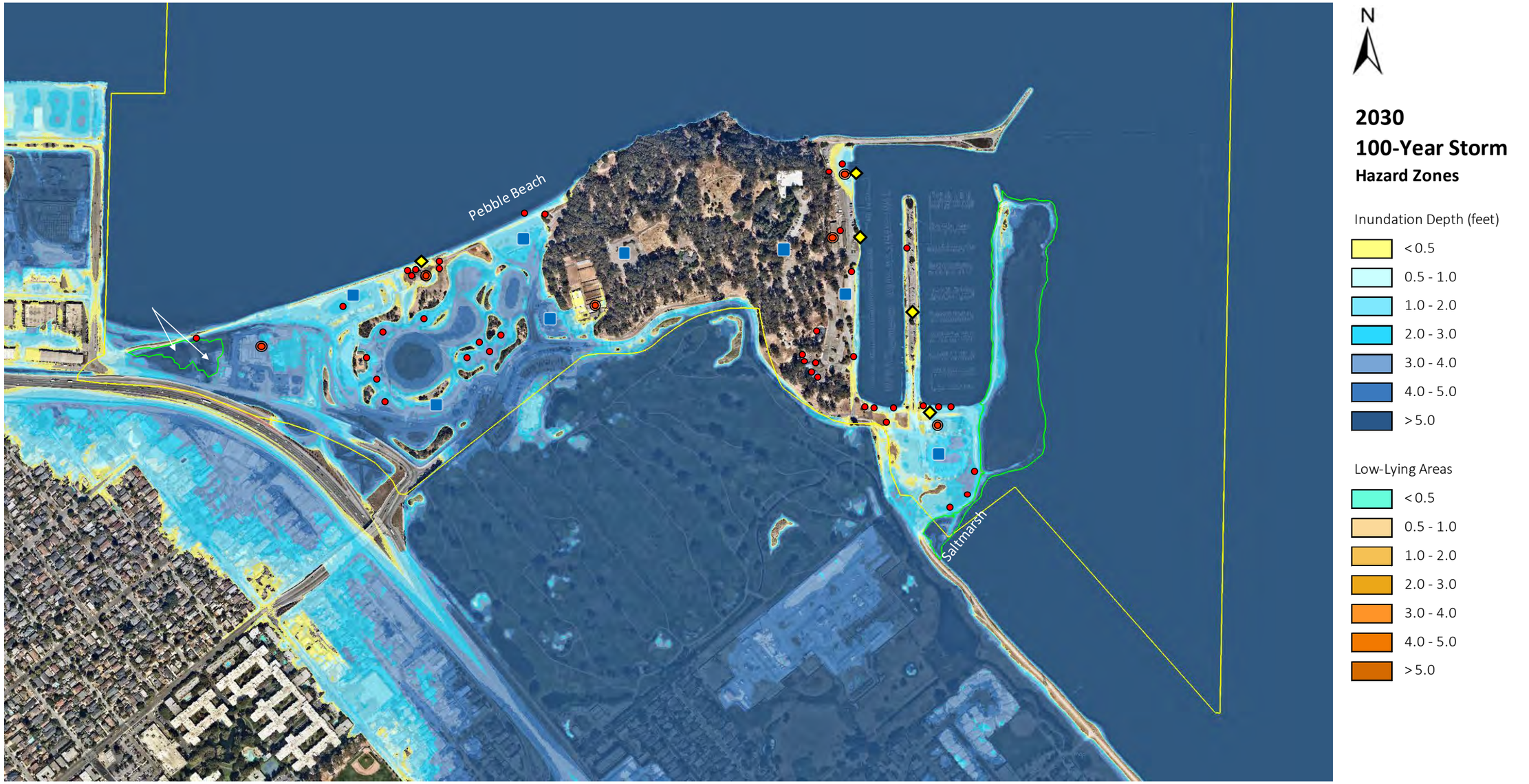

Plate 14: Flood Hazard Zones associated with 100-Year Storm and 0.8 feet of SLR by 2030

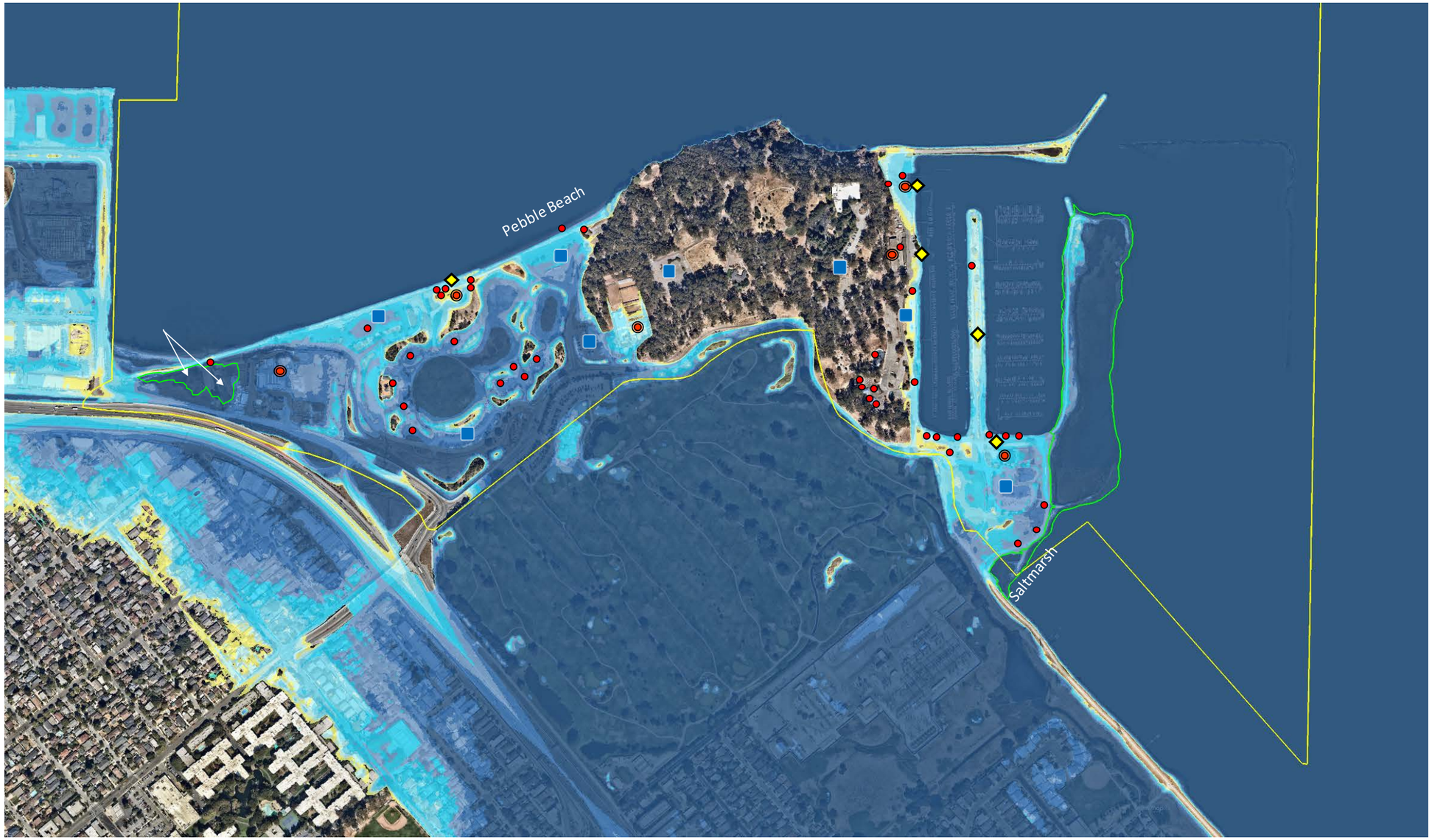

Plate 15: Flood Hazard Zones associated with 100-Year Storm and 1.9 feet of SLR by 2050

Plate 16: Flood Hazard Zones associated with 100-Year Storm and 6.9 feet of SLR by 2100

Legend

I. Western Promande	BP. Burlingame Point	CPL. Coyote Point Levee
II. Eastern Promenade	P_C. Coyote Point Pump Station	NLI. Northern Levee Improvements
V. North Shoreview	P_P. Poplar Avenue Pump Station	BL. Bayfront Levee

Plate 17: Capital Improvement Projects (Completed and Planned)

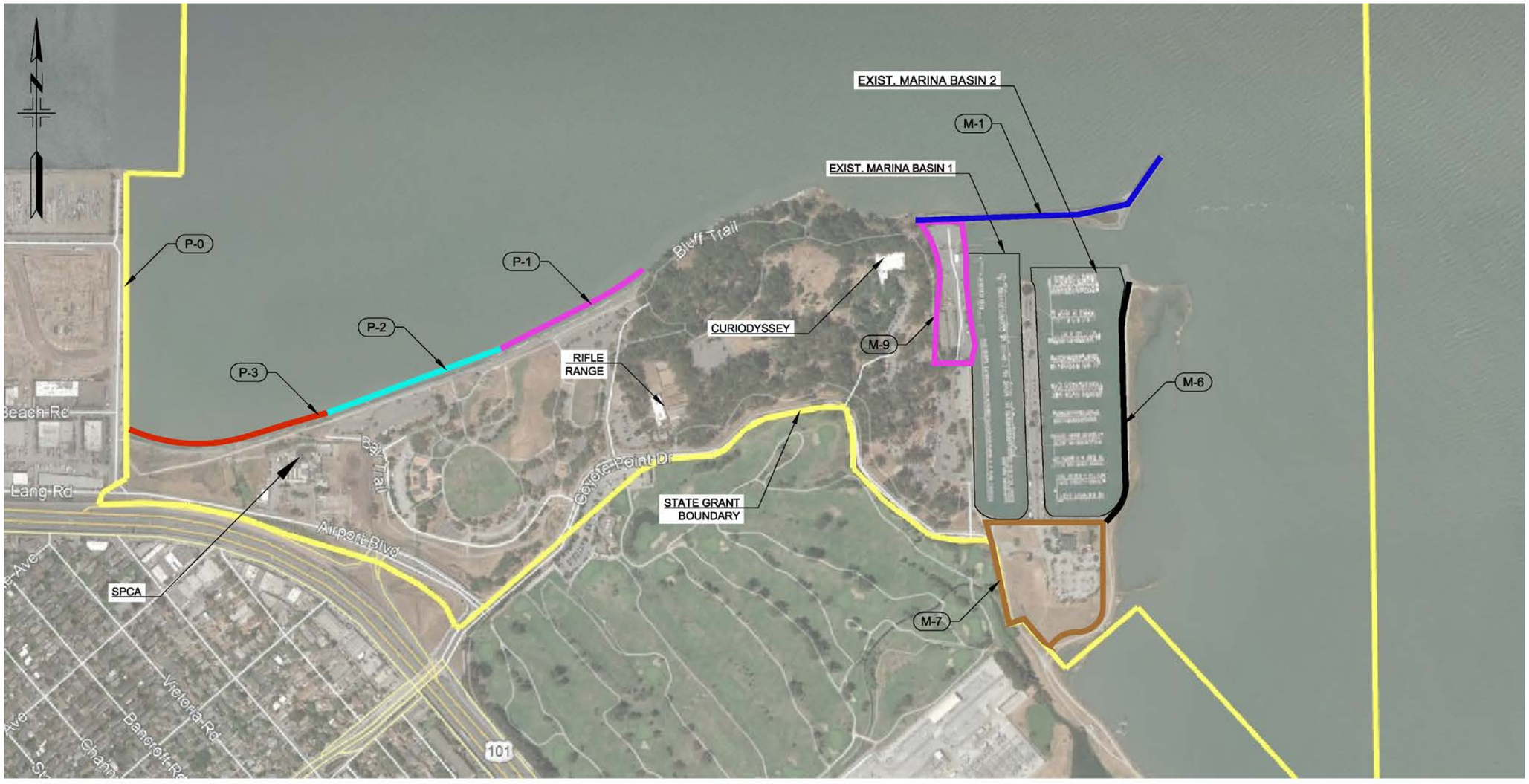

Plate 18: Sea-Level Rise Adaptation/Mitigation by 2050 and 2100