Sea Level Rise Vulnerability Assessment Update

City of Pismo Beach

City of Pismo Beach

7 August 2026

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DRAFT



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Acronyms and Abbreviations

Acronym	Meaning
ags	above ground surface
BFE	Base Flood Elevation
bgs	below ground surface
CCC	California Coastal Commission
CCSMW	California Coastal Sediment Management Workgroup
CDIP	Coastal Data Information Program
COAST	Coastal One-line Assimilated Simulation Tool
CoSMoS	U.S. Geological Survey Coastal Storm Modeling System
ENSO	El Niño–Southern Oscillation
ESWL	Extreme Still Water Levels
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
H++	Extreme SLR scenario due to rapid Antarctic ice sheet mass loss (Sweet et al, 2017)
H_s	Significant Wave Height
IPCC	Intergovernmental Panel on Climate Change
LCP	Local Coastal Program
LiDAR	Light Detection and Ranging (remote sensing method used for collecting topography)
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
MOP	Monitoring and Prediction transects for coastal waves (CDIP model)
MSL	Mean Sea Level
NAVD88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
NOAA CO-OPS	NOAA's Center for Oceanographic Products
OPC	Ocean Protection Council
SIO	Scripps Institution of Oceanography
SLR	Sea Level Rise
TWL	Total Water Level
USGS	U.S. Geological Survey
WIS	Wave Information Studies

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Executive summary

The City of Pismo Beach is vulnerable to the impacts of sea level rise (SLR) due to its low-lying coastal setting, bluff-backed shoreline, and the concentration of critical infrastructure, public access amenities, and economic activity within the coastal zone. This SLR Vulnerability Assessment Update (Assessment) builds upon the City's 2019 assessment and incorporates the latest State of California Sea-Level Rise Guidance, updated coastal hazard modeling, and refined planning areas identified in the Land Use Element. The purpose of this update is to provide an improved understanding of how SLR may affect the City over time, identify areas of heightened vulnerability, and support informed decision-making for adaptation planning, capital investment, and policy development at the neighborhood scale.

To better understand how SLR and coastal hazards may affect Pismo Beach, the City was divided into seven planning zones representing distinct shoreline environments, land uses, and development patterns (Figure ES-1). Vulnerability varies across the City's seven coastal planning zones due to differences in elevation, shoreline type, land use, infrastructure configuration, and dominant coastal processes. Bluff-backed residential neighborhoods along the northern shoreline (Zones 1–5) are primarily vulnerable to episodic bluff erosion, narrowing or loss of pocket beaches, and impacts to coastal access infrastructure. In contrast, the Downtown Core (Zone 6) and Pismo Creek/Pismo Marsh area (Zone 7) are lower-lying environments where coastal flooding, tidal flooding, and fluvial flooding play a more significant role.

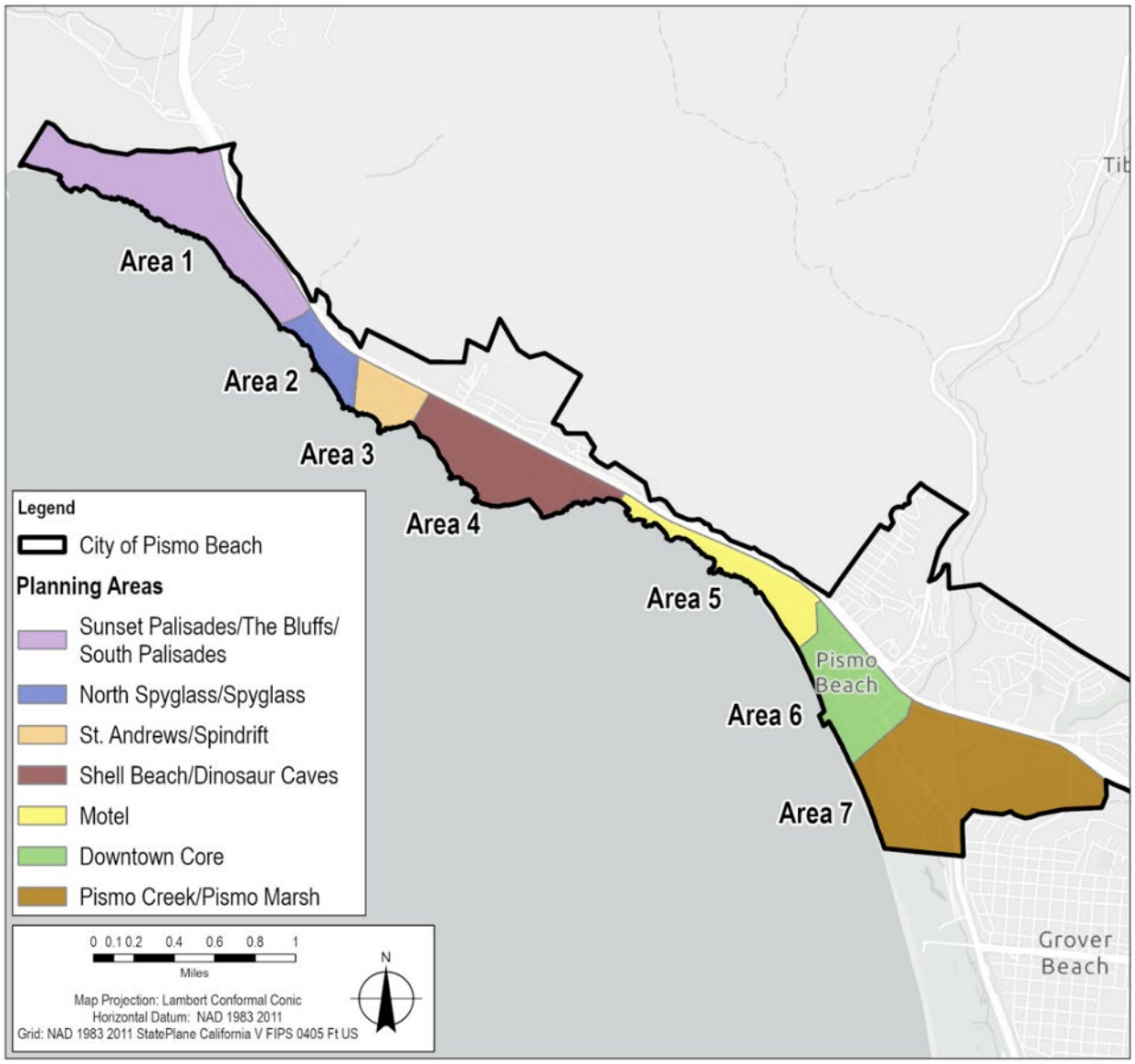


Figure ES-1 Map of City limit and neighborhood-scale planning areas

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Since publication of the previous assessment in 2019, the State of California has released updated SLR guidance. Figure ES-2 illustrates the updated SLR projections from the California Ocean Protection Council's (OPC) 2024 guidance for the Port San Luis tide gauge. Compared to the projections used in 2019, the 2024 guidance generally indicates lower SLR projections through much of this century and no longer includes the H++ scenario prior to 2100. Instead, the California Coastal Commission recommends evaluating future vulnerabilities using the Intermediate, Intermediate-High, and High SLR scenarios. In consideration of the updated OPC 2024 scenarios, planning horizons representative of the Intermediate-High SLR scenario for the Near, Mid, and Long-Term were used, corresponding to approximately 1.6 ft, 3.3 ft, and 4.9 ft of SLR, respectively.

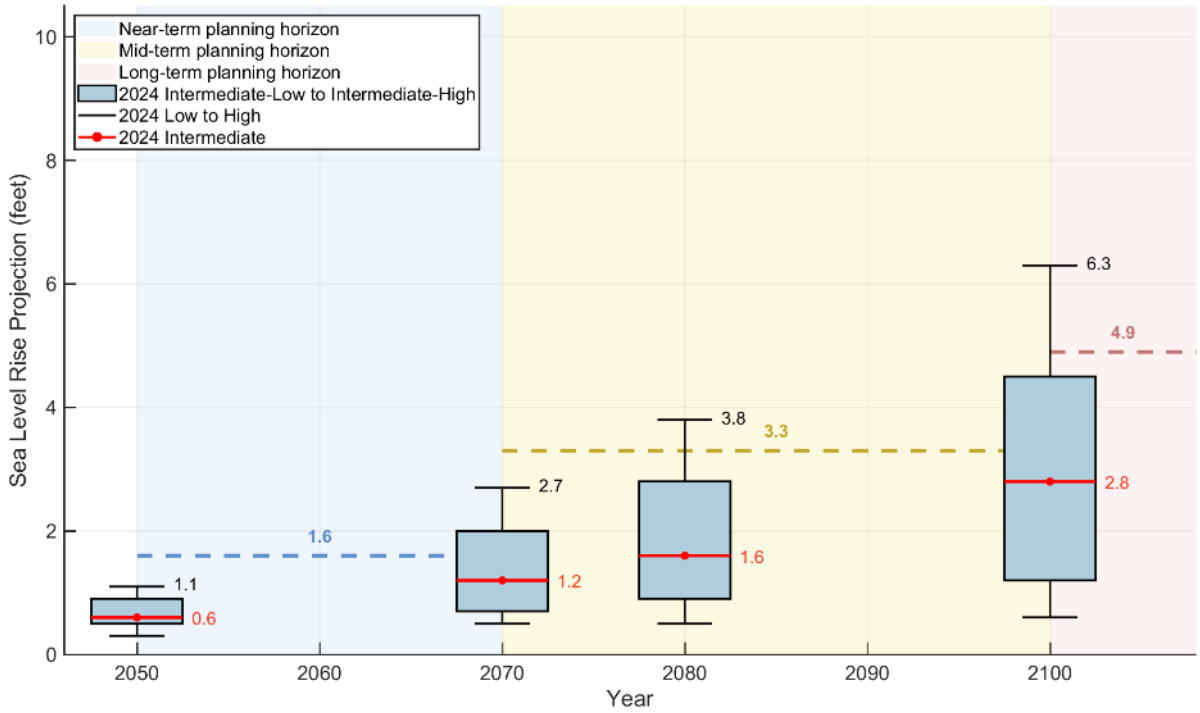


Figure ES-2 Port San Luis, CA OPC 2024 Sea Level Rise Projection Ranges and Planning Horizons.

This Assessment evaluates vulnerability as a function of exposure to SLR-related hazards, sensitivity of assets and land uses, and the capacity for adaptation. The hazard assessment described in Section 5 includes bluff erosion based on updated SIO bluff retreat data and assumptions about future shoreline protection performance; beach and shoreline change based on CoastSat and Bruun Rule analyses; coastal flooding based on USGS CoSMoS 100-year storm results and site-specific wave runup and overtopping analysis for the Downtown Core; groundwater emergence based on USGS groundwater projections; and compound flooding in the Pismo Creek/Pismo Marsh area using a 2D hydraulic model of tidal, fluvial, and future SLR conditions. These methods provide planning-level estimates of where and how hazards may increase over time and support comparison of relative vulnerability across the City's planning areas.

Key vulnerabilities across the study area are summarized in Table ES-1 for each planning horizon. Table ES-2 provides a summary of key vulnerabilities and thresholds for each planning area-at the near- and mid-term planning horizons. Near- and mid-term planning horizons will be the primary focus for adaptation strategies and LCP policy development, with the mid-term horizon identifying significant vulnerabilities within each planning area that may require changes in land use, infrastructure design, or major investment in hazard mitigation. Please refer to Section 6 for a discussion of long-term vulnerabilities within each planning area.

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Table ES-1 Overview of Vulnerabilities for Near-, Mid-, and Long-term Planning Horizons

Vulnerability Overview by Planning Horizon
Near-Term, 1.6 feet SLR (2050-2070): In **Areas 1-5**, vulnerabilities are driven by shoreline and bluff erosion which could damage beach access stairways and bluff-top trails reducing coastal access opportunities. These coastal processes increase risk of damage to residential and commercial properties from episodic bluff erosion though most vulnerable properties already have various shoreline protection structures in place. In **Area 6**, coastal flooding and wave overtopping during extreme storms are expected to affect low-lying beach access corridors, the Addie Street area, the boardwalk, Pier Plaza, and first-row beachfront commercial and residential properties. Higher sea levels during storms and periods of seasonal erosion may reduce the effective beach buffer and further increase overtopping and flooding rates. In **Area 7**, hydraulic modeling indicates that fluvial flooding is a high-probability concern, with 10-year creek flood events capable of producing widespread flooding downstream of Dolliver Street/PCH and the railroad corridor, while near-term tidal and coastal storm flooding begins to affect lowest portions of the RV park, campground, and creek-adjacent areas.
Mid-Term, 3.3 feet SLR (2070-2100): In **Areas 1-5**, higher water levels will allow waves to reach the bluff toe and shoreline protection structures more often, limiting coastal access to calm/low-tide conditions and increasing the likelihood of bluff-face undercutting and episodic bluff failures. Shoreline protection infrastructure may be exposed to conditions and forces that exceed their design limits, possibly increasing the severity of erosion events. In **Area 6**, wave overtopping rates are projected to exceed pedestrian, vehicle, and structural damage thresholds along the boardwalk, causing widespread flooding of beachfront properties and low-lying areas along Addie Street. Pismo Beach Pier becomes more vulnerable to wave related damage during extreme coastal storms. SLR could shift Pismo Beach from accretional to erosional, increasing exposure of public access facilities, shoreline infrastructure, and beachfront development. In **Area 7**, mid-term hazards become more frequent as coastal and fluvial processes interact, with tidal and coastal storm flooding extending into the RV park and campground, groundwater emergence affecting the campground and Pismo Marsh, and creek-mouth berm dynamics increasing the likelihood of recurring flood disruptions for recreational, residential, commercial, and open space uses.
Long-Term, 4.9 feet SLR (2100+) In **Areas 1-5**, significant evolution of the beach profile and bluff face is expected over this timeframe, increasing the extent of erosion-related damage to already exposed residential and commercial properties. Portions of Ocean Boulevard, Seacliff Drive and Price Street are vulnerable to bluff erosion increasing the risk of significant disruptions to property access, emergency services and utility services. Most coastal access & recreation features will require realignment or replacement in response to the future beach and bluff conditions. In **Area 6**, extensive coastal flooding could reach Cypress Street and further inland along the Pismo Creek corridor, affecting a much larger portion of the Downtown Core. Approximately 100 to 200 commercial and residential properties may be exposed to coastal flood impacts, including direct flood damage, wave-driven debris and sediment deposition, access disruptions, and utility failures during extreme coastal storm events. In **Area 7**, tidal flooding affects the entire RV Park southwest of Dolliver Street and groundwater emergence is widespread south of Pismo Creek. The frequency and extent of flooding during non-storm conditions will likely require a change in land use or major engineering interventions to mitigate flooding from tidal, fluvial and groundwater sources.

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Table ES-2 Planning Area Vulnerabilities for Near- and Mid-term Planning Horizons

Planning Area	Asset Category	Near-Term Vulnerabilities, 1.6 feet SLR (2050-2070)	Mid-Term Vulnerabilities, 3.3 feet SLR (2070-2100)
Area 1 Sunset Palisades The Bluffs South Palisades	Property	~11 residential properties along Indio Drive.	~28 residential properties along Indio Drive.
	Public Access	Beachcomber Drive staircase in South Palisades Park. Portions of Shell Beach Bluff Trail vulnerable to bluff retreat. Pirates Cove Beach becomes erosional (-0.5 to -1 ft/yr due to SLR).	South Palisades Park staircases unusable due to erosion & wave exposure. Damage to bluff-top trail network (South Palisades, Ebb Tide Park). Loss of pocket beach space for recreation.
	Infrastructure	Stormwater outfalls near Searidge Court & Silver Shoals.	Shoreline protection infrastructure exposed to conditions and forces that exceed their design limits, increasing the severity of erosion events.
Area 2 North Spyglass Spyglass	Property	~6-9 residential properties along Spyglass Drive, range depends on condition and performance of shoreline protection.	~14 residential properties along Spyglass Drive. SLR most likely exceeds shoreline protection design limits, increasing the severity of erosion events.
	Public Access	Beaches narrow 20-40 ft due to SLR. Access to pocket beaches, Spyglass Park tide pools, and surf breaks become more hazardous. Bluff-top parks vulnerable to bluff erosion and slope instability.	Loss of beach space for recreation. Shoreline access hazardous except for calm waves & low tide conditions. Further erosion of bluff-top landscaping and pedestrian pathways.
	Infrastructure	Three stormwater outfalls – exposed to greater wave action & scour during extreme events.	Stormwater outfalls subject to more frequent and intense wave action – causing scour and potential structural damage.

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Planning Area	Asset Category	Near-Term Vulnerabilities, 1.6 feet SLR (2050-2070)	Mid-Term Vulnerabilities, 3.3 feet SLR (2070-2100)
Area 3 St. Andrews Spindrift	Property	~4-6 residential properties along Seacliff Drive.	~8-10 residential properties along Seacliff Drive.
	Public Access	Memory Park staircase in South Palisades Park. Erosion of bluff-top park space at Memory Park.	Shoreline access hazardous except for calm waves & low tide conditions. Loss of bluff-top park space.
	Infrastructure	Bluff erosion threatens Seacliff Drive and utilities beneath roadway.	Bluff erosion likely undermines Seacliff Drive. Shoreline protection infrastructure exposed to conditions and forces that may exceed their design limits, increasing the severity of erosion events.
Area 4 Terrace Ave Shell Beach Dinosaur Caves	Property	~6-10 residential properties along Shoreline Drive and Ocean Blvd, including Chapman Estate.	~10-17 residential properties along Shoreline Drive and Ocean Blvd. SLR most likely exceeds shoreline protection design limits, increasing the severity of erosion events.
	Public Access	Damage to Vista Del Mar beach access stairs. Access to pocket beaches, tide pools, and surf breaks become more hazardous. Bluff-top parks (Eldwayen, Margo Dodd and Dinosaur Caves) vulnerable to bluff erosion and slope instability.	Damage to beach access stairways & parking areas at Eldwayen Ocean Park. Shoreline access hazardous except for calm waves & low tide conditions. Further erosion of bluff-top landscaping and pedestrian pathways.
	Infrastructure	Most stormwater outfalls and lift stations are integrated within shoreline protection structures.	Bluff erosion likely undermines portions of Ocean Blvd causing access disruptions for adjacent properties. Shoreline protection infrastructure exposed to conditions and forces that may exceed their design limits, increasing the severity of erosion events.

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Planning Area	Asset Category	Near-Term Vulnerabilities, 1.6 feet SLR (2050-2070)	Mid-Term Vulnerabilities, 3.3 feet SLR (2070-2100)
Area 5 Motel District	Property	Most properties include setbacks from the bluff edge to primary buildings, but landscape features & amenities could be vulnerable to bluff erosion damage.	Further erosion & undermining of landscape features & amenities at commercial properties in Motel District. The vulnerability of residential development will depend on how the beach and bluff erosion processes respond to SLR.
	Public Access	Beaches narrow 20-40 ft due to SLR. The California Coastal Trail and portions of Price Street will be exposed to bluff erosion.	Continued bluff retreat undermines the California Coastal Trail. Access to pocket beaches and tide pools become more hazardous and limited to low tide/calm conditions.
	Infrastructure	Segments of Price Street vulnerable to bluff erosion. Stormwater outfalls at lower bluff exposed to increased wave action and erosion.	Shoreline protection exposed to conditions and forces that exceed their design limits, increasing severity of erosion events. Reduced effectiveness of shoreline protection will increase exposure of Price Street.
Area 6 Downtown Core	Property	Beachfront commercial properties south of Pier Plaza. ~15-20 residential properties along Addie Street and Park Ave vulnerable to extreme coastal flooding.	More extensive coastal flood damage expected along beachfront commercial properties. ~20-30 low-lying residential properties between Stimson Ave to Addie Street.
	Public Access	Addie Street parking lot & beach restroom vulnerable to coastal storm damage. Wave overtopping causes hazardous conditions for pedestrians at Pier Plaza and boardwalk. Coastal erosion damage of beach amenities (i.e. volleyball courts and swing sets).	Widespread damage to public access infrastructure along backshore due to wave overtopping. Pismo Beach Pier vulnerable to wave impacts & damage during extreme events. More frequent hazardous conditions for pedestrians & vehicles along Pier Plaza, Boardwalk and beachfront parking lots.

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Planning Area	Asset Category	Near-Term Vulnerabilities, 1.6 feet SLR (2050-2070)	Mid-Term Vulnerabilities, 3.3 feet SLR (2070-2100)
Area 6 Downtown Core	Infrastructure	Addie St pump station exposed to flooding. Reduced capacity of storm drain systems due to backwater effects from Pismo Creek.	Damage to timber boardwalk due to wave action & scour. Increased backwater effects from Pismo Creek reduce stormwater conveyance capacity.
Area 7 Pismo Creek Pismo Marsh	Property	RV Parks, Mobile Home Parks, Campground & other commercial properties vulnerable to extreme fluvial flooding.	More frequent flooding of all development expected from fluvial events, compound flooding (tidal + fluvial) and backwater effects from creek-mouth berm dynamics.
	Public Access	Temporary disruptions to visitor-serving uses due to storm-related damage of campground, trail network, RV Park etc.	Tidal flooding and groundwater emergence become problematic for campground and low-lying portions of RV Park – further limiting windows for recreational use.
	Infrastructure	Wastewater lift stations at Cypress St bridge and northeast of Dolliver St are sensitive to both surface flooding and elevated groundwater. Disruptions to transportation infrastructure during & after extreme events to perform cleanup, maintenance and repairs.	Groundwater emergence and backwater effects from Pismo Creek and Meadow Creek Surface reduce the effectiveness of drainage systems. More frequent and significant disruptions to transportation infrastructure due to flooding from extreme events.

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1. Introduction

The City of Pismo Beach (City) is located along the central California coast in San Luis Obispo County, with a shoreline that includes sandy beaches, coastal bluffs, and low-lying areas (Figure 1). The City's shoreline already experiences coastal flooding events and bluff and beach erosion. With increasing SLR, these hazards are expected to occur more frequently and with greater severity.

The City is in the process of updating its General Plan and Local Coastal Program (LCP). To support this effort, the City was awarded grants from the California Coastal Commission Local Coastal Planning grant program and the Ocean Protection Council Senate Bill 1 Sea Level Rise Adaptation grant program in 2025. These grants provides funds to support updates to the Safety Element and the Parks, Recreation, and Access Element of the Coastal Land Use Plan/General Plan and corresponding sections of its Implementation Plan to address SLR resilience. The grant also provided funds to support three technical studies that include:

– An update to the 2019 SLR Vulnerability Assessment (Moffatt & Nichol, 2019) to identify which areas and resources are most vulnerable to SLR
– An updated Sea Level Rise Adaptation Plan; and
– An updated economic assessment that evaluates potential losses resulting from projected SLR hazards and provides a cost-benefit analysis of adaptation alternatives.

GHD was contracted to develop the updated SLR Vulnerability Assessment and SLR Adaptation Plan.

1.1 Purpose of this report

The purpose of this Assessment is to update the City's understanding of SLR risks using the best available science and current state guidance. It is also intended to inform City staff, decision-makers, and the public about potential SLR vulnerabilities as the City continues to update its Local Coastal Program (LCP) and General Plan.

Since publication of the previous SLR vulnerability assessment in 2019, the State of California has released updated SLR guidance, and improved scientific tools have become available. This Assessment incorporates several advancements to evaluate how rising sea levels may affect different areas of Pismo Beach over time which include:

– Re-evaluating future SLR exposure risks using the 2024 California SLR Guidance (OPC 2024)
– Providing updated, neighborhood scale coastal hazard information, including coastal and fluvial flooding, beach and bluff erosion, and a newly evaluated hazard—coastal groundwater emergence; and
– Expanding on SLR vulnerability descriptions to include equity and environmental justice considerations.

1.2 Scope and limitations

This Assessment has been prepared for the City and reflects conditions, datasets, and scientific understanding available at the time of preparation. The scope of work is limited to a qualitative and quantitative review of SLR-related coastal hazards using publicly available modeling tools and published datasets. Future changes in coastal processes, infrastructure condition, sediment supply, storm characteristics, or climate science could alter the magnitude, timing, or extent of impacts described herein. As with the 2019 assessment, the projections presented are subject to uncertainty and should be interpreted as planning-level information rather than predictions of future conditions.

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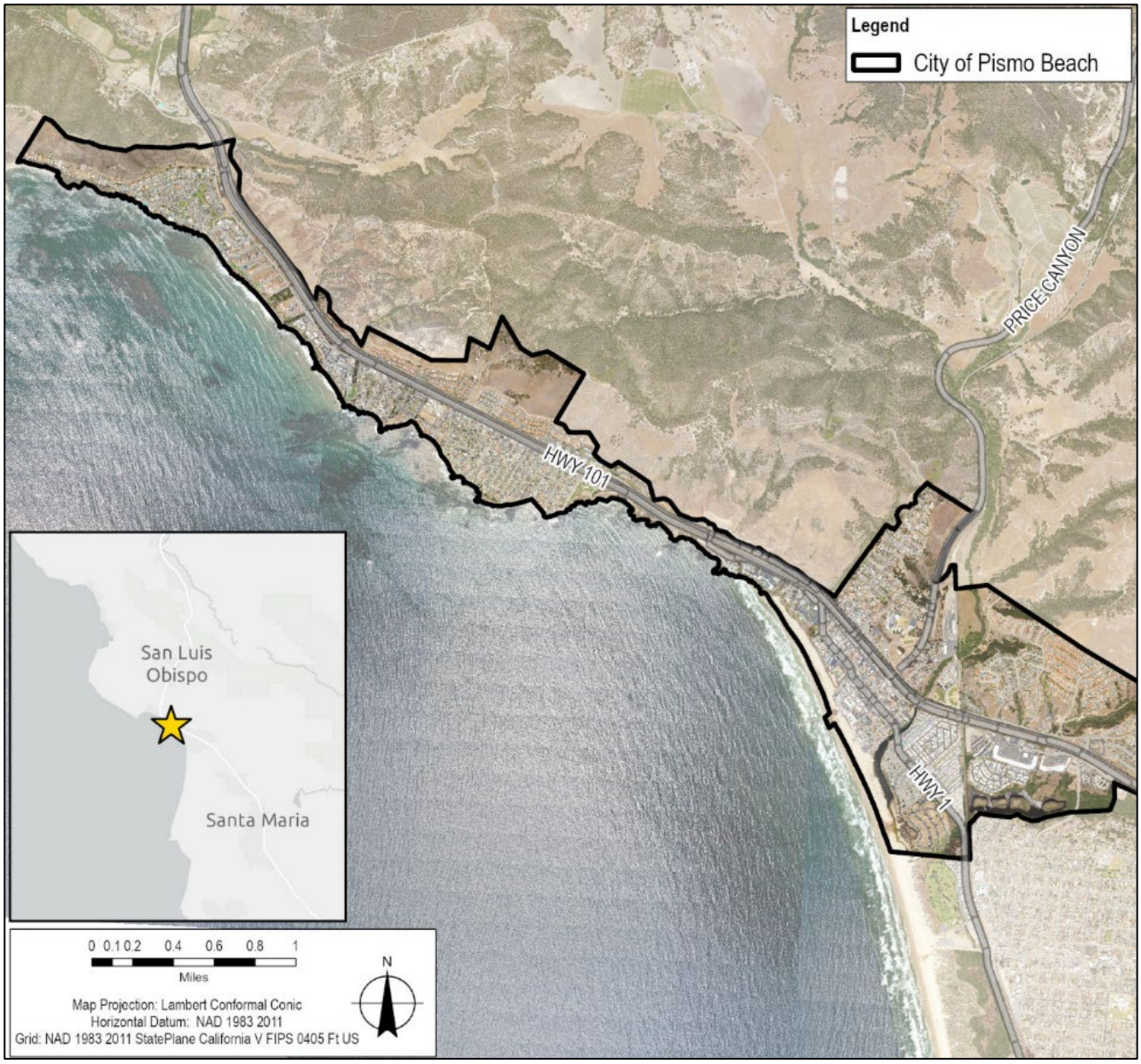


Figure 1 ***Map depicting the City limits in San Luis Obispo County.***

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2. Background

The City of Pismo Beach has been engaged in sea level rise (SLR) planning and Local Coastal Program (LCP) updates since 2017, when the City received California Coastal Commission (CCC) Local Coastal Program grant funding to support technical studies and policy development related to coastal hazards and climate resilience.

These efforts included preparation of the City's original Sea Level Rise Vulnerability Assessment (2019), Sea Level Rise Adaptation Plan (2020), and supporting work associated with the ongoing General Plan and Local Coastal Program update process. The original vulnerability assessment evaluated coastal hazards at a citywide scale and provided the first comprehensive assessment of the City's exposure to sea level rise and related coastal processes. The assessment identified vulnerabilities associated with coastal flooding, bluff erosion, shoreline retreat, and impacts to public access, infrastructure, and development throughout the coastal zone. The findings informed development of the City's 2020 Adaptation Plan, which identified a broad range of potential adaptation strategies intended to improve long-term coastal resilience.

Since completion of the original vulnerability assessment, the City has advanced a comprehensive update to its General Plan/Land Use Plan (GP/LUP) and Coastal Implementation Plan. By 2023, following extensive community outreach and stakeholder engagement, the Planning Commission recommended approval of the updated GP/LUP. However, public concerns regarding proposed coastal hazard and adaptation policies within the Safety Element resulted in the decision to proceed with the broader LCP update while deferring the Safety Element for additional study and public engagement. As a result, the City, in coordination with Coastal Commission staff, initiated a focused effort to update the Safety Element and the Parks, Recreation, and Access Element along with supporting technical studies as a separate phase of the overall LCP update process.

Since the original studies were completed, several advancements have occurred in the science of sea level rise and coastal hazard assessment. The State of California has adopted updated Sea Level Rise Guidance through the Ocean Protection Council (OPC) and California Coastal Commission, including new projections, updated planning recommendations, and improved understanding of emerging hazards such as coastal groundwater rise. New modeling tools and datasets are also available to better evaluate shoreline change, coastal flooding, bluff erosion, and compound flooding processes. The updated Vulnerability Assessment incorporates these advancements and reflects current best available science to support future planning and decision-making at the neighborhood-scale.

2.1 Neighborhood-Scale Study Approach

Pismo Beach's coastline is characterized by diverse physical settings, including bluff-backed residential neighborhoods, pocket beaches, visitor-serving commercial areas, the Downtown waterfront, and the low-lying Pismo Creek and Pismo Marsh corridor. Because coastal processes, development patterns, infrastructure, public access opportunities, and adaptation constraints vary considerably throughout the City, future adaptation strategies will similarly need to reflect neighborhood-specific conditions and priorities.

The neighborhood-scale approach reflects recommendations that have emerged from extensive collaboration among local governments, Coastal Commission staff, and practitioners through the California Coastal Commission Local Government Working Group (LGWG). The LGWG was established to address the complex challenges associated with updating Local Coastal Programs to address sea level rise and has recognized that phased, incremental approaches can improve the efficiency and ultimate success of LCP updates. Rather than relying on broad citywide policies alone, the LGWG has promoted development of localized adaptation pathways and neighborhood-specific planning frameworks that incorporate varying coastal conditions, hazards, land uses, and community objectives. This approach allows jurisdictions to establish adaptation strategies that are responsive to local circumstances while maintaining consistency with Coastal Act policies and state guidance.

The neighborhood-based adaptation planning framework has recently been applied successfully in several California coastal communities and is increasingly viewed as a model for implementing sea level rise adaptation through Local Coastal Program updates. Communities such as Pacifica have demonstrated how geographically focused vulnerability assessments and adaptation planning can support development of implementable LCP policies that address the unique conditions and challenges of individual shoreline segments while advancing broader community resilience goals.

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Consistent with the City's Land Use Element, this study evaluates seven distinct planning areas (Figure 2) to better understand how hazards, vulnerabilities, and adaptation opportunities differ across the shoreline.

The seven neighborhood planning areas are:

– Area 1: Sunset Palisades / The Bluffs / South Palisades
– Area 2: North Spyglass / Spyglass
– Area 3: St. Andrews / Spindrift
– Area 4: Terrace Ave / Shell Beach / Dinosaur Caves
– Area 5: Motel District
– Area 6: Downtown Core
– Area 7: Pismo Creek / Pismo Beach

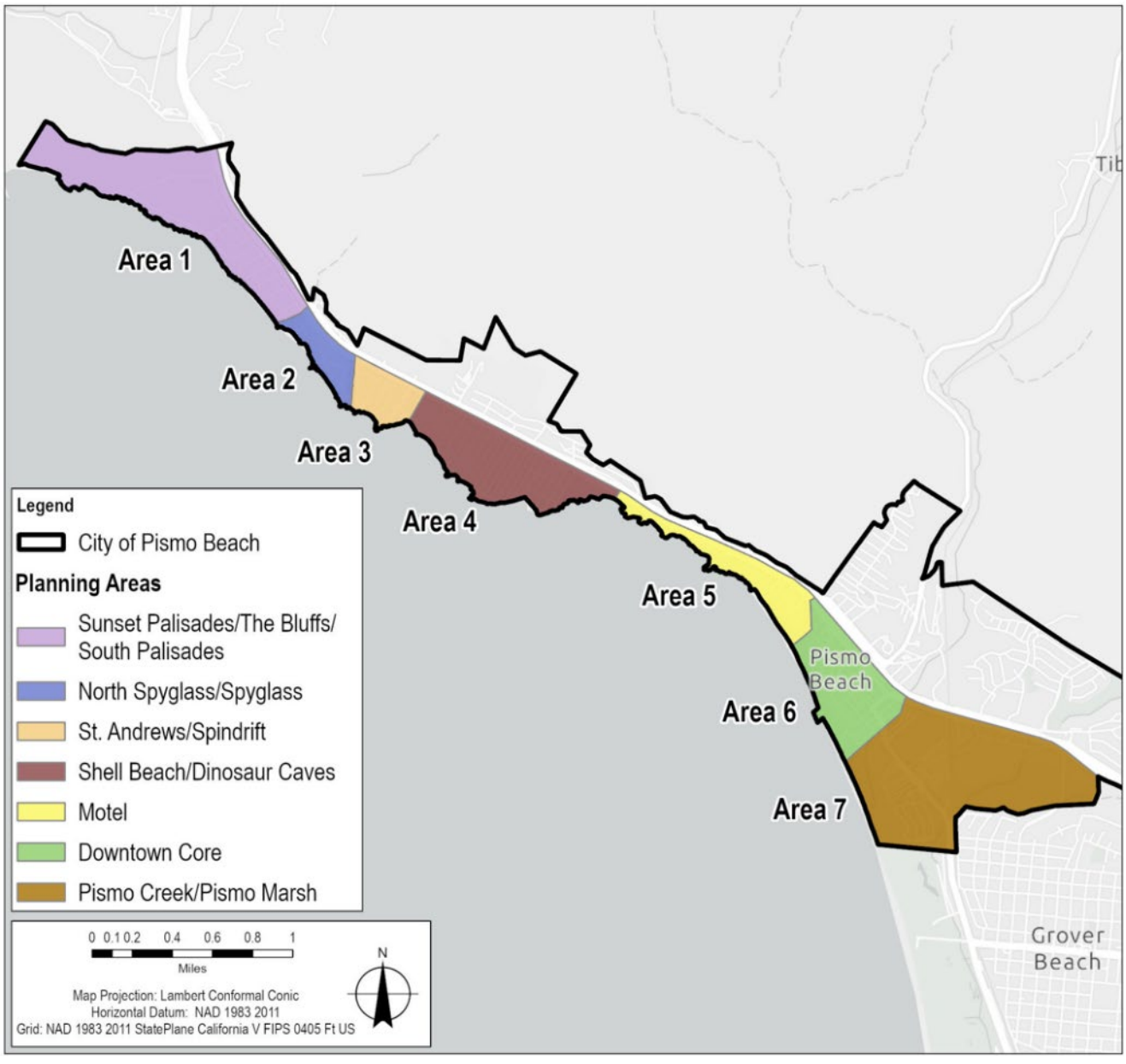


Figure 2 Map of City limits and seven neighborhood-scale planning areas evaluated

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3. Coastal Setting

This chapter describes the current physical conditions in the City, with a focus on the natural coastal processes that shape the Pismo Beach shoreline and influence how SLR may affect the City over time. These processes, including tides, waves, sediment movement, and erosion, help explain why some areas are more vulnerable than others. Identifying notable changes or trends in these processes since the 2019 assessment provides important insight for the updated evaluation of SLR vulnerabilities in later chapters.

3.1 Water Levels

Water levels along the Pismo Beach shoreline are influenced by a combination of astronomical tides, storm surge, and regional long-term sea level trends. Together, these factors influence how often coastal areas are flooded and how far inland water can reach during storm events.

The closest long-term tide gauge is located at Port San Luis, which has recorded water level records since the mid-1900s. These records are used as a reasonable representation of water level conditions along the Pismo Beach coastline. Tidal datums remain the same as presented in the 2019 assessment. For reference, they are included in Table 1 below. The difference between average low tide and average high tide at Port San Luis remains about 5.3 feet (ft). During extreme tides, commonly referred to as King Tides, water levels have exceeded 7 ft above NAVD88, even without storms.

Table 1 Tidal datums from the Port San Luis tide gauge

Datum	Elevation (ft, NAVD88)
Highest Observed Tide (1/18/1973)	7.57
Highest Astronomical Tide (HAT)	7.03
Mean Higher High Water (MHHW)	5.25
Mean High Water (MHW)	4.54
Mean Sea Level (MSL)	2.72
NAVD88	0.00
Mean Low Water (MLW)	0.96
Mean Lower Low Water (MLLW)	-0.08
Lowest Astronomical Tide (LAT)	-2.05
Lowest Observed Tide (1/7/1951)	-2.48

3.2 Wave Climate

The wave climate along Pismo Beach is dominated by west and northwest swell generated by North Pacific storm systems, resulting in pronounced seasonal variability. Higher-energy wave conditions typically occur during the winter months, while lower-energy conditions prevail in summer.

Consistent with the prior SLR assessment, wave data were sourced from the Scripps Institution of Oceanography (SIO) Coastal Data Information Program (CDIP) Monitoring and Prediction (MOP) Station 076 (Diablo Canyon), located approximately 13 miles northwest of the City. Data from this station indicate that the overall directional distribution and seasonal patterns of wave energy have remained generally consistent over time. The dominant wave approach direction is approximately 270 degrees relative to true north, as shown in Figure 3. Although wind- and storm-generated waves also approach from the south and southwest, these conditions occur less frequently (CCSMW, 2016).

Extreme value analysis was performed using peak storm event H_s values derived from the U.S. Army Corps of Engineers Wave Information Studies (WIS) hindcast dataset. The WIS program provides a long-term, numerically

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modeled reconstruction of historical offshore wave conditions and is commonly used to characterize regional wave climate and evaluate extreme events. As shown in Figure 5, peak storm event H_s values increase with time, and a linear fit can be used to estimate long-term return levels. Based on this analysis, the estimated 50-year storm event H_s is approximately 29 ft, while the estimated 100-year storm event H_s is approximately 30 ft, providing an indication of potential extreme wave conditions affecting the study area.

In addition to long-term trends, interannual climate variability influences wave energy along the California coast. El Niño-Southern Oscillation (ENSO) conditions are associated with sustained increases in winter wave energy. During the 2015–2016 ENSO winter, wave energy along the California coast was approximately 50 percent higher than typical winter conditions along much of the coast (Smith & Barnard, 2021). These episodic conditions can contribute to elevated coastal erosion and bluff retreat when combined with high tides and storm surge.

Findings from the updated analysis found that average mean significant wave heights (H_s) from 2019-2026 were approximately 5 ft; consistent with the H_s found in the previous SLR vulnerability assessment. In winter, H_s averages 6.2 ft and in summer, H_s averages 4.0 ft. Extreme wave conditions were also similar between study periods. The maximum H_s recorded during the 2012–2019 period was 20.8 ft, compared to 20.1 ft during the 2019–2026 period (Figure 4).

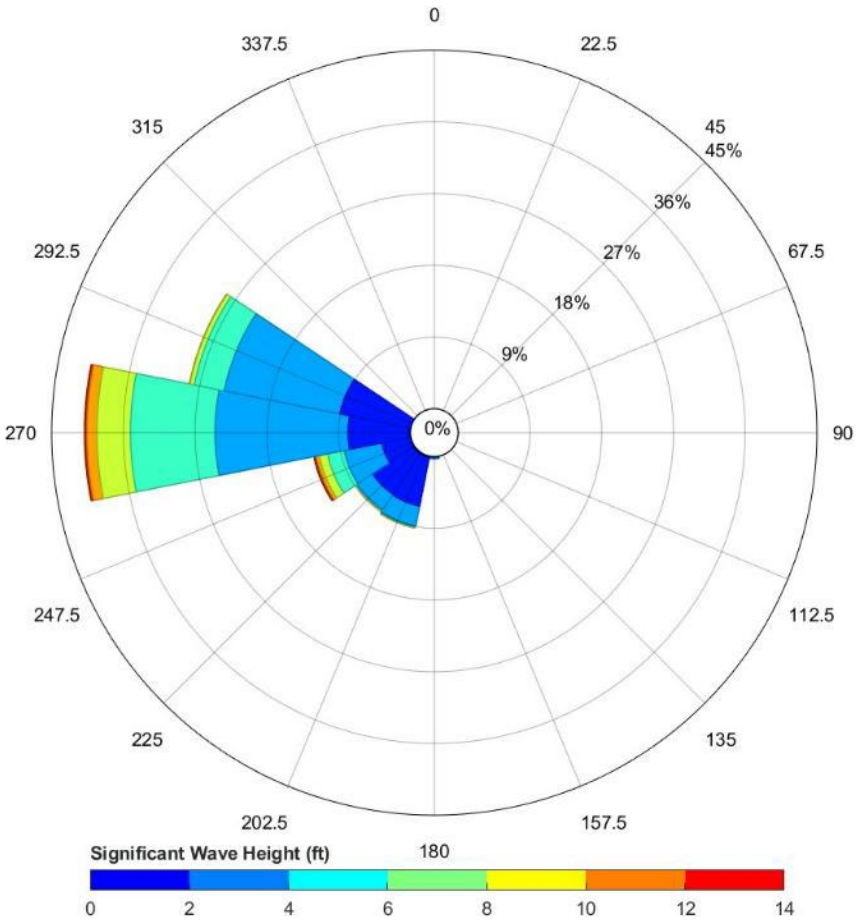


Figure 3 ***Wave orientation and significant height at CDIP Station 076 Diablo Canyon, 2019-2026.***

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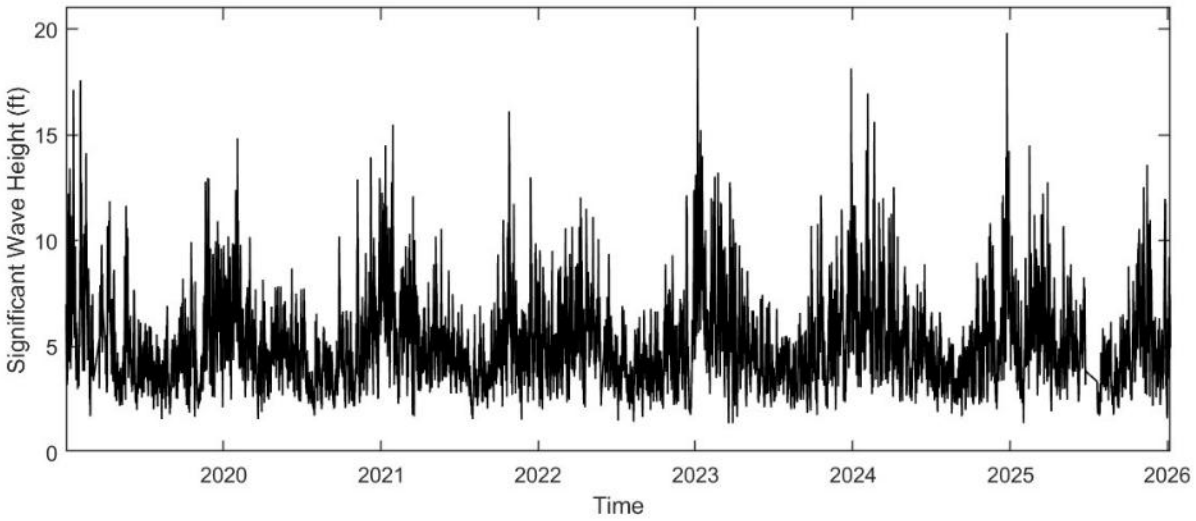


Figure 4 *Time series of significant wave height at CDIP Station 076 (Diablo Canyon) for the 2019–2026 period, highlighting typical seasonal conditions and episodic extreme events.*

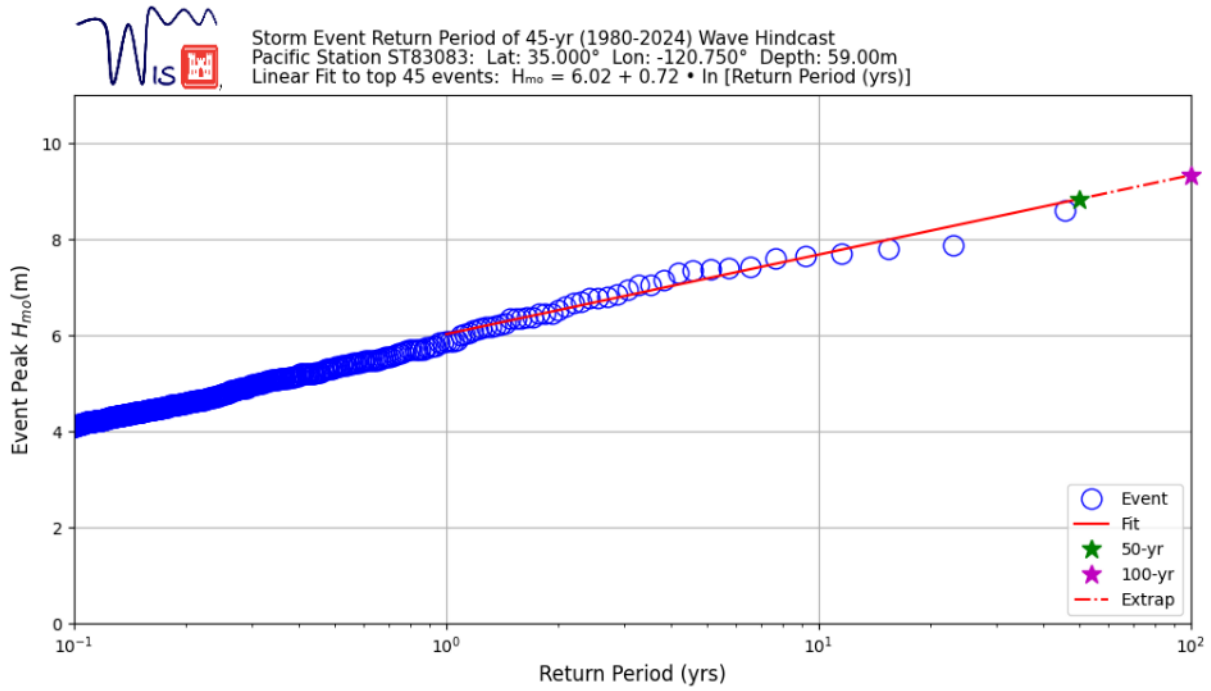


Figure 5 *Extreme value analysis of peak storm event significant wave heights at WIS Pacific Station ST38083.*

3.2.1 Nearshore Waves

Nearshore wave conditions vary considerably along the Pismo Beach coastline due to differences in shoreline orientation, bathymetry, and geomorphology. These factors influence the degree to which offshore wave energy reaches the shoreline and, ultimately, the types and severity of coastal hazards experienced in different parts of the City. Consistent with findings from the City's previous Vulnerability Assessment and Adaptation Plan, exposure to wave energy is not uniform and can vary substantially over relatively short distances due to local coastal features.

The northernmost portions of the shoreline, including The Bluffs, Sunset Palisades and South Palisades (Area 1), face generally south to southwest and are therefore partially sheltered from the predominant west-northwest swell that characterizes winter storm conditions along California's central coast. Throughout the bluff-backed reaches of

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Areas 1 through 4, nearshore bathymetry is generally steeper and characterized by rocky reefs, headlands, and pocket beaches. These geomorphic features interact with incoming waves in complex ways, sometimes refracting and focusing wave energy into localized areas and, in other cases, dissipating wave energy and providing partial shelter from storm impacts. As a result, wave exposure can vary significantly along adjacent shoreline segments, contributing to localized differences in erosion, bluff retreat, and wave runup hazards.

A major transition in coastal setting occurs in Area 5, where the shoreline shifts from predominantly bluff-backed geomorphology to a broad sandy beach system that extends to the southern City limit through Areas 6 and 7. Along these southern shoreline segments, the nearshore bathymetry becomes much flatter and more gradually sloping. Although these beaches are directly exposed to prevailing winter wave energy, the shallow nearshore profile causes waves to shoal and break farther offshore, dissipating a substantial portion of their energy before reaching the back beach. Consequently, wave-related hazards along these sandy shoreline segments are strongly influenced by water levels. During periods of elevated tides, storm surge, El Niño conditions, or future sea level rise, waves are able to propagate farther landward and exert greater influence on low-lying developed areas. Recent storm events, described in Section 3.4, have demonstrated that flooding and wave impacts along the downtown waterfront, Pismo State Beach, and other low-elevation coastal areas are often driven more by elevated water levels than by changes in offshore wave conditions alone.

The CDIP Monitoring and Prediction (MOP) system provides a useful quantitative basis for comparing nearshore wave exposure along this variable shoreline. MOP transects are available throughout the study area and provide nearshore wave conditions at a depth of ~50 feet (15m) based on buoy observations and a high-resolution spectral wave model that accounts for effects such as island blocking, refraction, and shoaling. The MOP data is available since 2000 and the largest wave events range from 12 to 26 feet throughout the study area, as shown in Figure 6. The MOP data illustrates how shoreline orientation, complex reef/headland bathymetry, and the transition from steep bluff-backed shorelines to flatter sandy beach morphology produces spatially variable exposure to wave energy and different hazard mechanisms.

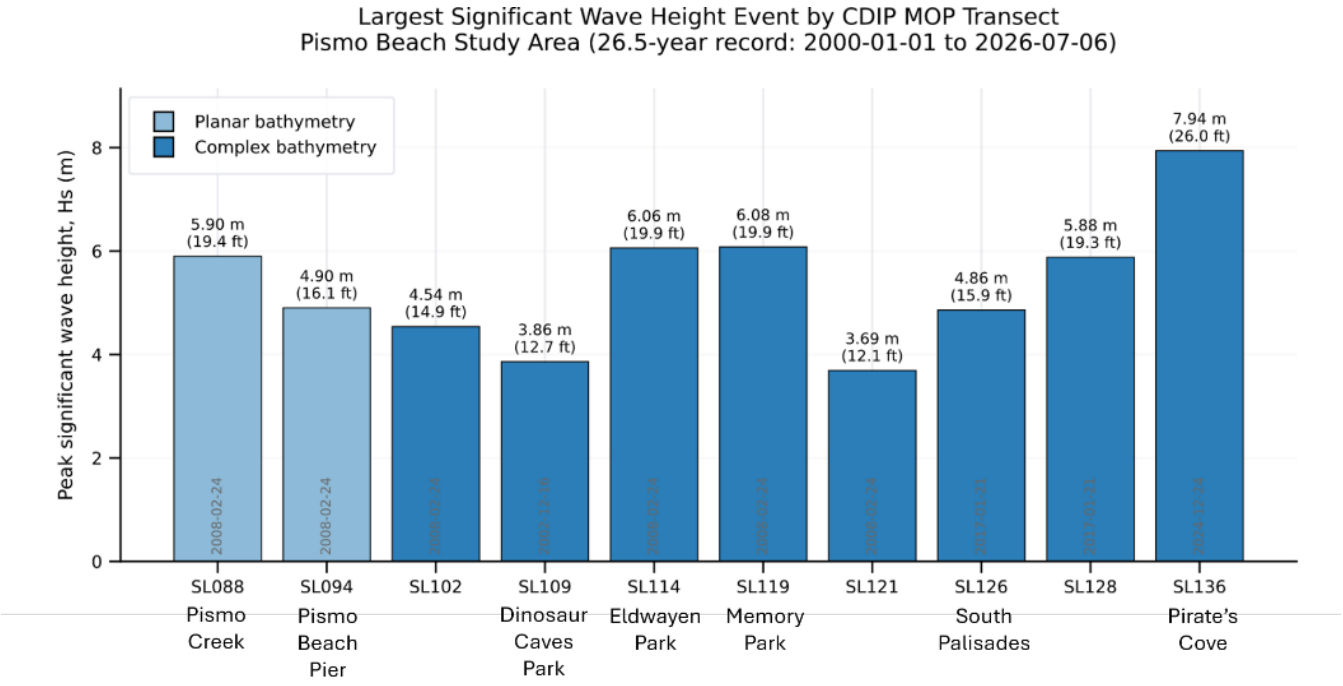


Figure 6 *Spatial Variability in Nearshore Wave Heights at Representative CDIP MOP Transects*

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3.3 Littoral Processes

3.3.1 Regional Sediment Movement

The City's shoreline lies within the Santa Maria littoral cell, named for the Santa Maria River that acts as its primary sediment source from about 10 to 15 miles south of the City (CCSMW 2016). This littoral cell is recognized to generally extend from Port San Luis in the northwest to Mussel Point in the south. Most sediment in the cell has historically been supplied by fluvial sources that currently have impaired sediment supply capabilities due to damming of their upstream tributaries (Moffatt & Nichol, 2001). The primary sediment sinks in this cell are wind-driven transport to the Oceano Dunes and Guadalupe-Nipomo Dunes, and cross-shore transport offshore beyond the depth of closure.

Early work found that this littoral cell exhibited a net southward sediment transport, resulting in sediment loss from the southern boundary of the cell. Subsequent analyses recognized that construction of the Port San Luis breakwater in 1913 likely altered local littoral processes by trapping sediment and limiting southward transport from areas north of Point San Luis, thereby reducing sediment supply to downcoast beaches such as Pismo Beach. Additional barriers to longshore transport have been identified at Fossil Point and the Shell Beach headlands. Additional information on prior studies of the Santa Maria littoral cell is provided in the City's SLR Vulnerability Assessment (Moffatt & Nichol, 2019).

3.3.2 Sandy Beach Change

The previous assessment found that beach width generally increased through the first half of the 20th century (Moffatt & Nichol, 2001). Since damming of the Santa Maria River, shoreline positions were described as relatively stable, with greater retreat toward the south near the river mouth.

Since the previous assessment, CoastSat, a new open-source toolkit was released by the University of New South Wales and USGS. CoastSAT creates time series of shoreline position from satellite imagery (Vos et al. 2019) providing a reliable database for evaluating annual shoreline change. For this update, CoastSat shorelines were derived from publicly available satellite imagery spanning 1984 to 2026 for Pismo Beach and Pirate's Cove Beach. Satellite imagery was unavailable for the smaller pocket beaches along the City's coast. An evaluation of CoastSAT data found that beach width remains stable at both Pismo Beach and Pirate's Cove Beach. More details on the trends at these beaches are provided in Chapter 5.

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3.4 Recent Coastal Storm Damage

Recent storm events provide important real-world examples of how waves, high tides, and coastal erosion can affect City infrastructure and public access today, and they help illustrate how future SLR may increase the frequency and severity of similar impacts. Since 2019, multiple storms have caused bluff failures and cracking, damage to beach access stairways, temporary closures of parks and trails, and costly repairs to public infrastructure.

October 2021

A storm event with wind speeds of 34.5 mph produced waves reaching up to 16 ft. The waves undermined the bluff supporting one of the pilings for the stairway at the end of Pier Avenue in Shell Beach (Figure 7), leading to closure of the stairway while damage assessments were initiated (Bertola, 2021; Russell, 2021). The damage assessments noted the Pier Avenue stairway had also experienced storm-related failures in 2003, 2005, and 2014, and a Coastal Development Permit for closure of the Pier Avenue Stairs was filed in 2025 (Bertola, 2021).



Figure 7 Bluff erosion at the Pier Avenue stairway (San Luis Obispo Tribune, October 26, 2021)

January 2023

A series of storms brought heavy rain and high surf that contributed to widespread coastal erosion and damage (Figure 8). During this event, wind speeds reached 41.4 mph and wave heights reached approximately 20 ft. In the Shell Beach/Dinosaur Caves area, City crews identified a significant crack extending from Ocean Boulevard toward the bluff edge near a popular bench overlook, prompting closure of the area due to expectations of additional erosion and potential bluff collapse (Hawkins, 2023). The City also reported continuing bluff erosion and related public safety closures in multiple locations, including the area adjacent to Spyglass Park, and estimated that public infrastructure damage from the January 2023 storm impacts was on the order of $17 million, noting that estimates could fluctuate as conditions evolved and additional impacts were documented (Buccio, 2023). Additionally, officials reported approximately 2–5 ft of beach and dune elevation loss and approximately 100 ft of beach width reduction at Pismo Beach and Oceano Dunes during the January 2023 storm period, underscoring the magnitude of wave-driven erosion possible during high-energy events (Franco, 2023). The same storm sequence also produced substantial inland and backshore flooding impacts in the greater area; for example, a levee failure in Oceano caused significant flooding that stranded residents at the North Beach Campground for an extended period until floodwaters receded (White, 2023).

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Figure 8 Storm impacts from the January 2023 storm sequence, including bluff cracking near Ocean Boulevard (left) and bluff erosion in the Spyglass area (right) (San Luis Obispo Tribune, January 2023; KSBY News)

January 2024

Another North Pacific storm generated long-period swell and high surf combined with elevated tides that again damaged coastal infrastructure and produced erosion impacts. City reporting indicated that waves reached 15-25 ft, damaging multiple beach access stairways near Pier Plaza and beachside swing sets and volleyball courts. Flooding damaged coastal properties and deposited sediment onto roadways (Figure 9). Structural damage at the Chapman Estate was also reported (Wernik, 2024; Huijon, 2024). Estimated near-term repair costs for City facilities were reported at approximately $55,000, and the storm resulted in temporary loss of public access and recreational amenities while repairs and cleanup were completed, which included fixing the three wooden stairways and swing set adjacent to the Pier Plaza (Wernik, 2024).



Figure 9 High-surf storm impacts during the January 2024 event, showing damage to coastal access infrastructure and beach amenities in the Pier Plaza/Downtown Core area (KCBX, January 3, 2024)

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4. Sea Level Rise

SLR refers to the long-term increase in average ocean water levels. Although sea levels rise gradually over decades, SLR does not act alone; its impact is often greatest when combined with high tides, storm surge, waves, and river flows. Therefore, even small SLR increases can significantly affect coastal communities by increasing the frequency of coastal flooding and wave overtopping and accelerating beach and bluff erosion.

This chapter describes how SLR and related coastal hazards were evaluated for the City. The analysis focuses on understanding where and how coastal flooding, erosion, and other hazards may occur over time as sea levels increase. The results presented in this chapter form the technical basis for the vulnerability assessment discussed in Section 6.

4.1 Projections and Probability

SLR projections describe a range of possible future water levels rather than a single predicted outcome. These projections account for uncertainty related to greenhouse gas emissions, ice sheet behavior, and global climate response.

The 2019 SLR Vulnerability Assessment evaluated five potential SLR futures for the years 2050-2100. This assessment relies on the updated 2024 SLR scenarios provided by the State of California SLR Guidance (OPC 2024), specifically those projections for the Port San Luis tide gauge. Below is a table comparing the previous assessment scenarios to the 2024 SLR scenarios to reflect how the anticipated timing of various sea levels has shifted.

A notable advancement in the 2024 California SLR science is the increased understanding of how low confidence processes (e.g., ice-shelf disintegration, marine ice-sheet-ice-cliff instability, and faster-than-projected changes in surface-mass balance) are anticipated to affect sea levels near the end of the century (OPC 2024). As a result, the H++ scenario was determined to no longer be physically realistic for 2100. Instead, the 2024 Intermediate-High and High scenarios now account for plausible rapid ice sheet processes.

Table 2 Comparison of SLR Projections from OPC 2018 and OPC 2024 Guidance

Year	OPC 2018 Scenarios		OPC 2024 - Port San Luis Scenarios				
	Medium-High Risk Aversion	H++	Low	Int-Low	Int	Int-High	High
2050	1.6	-	0.3	0.5	0.6	0.9	1.1
2070	3.3	-	0.5	0.7	1.2	2.0	2.7
2080	4.3	-	0.5	0.9	1.6	2.8	3.8
2100	6.7	9.9	0.6	1.2	2.8	4.5	6.3

To support long-range land use and adaptation planning, the OPC 2024 SLR guidance and the subsequent 2024 California Coastal Commission (CCC) SLR Guidance recommend evaluating future vulnerabilities using the Intermediate, Intermediate-High, and High scenarios. The assumptions about the probability behind these scenarios is described below:

Intermediate Scenario: This scenario represents a future with high emissions and thus higher global warming and is considered a reasonable estimate for the upper bound of the most likely SLR in 2100 (OPC 2024).

Intermediate-High Scenario: This scenario is representative of a world where rapid ice sheet loss processes contribute to SLR, associated with intermediate to high future emissions, and high warming (OPC 2024). This corresponds to scientific estimates for plausible high-end SLR projections by 2100.

High Scenario: This scenario is representative of rapid ice sheet loss processes due to high future emissions and high warming that result in global warming exceeding 4°C in 2100. The likelihood of this

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scenario is not possible to state; however, it can be used to evaluate worst-case scenarios and potential impacts.

In consideration of the updated OPC 2024 scenarios, three planning horizons were established for this Assessment. These planning horizons were determined to be representative of the projected Intermediate-High SLR scenario increases for the Near, Mid, and Long Term. Various models and data were used for investigated hazards so the increment of SLR is slightly different for each as described in Table 3.

Table 3 Representative OPC SLR and USGS CoSMoS model scenarios for each planning horizon

Planning Horizon	Year	OPC 2024 Intermediate-High Scenario (ft)	SLR (ft) used for flooding hazard and shoreline erosion assessments	SLR (ft) used for bluff erosion assessments
Near-term	2050	0.9	1.6	1.0
	2060	1.4		
Mid-term	2070	2.0	3.3	2.8
	2080	2.8		
	2090	3.5		
Long-term	2100	4.5	4.9	n/a
	2110	5.3		

Sea level rise projections and associated coastal hazard assessments are inherently uncertain because they depend on a range of factors, including future greenhouse gas emissions, climate system responses, ice sheet dynamics, storm frequency and intensity, sediment supply, and site-specific coastal processes. As a result, the hazard extents and vulnerability findings presented in this assessment should be viewed as planning-level estimates intended to identify potential future conditions, relative risk, and adaptation needs rather than precise predictions of when or where impacts will occur.

Small differences in sea level rise elevations between planning horizons are due to limitations in publicly available datasets and the discrete water level increments available within existing hazard models. These minor differences, typically on the order of tenths of a foot, are not expected to materially affect the overall conclusions of this assessment. Instead, greater emphasis should be placed on the broader trends in coastal change and the identification of thresholds or tipping points where hazards, vulnerabilities, infrastructure exposure, or adaptation needs increase substantially. For long-term planning purposes, understanding these transitions is generally more important than distinguishing impacts associated with small incremental differences in sea level rise.

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5. Coastal Hazards

The type and extent of coastal hazards depends on the shoreline characteristics which vary throughout the study area. Within the City's coastal zone, hazards include shoreline and bluff erosion, coastal flooding, groundwater emergence and fluvial flooding. A variety of hazard analysis methods and models were used to effectively capture the distinct coastal characteristics and hazard exposure within each of the planning areas as described in Table 4. This is followed by a summary of how hazard assessments were updated since the 2019 assessment and where new science was used to address gaps.

Table 4 Summary of Hazards Evaluated for Each Planning Area

	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
Bluff Erosion (SIO/GHD)	✓	✓	✓	✓	✓		
Coastal Flooding (CoSMoS & EurOtop)					✓	✓	✓
Fluvial Flooding (FEMA & GHD)						✓	✓
Compound Flooding (GHD)						✓	✓
Shoreline Erosion (CoastSat, CoSMoS-COAST, Bruun)	✓				✓	✓	✓
Groundwater Flooding (USGS CoSMoS-GW)						✓	✓

5.1 Bluff Erosion

As sea levels rise, waves are expected to reach coastal bluffs more frequently, leading to an increase in bluff erosion over time (Barnard et al., 2019). Bluff retreat has historically been measured based on bluff-top recession, but newer technologies now also allow measurement of change along the bluff face.

Previous studies of Pismo Beach bluffs reported long-term bluff-top retreat of approximately 0.33 ft per year (Hapke, Reid, Richmond, Ruggiero, & List 2006; Fugro West, Moffat &Nichol 2002). Since 2021, the Scripps Institution of Oceanography (SIO) Coastal Processes Group has used LiDAR surveys to develop more detailed estimates of bluff-top and bluff-face retreat across California. The rates along Pismo Beach's coastline are summarized in Table 5 for 1-kilometer (km) sections. These illustrate that bluff-top retreat rates are generally similar in magnitude to earlier estimates ranging from 0.00 to 0.30 ft/year. Whereas bluff-face erosion rates can be greater ranging from 0.01 to 0.53 ft/year (Young 2018; Swirad & Young 2021, 2022a, 2022b; Xie 2026).

Table 5 Historic bluff-top and bluff-face retreat rates in the City of Pismo Beach, summarized by 1 km sections (Young 2018; Swirad & Young 2021, 2022a, 2022b; Xie 2026)

Time Period	Bluff Section (# km from the California-Mexico Border)							
	572-573	571-572	570-571	569-570	568-569	567-568	566-567	565-566
Mean Bluff Top Retreat Rate (ft/yr)								
1998 - 2010	0.12	0.17	0.25	0.04	0.04	0.30	0.22	0.26
2010 - 2016	0.10	0.04	0.16	0.23	0.03	0.26	0.00	0.00
2016 - 2023	0.01	0.08	0.20	0.03	0.04	0.06	0.00	0.00
Mean Bluff Face Retreat Rate (ft/yr)								
1998 - 2010	0.14	0.25	0.42	0.22	0.17	0.34	0.20	0.06
2010 - 2016	0.21	0.07	0.20	0.15	0.07	0.12	0.02	0.01
2016 - 2023	0.16	0.19	0.20	0.20	0.21	0.53	0.27	0.06

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To estimate future bluff retreat, this Assessment uses SIO Coastal Processes Group data to develop linear extrapolation for the 2050 and 2080 time horizons. This approach was selected instead of the USGS CoSMoS bluff retreat model because the SIO data capture the spatial variability of the bluffs by providing distinct retreat rates for 1-km bluff sections along the City's shoreline. It also enabled the inclusion of existing shoreline protection data from the California Coastal Armoring Database and assumptions about the lifespan of these structures and their capacity to provide wave protection as sea levels rise.

Using this method, Near-term bluff retreat (to 2050) was estimated only for unarmored segments of the shoreline. Although 1 ft of SLR was not explicitly modeled, existing shoreline armoring was assumed to provide sufficient protection under this increment of SLR. For the Mid Term scenario (2080), the Intermediate-High scenario projects 2.8 ft of SLR. Increasing the frequency of wave runup and exposure higher on the bluff face. Under these conditions, it is assumed that any existing armoring would have deteriorated and/or no longer provide effective protection, resulting in accelerated erosion as armored segments adjust toward retreat positions comparable to currently unarmored areas. While this methodology could be extended to the Long-Term scenario (2100), it was not applied due to increasing uncertainty and the episodic nature of bluff erosion, which could lead to over- or under-estimation of hazard extents.

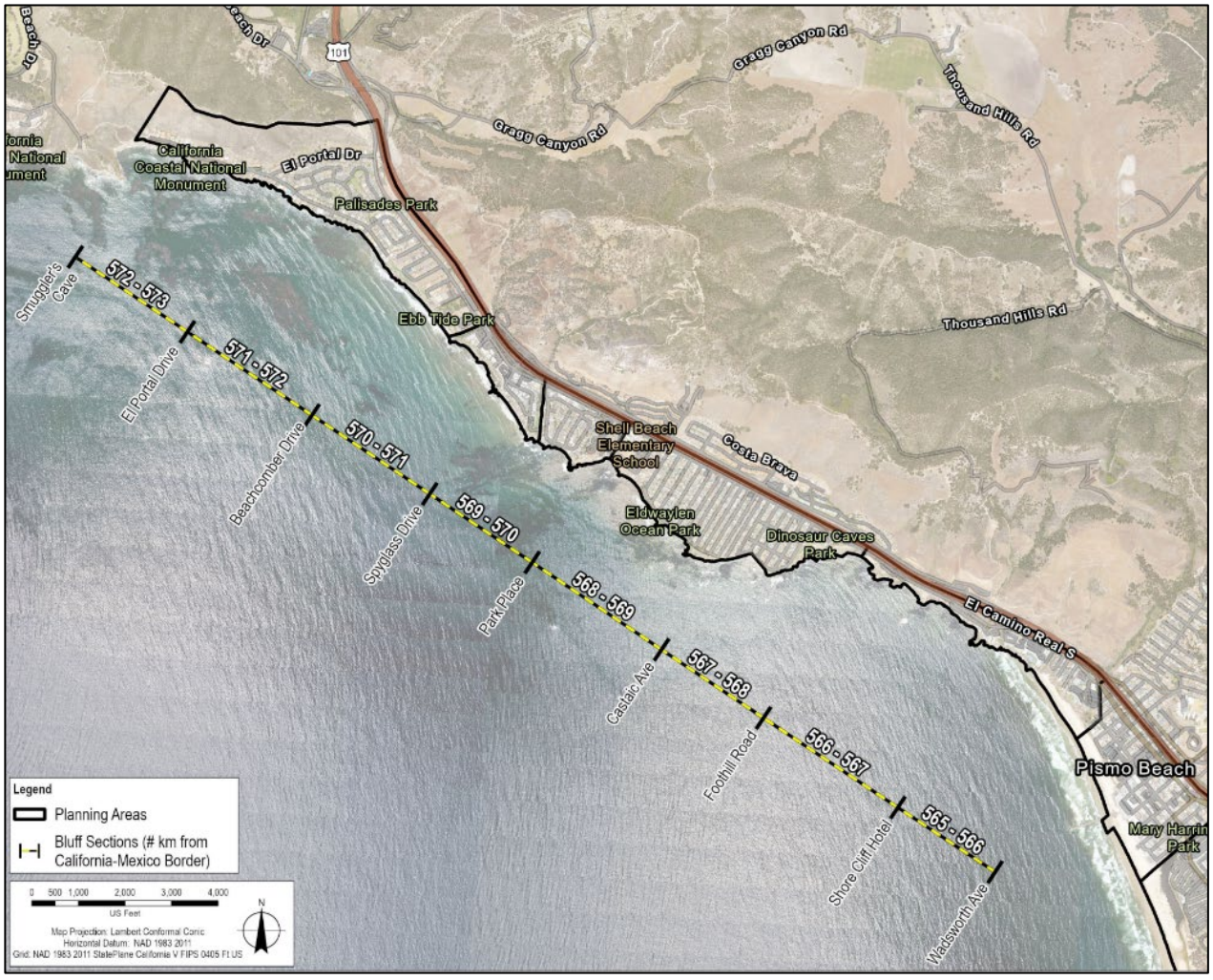


Figure 10 Map of 1- km areas used for summarizing historic bluff retreat rates along the City's coastline

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5.2 Beach and Shoreline Change

Since completion of the 2019 Vulnerability Assessment, several new datasets have become available that provide a more detailed understanding of shoreline behavior and future coastal hazards. Most notably, this update incorporates historical shoreline analyses derived from CoastSat and future shoreline projections from the USGS Coastal One-line Assimilated Simulation (CoSMoS-COAST) model. CoastSat uses satellite imagery to map shoreline position over time, providing an approximately 40-year record (1984–2026) of shoreline variability and long-term trends. CoSMoS-COAST builds upon these historical trends by simulating future shoreline response under a range of sea level rise (SLR) scenarios while accounting for shoreline processes, sediment transport, and changing coastal water levels.

To complement the CoastSat and CoSMoS-COAST analyses, a simplified shoreline recession assessment was conducted using the Bruun Rule, a commonly applied conceptual method for estimating shoreline retreat associated with sea level rise (Bruun, 1962). The Bruun Rule is based on a two-dimensional sediment mass conservation principle and assumes that the active beach profile responds to rising sea levels through a landward and upward translation while maintaining its overall shape. Under this concept, sediment eroded from the upper beach is redistributed offshore across the active profile, resulting in long-term shoreline recession.

The Bruun Rule is commonly used as a screening-level tool to evaluate the relative sensitivity of beaches to sea level rise by estimating the magnitude of shoreline recession associated with rising water levels. Because the method does not account for factors such as longshore sediment transport, shoreline armoring, sediment supply, wave climate variability, or other complex coastal processes, the results should be interpreted as order-of-magnitude estimates rather than predictions of future shoreline position. Nevertheless, the approach provides a useful basis for comparing recession rates from SLR to those observed from CoastSat.

5.2.1 Pismo Beach

The CoastSat analysis highlights important differences between the broad sandy beach characteristic of Pismo Beach (Figure 11) and the smaller pocket beaches that characterize the northern bluff-backed shoreline. Along Pismo Beach, the shoreline experiences substantial seasonal variability due to changes in wave climate as illustrated in Figure 12, at a transect ~300 feet south of Pismo Pier. The beach has a relatively flat profile, with an average slope of approximately 30:1 (horizontal:vertical), allowing shoreline position to fluctuate by approximately 200 to 300 feet between seasons. Wider beach conditions typically occur during late summer and fall when wave energy is lower, while narrower beach conditions are common during winter and spring when higher-energy wave conditions transport sediment offshore. The largest erosional excursions observed in the CoastSat record correspond to major El Niño winters, particularly the 1982–1983, 1997–1998, and 2015–2016 events, which produced unusually energetic wave conditions and significant beach erosion throughout California. Despite these episodic erosional events, the long-term trend at Pismo Beach remains strongly accretionary, with shoreline advance averaging approximately 2.8 feet per year since 1984. This persistent accretion trend suggests that natural sediment supply and shoreline recovery processes have generally outpaced the effects of SLR and other erosional forces over the period of record. A continuation of this trend will partially offset the near-term effects of SLR.



Figure 11 Pismo Beach, wide sandy beach typical of Areas 6 and 7

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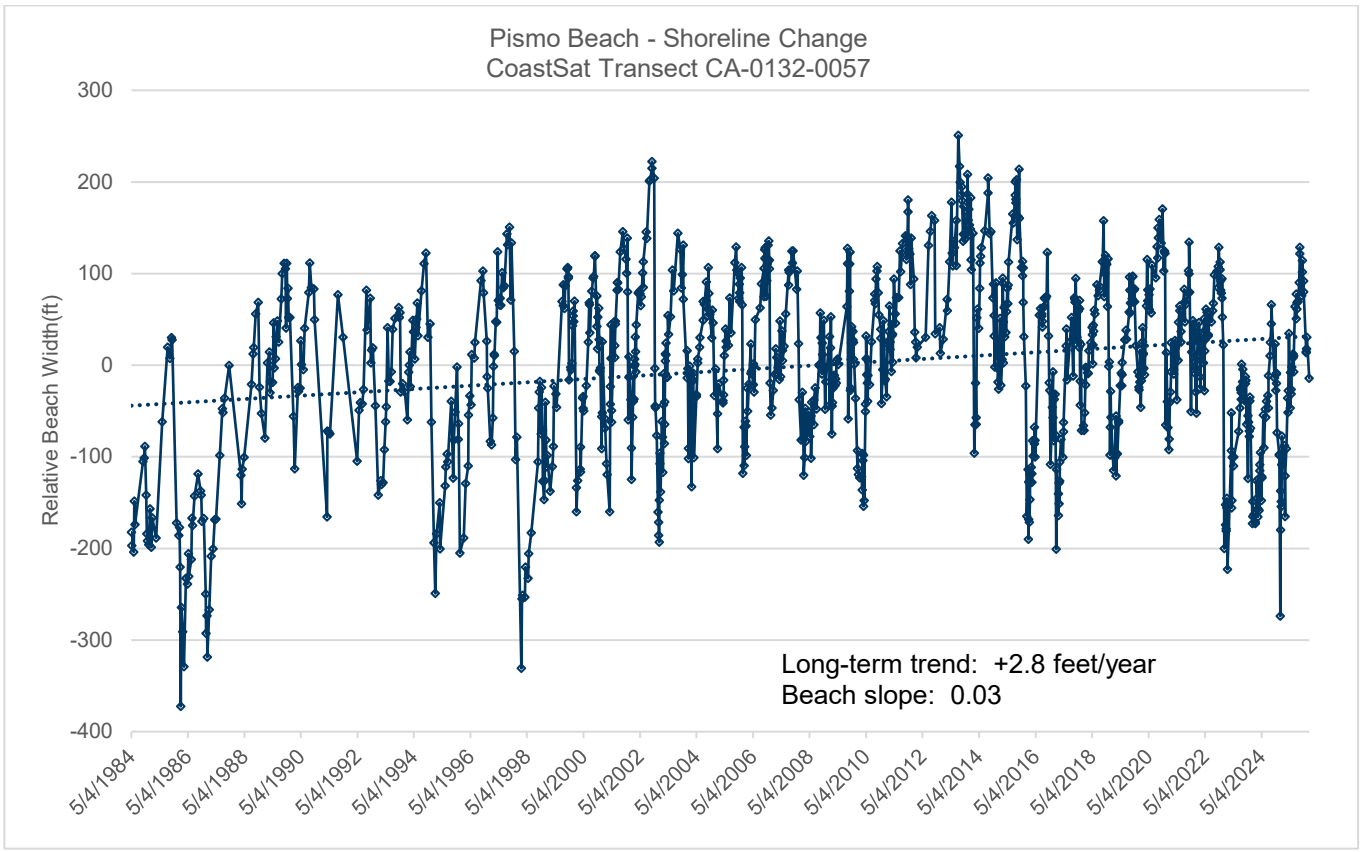


Figure 12 Pismo Beach Shoreline Change - CoastSat Data 1984-2026

Future shoreline projections from CoSMoS-COAST indicate that the recent accretionary trend at Pismo Beach is likely to continue under lower SLR scenarios over the near term. Bruun Rule calculations for Pismo Beach support this finding with estimated recession rates ranging from approximately -1 to -2 ft/yr for near-term and mid-term SLR scenarios. Because the observed rate of accretion exceeds the estimated recession rates associated with sea level rise, the results suggest that Pismo Beach is relatively resilient to the near- and mid-term effects of sea level rise.

As SLR increases over the long-term, however, the ability of the shoreline to maintain this positive sediment balance is expected to diminish. Under higher SLR scenarios, the rate of sea level rise eventually exceeds the natural accretion rate, causing shoreline behavior to transition from gradual growth to net retreat. While Pismo Beach is expected to remain a relatively wide and resilient beach system compared to other areas of the City, higher SLR scenarios will likely result in progressive beach narrowing and increased landward migration of the shoreline. These effects will be most noticeable during winter months when seasonal and storm-related erosion will likely push the shoreline back to the line of development or base of bluff.

5.2.2 Pirate's Cove

The CoastSat record for Pirate's Cove, which serves as a representative analogue for the pocket beaches present throughout Areas 1 through 4, demonstrates a markedly different shoreline response than observed along the broad and flat Pismo Beach. Pirate's Cove has a steeper beach profile, approximately 8:1 (horizontal:vertical), reflecting the confined geomorphology and more complex bathymetry typical of the northern study area. Seasonal shoreline fluctuations are considerably smaller than those observed at Pismo Beach, generally ranging between 60-100 feet as illustrated in Figure 13 at a transect located at the eastern side of the cove. CoastSat data indicate a slight long-term trend of accretion, but at a much lower rate than observed at Pismo Beach. The shoreline appears to be quasi-stable, fluctuating within a relatively consistent range of beach widths over the period of record. This stability is a positive indicator because it suggests that the beach has generally maintained equilibrium despite episodic storm impacts and SLR observed over recent decades.

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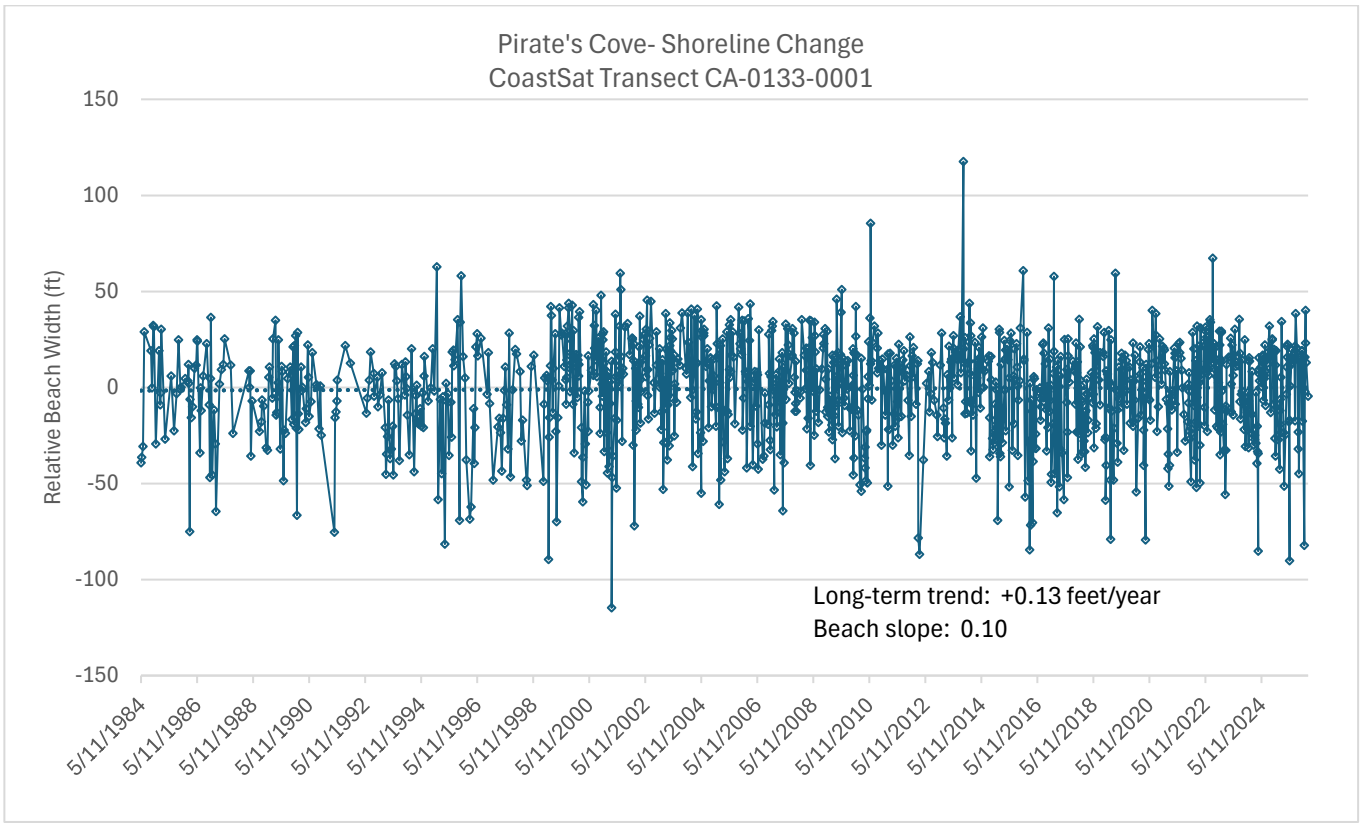


Figure 13 Pirate's Cove Shoreline Change - CoastSat Data 1984-2026

Although Pirate's Cove and similar pocket beaches have remained relatively stable historically, they are likely to be more vulnerable to future SLR than Pismo Beach. CoastSat data indicate a slight accretionary trend and generally stable beach width over the period of record; however, this modest rate of accretion is unlikely to fully offset the erosional effects of sea level rise over the near term.

Bruun Rule calculations for Pirate's Cove indicate recession rates ranging from approximately -0.5 to -1 ft/yr for near-term and mid-term SLR scenarios. Although these rates are smaller in magnitude than those estimated for Pismo Beach, they are substantially larger relative to observed historical shoreline trends. As SLR accelerates over the coming decades, many of these pocket beaches are expected to transition from their current quasi-stable condition toward a more persistent erosional trend. Progressive beach narrowing would reduce the natural buffer between waves and coastal bluffs, allowing wave energy to act more frequently and directly at the bluff toe and increasing the potential for future bluff erosion and shoreline instability.

Although CoSMoS-COAST projections were evaluated for several beaches within the northern study area, their usefulness is limited for Areas 1 through 4 due to the complex geomorphic conditions that characterize these pocket beaches. Shoreline behavior in these areas is strongly influenced by headlands, rocky reefs, variable sediment supply to/from adjacent beaches, and the dynamic interaction between beach erosion and bluff retreat processes. These site-specific factors are difficult to resolve using regional-scale shoreline modeling framework available from CoSMoS-COAST.

5.3 Coastal Flooding

This assessment evaluates future coastal flooding hazards using three complementary approaches: (1) regional-scale coastal flood mapping from the USGS Coastal Storm Modeling System (CoSMoS), (2) site-specific wave runup and overtopping analyses using EurOtop methods for the Downtown Core shoreline, and (3) coastal groundwater emergence projections for low-lying portions of the Pismo Creek and Pismo Marsh area. Together, these analyses provide a more complete understanding of future flooding mechanisms than was available in the City's 2019 Vulnerability Assessment. The evaluation recognizes that no single modeling tool adequately captures all flooding pathways and that different hazard mechanisms govern vulnerability across different portions of the shoreline.

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5.3.1 USGS CoSMoS Coastal Flooding

The USGS Coastal Storm Modeling System (CoSMoS) remains the primary source of regional coastal flood hazard information for this assessment and provides continuity with the methodology used in the City's 2019 Vulnerability Assessment. CoSMoS simulates coastal flooding under a range of sea level rise and storm conditions and provides spatially explicit flood extents for coastal planning purposes. Flood projections are available for multiple SLR increments and storm return periods, allowing the City to evaluate potential exposure under a broad range of future conditions. This assessment utilizes CoSMoS results corresponding to approximately 1.6 ft, 3.3 ft, and 4.9 ft of SLR to represent the near-, mid-, and long-term planning horizons, respectively.

Although CoSMoS provides a valuable planning-level assessment of coastal flood hazards, it has limitations in areas where flooding is controlled by localized wave runup and overtopping processes. These limitations are particularly important within the Downtown Core (Area 6), where seawalls, beach access structures, elevated backshore areas, and complex shoreline features strongly influence how storm waves interact with the developed waterfront. Comparison of CoSMoS flood projections with observed flooding during the January 2024 storm event suggests that flooding extended substantially farther inland along portions of Addie Street and Park Avenue than would be predicted by CoSMoS even under higher SLR scenarios. These observations indicate that coastal flooding within the Downtown Core is often driven by wave overtopping processes that are not fully represented within the regional-scale CoSMoS model.

Because of these limitations, the updated Vulnerability Assessment uses CoSMoS flood mapping as the primary basis for evaluating coastal flooding hazards in the low-lying shoreline areas outside of the Downtown Core, where regional flooding processes are well represented by the model. Within the Downtown Core (Area 6), however, CoSMoS results were supplemented with a site-specific wave runup and overtopping analysis to better evaluate flooding thresholds associated with rising sea levels and storm wave conditions.

5.3.2 Wave Runup and Overtopping Assessment (Downtown Core)

To improve the evaluation of coastal flooding hazards within the Downtown Core, a site-specific wave runup and overtopping analysis was conducted using methods described in the EurOtop Manual (2018). EurOtop provides internationally accepted guidance for evaluating wave overtopping of coastal structures and is widely used to assess flooding hazards where seawalls, revetments, promenades, and other coastal protection features influence the magnitude and extent of wave induced flooding.

The analysis focused on the seawalls and backshore infrastructure along the Downtown Core, where recent storm events have demonstrated that wave overtopping can be a significant mechanism for coastal flooding. EurOtop methods were used to estimate overtopping discharge rates under combinations of future SLR and storm wave conditions. Overtopping discharge represents the volume of water passing over a coastal structure and provides a quantitative measure of potential flood severity. Resulting overtopping rates were compared against established EurOtop and Coastal Engineering Manual (CEM) guidance that relates overtopping rates to risks for pedestrians, vehicles, infrastructure, and coastal structures. To provide a consistent framework for evaluating overtopping-related impacts, several representative overtopping thresholds were applied in this assessment:

- **Pedestrian Safety Threshold –1 L/s/m:** Applied to identify conditions that may become hazardous for pedestrians walking adjacent to seawalls and coastal structures. This threshold is based on EurOtop guidance for wave heights on the order of approximately 2 m and represents conditions where overtopping discharges can create unsafe walking conditions.
- **Vehicle Safety Threshold – 10–20 L/s/m:** Applied to roadways and parking areas located landward of coastal protection structures. Based on EurOtop guidance for wave heights of approximately 2 m, overtopping discharges within this range are associated with hazardous driving conditions and potential loss of vehicle control.
- **Structural Damage Threshold – 50 L/s/m:** Applied to seawalls and coastal protection structures based on Coastal Engineering Manual (CEM) guidance for seawalls with a protected or paved back slope. Overtopping rates above this threshold may result in structural damage, accelerated deterioration, or maintenance concerns.

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Building and infrastructure damage thresholds are more difficult to define because susceptibility varies based on structure type, elevation, condition, foundation characteristics, and the pathways through which floodwaters can enter a site. Therefore, building-specific damage assessments were outside the scope of this study. However, the onset of damage to buildings and adjacent infrastructure is generally expected to occur within a similar range of overtopping discharges associated with pedestrian and vehicle safety concerns. These thresholds were used to identify the approximate SLR and storm conditions at which overtopping hazards transition from nuisance flooding to impacts affecting public safety, transportation access, and coastal infrastructure.

Unlike CoSMoS, which primarily evaluates flood extents at a regional scale, the EurOtop approach provides insight into the specific SLR thresholds at which wave overtopping begins to occur and how flood severity may increase as water levels rise. This information allows for a more realistic assessment of flooding vulnerability within the developed waterfront area where relatively small increases in water level may significantly increase overtopping frequency and flood impacts. The results of the EurOtop analysis, including estimated overtopping thresholds and projected flooding conditions under future SLR scenarios, are discussed in the Area 6 vulnerability assessment.

5.3.3 Coastal Groundwater Emergence

In addition to surface flooding, rising sea levels can cause groundwater levels to rise in coastal areas. This process, known as coastal groundwater emergence, can result in flooding from below ground even when the land surface is not directly inundated by ocean water. An assessment of groundwater flood hazards due to SLR was not conducted in previous studies but is considered an important gap to understand for future development within the City.

Recently, the USGS conducted numerical modeling to project coastal areas that may be vulnerable to elevated groundwater levels driven by SLR (Befus et al. 2020). This USGS groundwater flooding projection tool provides a simplified overview of potential groundwater flooding areas. Since little is known about the groundwater geology in the City, a “moderate” subsurface geology was selected in this tool to represent a moderately permeable and deep, water table. For the purposes of this assessment, groundwater flooding hazards are identified as areas where the water table is projected to be elevated into a shallow zone, 0 m to 1 m below ground surface (bgs), or projected to emerge above ground surface (ags) assuming “moderate” subsurface geology.

5.4 Compound Flooding (Pismo Creek/Marsh)

Low-lying areas near the Downtown Core and Pismo Creek are particularly sensitive to coastal flooding due to their elevation and proximity to both ocean and creek processes. Existing regulatory flood zones provide some context for understanding flood exposure within the project area. Figure 14 presents the FEMA Flood Insurance Rate Map (FIRM) coverage for the southern portion of the project area (Areas 6 and 7). The FIRM depicts flood hazards from a 100-year fluvial storm event, but doesn’t account for the effects of sea level rise which will further compound flooding at the mouth of Pismo Creek and confluence with Meadow Creek.

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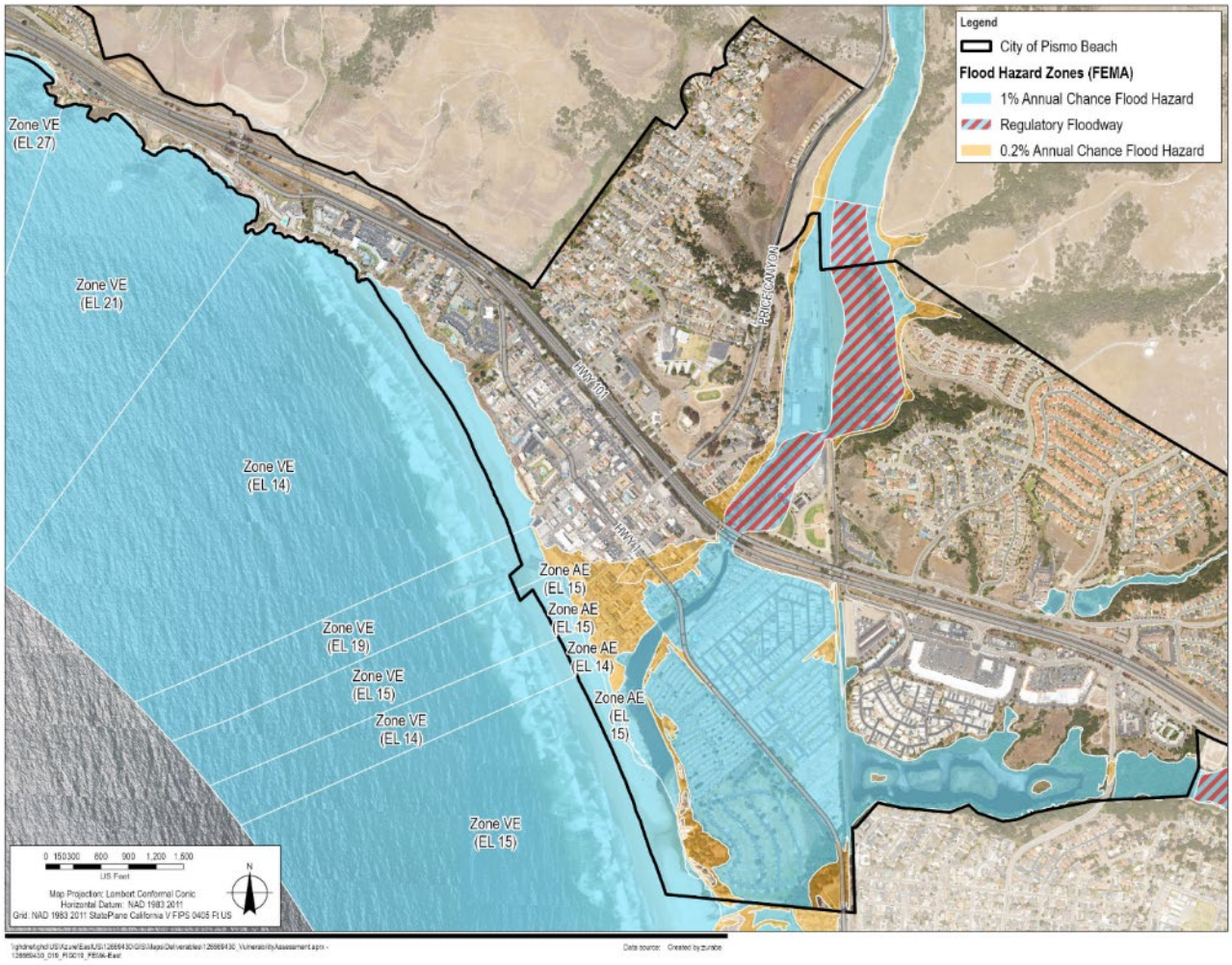


Figure 14 FEMA Flood Insurance Rate Map (FIRM) panel (No. 06079C1344H) for the project area (south panel).

5.4.1 Hydraulic Modeling Approach

A two-dimensional (2D) hydraulic model was developed using the U.S. Army Corps of Engineers HEC-RAS software (version 7.0.1) to evaluate compound fluvial and tidal flooding within the Pismo Creek and Meadow Creek system under existing and future sea level rise (SLR) conditions. The model build was based on available Federal Emergency Management Agency (FEMA) models, including a one-dimensional (1D) Pismo Creek model obtained from the City of Pismo Beach and a 2D Meadow Creek model obtained from San Luis Obispo County. The FEMA Meadow Creek 2D model served as the foundation for the model created for this analysis, and the domain was expanded to incorporate Pismo Creek and adjacent low-lying areas. The final model domain covers Pismo Creek from the Pacific Ocean to the existing bridge at Bello Street, located upstream of the Pismo Beach Wastewater Treatment Plant.

Model geometry incorporated bridge representations from both FEMA models. The model terrain was primarily based on the FEMA Meadow Creek terrain and supplemented with publicly available U.S. Geological Survey (USGS) 1-meter lidar (FEMA Region 9, 2017). Targeted terrain modifications were performed within HEC-RAS RAS Mapper to improve representation of channel bathymetry and coastal conditions. In the lower reach of Pismo Creek, the channel invert elevations were refined using data from the FEMA 1D model, which was assumed to better represent the channel geometry. Additional grading was applied to transition the creek to coastal boundary elevations and maintain hydraulic continuity at the ocean interface.

The model was used to simulate a suite of tidal-only and combined fluvial-tidal scenarios representing a range of hydrologic and oceanographic conditions, as summarized in Table 6. Tidal boundary conditions were based on a representative king tide event (January 3, 2026) from NOAA Station 9412110. For combined fluvial-tidal scenarios, the tidal signal was scaled to reflect mean higher high water (MHHW) peak conditions. Fluvial inputs included 10-year and 100-year flow hydrographs derived from the FEMA models. Pismo Creek inflow hydrographs were

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developed by scaling a Meadow Creek hydrograph to match the 10-year and 100-year peak discharges reported in the Flood Insurance Study.

Sea level rise was incorporated into model boundary conditions using three representative increments (1.6 ft, 3.3 ft, and 4.9 ft), corresponding to near-, mid-, and long-term planning horizons. For combined fluvial–tidal scenarios, peak river discharge was temporally aligned with peak tidal water levels to represent conservative compound flood conditions. Each simulation was run over an 18-hour period to capture the full evolution of tidal forcing and fluvial hydrographs. Please refer to Section 6.7 for a discussion of these modeling results.

Table 6 Summary of hydraulic modeling scenarios

	Scenario	Tidal Boundary Condition	Fluvial Event
Tidal Only	1	King tide sequence plus 1.6 SLR	-
	2	King tide sequence plus 3.3 SLR	-
	3	King tide sequence plus 4.9 SLR	-
Fluvial/Tidal	4	King tide sequence scaled to MHHW peak	10yr
	5	King tide sequence scaled to MHHW peak, plus 1.6 SLR	10yr
	6	King tide sequence scaled to MHHW peak, plus 3.3 SLR	10yr
	7	King tide sequence scaled to MHHW peak	100yr
	8	King tide sequence scaled to MHHW peak, plus 1.6 SLR	100yr
	9	King tide sequence scaled to MHHW peak, plus 3.3 SLR	100yr

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6. Vulnerability Assessment

This chapter evaluates the vulnerability of coastal resources, infrastructure, development, and public access assets within each of the seven planning areas in the City of Pismo Beach. The neighborhood-scale assessment is organized to reflect the distinct physical settings and dominant hazard mechanisms described in the preceding chapters. This structure supports comparison of vulnerabilities across the City while providing the local detail needed to inform adaptation planning and policy development at the neighborhood scale.

The seven planning areas generally fall within four coastal settings that experience different combinations of hazards.

– Areas 1 through 4 are primarily bluff-backed shoreline areas where vulnerability is driven by episodic bluff erosion, narrowing or loss of pocket beaches, damage to coastal accessways, and exposure of stormwater outfalls and bluff-edge development.
– Area 5 forms a transition between the bluff-backed shoreline and the wider sandy beach system, with vulnerabilities associated with both bluff erosion and changing beach width along the north end of Pismo Beach.
– Area 6 includes the Downtown Core, where the wide sandy beach provides an important buffer but low-lying backshore development, beach access facilities, shoreline protection infrastructure are increasingly sensitive to coastal storm flooding, wave runup, overtopping during extreme events.
– Area 7 includes the Pismo Creek and Pismo Marsh low-lying area, where vulnerability is shaped by the interaction of tidal flooding, coastal storm flooding, fluvial flooding from Pismo Creek and Meadow Creek, creek-mouth berm dynamics, and groundwater emergence.

6.1 Area 1: Sunset Palisades / The Bluffs / South Palisades

The Sunset Palisades, The Bluffs, and South Palisades area consists primarily of established low-density residential neighborhoods situated atop coastal bluffs overlooking the Pacific Ocean. The planning area includes bluff-top open space, coastal habitat areas, and scattered public recreational resources that provide opportunities for coastal access and scenic viewing. Its character is defined by its residential setting, natural coastal landscape, and proximity to beaches and intertidal resources. Due to its location along actively eroding bluffs, this area is particularly vulnerable to long-term bluff retreat, wave-induced erosion, and storm-related damage that could affect public access, open-space areas, and bluff-top development.

6.1.1 Existing Conditions

Area 1 is the northernmost planning area in the City characterized by steep coastal bluffs with predominantly residential development located along the bluff top. The area has been broken up into three subareas to describe bluff conditions, land uses, and coastal assets (Figure 15).

Smuggler's Cave to El Portal Drive (km 572–573)

– Largely undeveloped bluff face backed by Bluff Drive. Bluff elevations ranging from approximately 55 to 115 ft NAVD88.
– Residential homes are located approximately 90 to 200 ft landward of the bluff edge.
– Key public assets include the Cave Landing Natural Area, Pirates Cove Beach (Figure 16) accessible by stairway, a public bluff-top trail, and an unpaved parking area at the bluff edge.
– Two stormwater outfalls discharge onto the bluffs.

El Portal Drive to Beachcomber Drive (km 571–572)

– Residential bluff-backed shoreline at elevations of approximately 35 to 45 ft NAVD88, with extensive but non-contiguous shoreline protection consisting primarily of private seawalls and rock revetments along the lower bluff face (Figure 17).

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– Nine stormwater drainage infrastructure discharges directly onto the beach and armored bluff face, contributing to localized erosion and scour around revetment structures.
– Public infrastructure is limited to small bluff-top amenities; beach access is primarily private.

Beachcomber Drive to Ebb Tide Park (km 570–571)

– Unarmoured bluff at elevations of approximately 45 to 70 ft NAVD88.
– Includes South Palisades Park (Figure 18), two public access stairways (Figure 20), and pedestrian walkways along the bluff top.
– Two stormwater outfalls discharge directly onto the bluff face or beach.

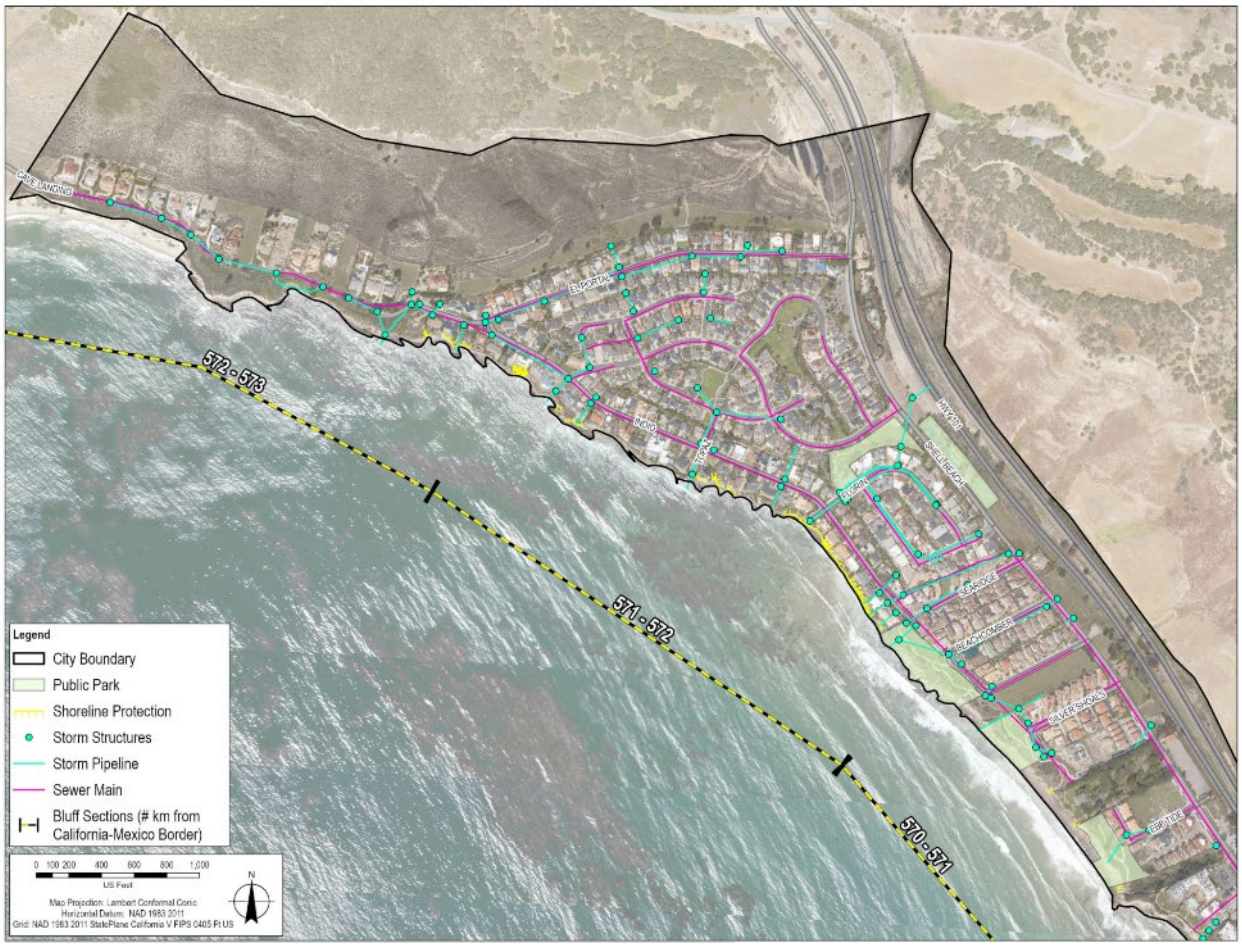


Figure 15 Existing conditions for Area 1: Sunset Palisades / The Bluffs/ South Palisades

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Figure 16 Pirate's Cove looking toward The Bluffs, West segment of Area 1

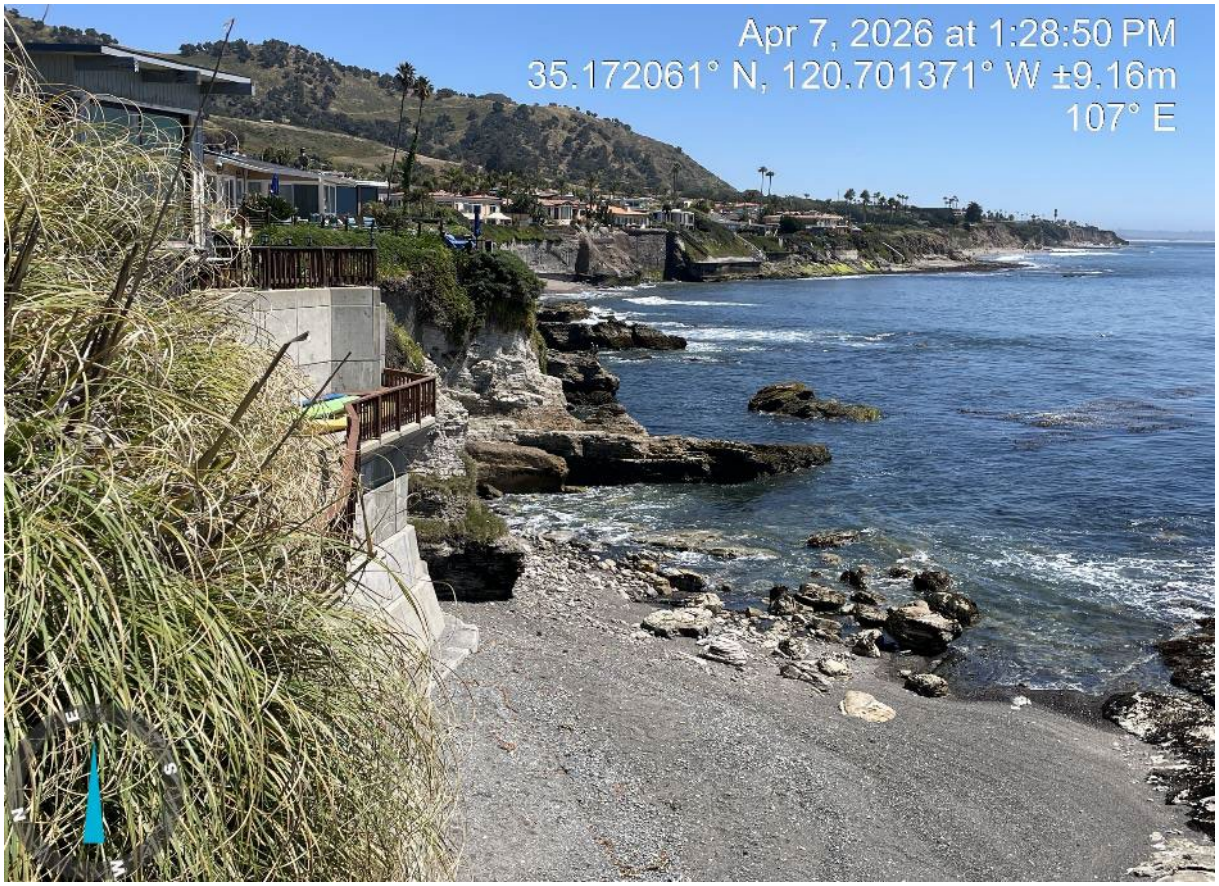


Figure 17 Bluff-top Residential Development with Shoreline Protection, Typical of central segment of Area 1

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Figure 18 ***Bluff backed beach at South Palisades Park, Typical of east segment of Area 1***

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6.1.2 Future SLR Vulnerabilities

The primary SLR hazards in Area 1 are bluff erosion throughout and shoreline erosion at Pirate's Cove Beach and South Palisades Park. Vulnerability in this area reflects the combination of high exposure (proximity of development and infrastructure to the bluff edge), moderate-to-high sensitivity (residential structures, public access stairways, and stormwater outfalls with limited tolerance for erosion), and limited adaptive capacity (constrained setback options and reliance on existing armoring of uncertain remaining lifespan). Vulnerabilities by hazard type are described below.

Coastal Bluff Erosion

Bluff erosion in Area 1 is episodic, often triggered by major storm events rather than gradual retreat. SIO historic bluff-face retreat rates consistently exceed bluff-top retreat rates across all three subsections, indicating that wave-driven undercutting at the bluff toe is the dominant erosion mechanism. The pattern is most pronounced in Section 570–571 (Beachcomber Drive to Ebb Tide Park), where bluff-face retreat has ranged from 0.20 to 0.42 ft/yr — the highest rates in the area — making the southern portion of Area 1 the most vulnerable to future bluff loss. Bluffs in this area are unarmored, but most residential development is setback ~100 feet or more from the bluff top.

Bluff instability in Area 1 has resulted in a variety of stabilization measures for residential development along Indio Drive, including recent applications for emergency coastal development permit to mitigate erosion hazards. Although annual bluff erosion rates are relatively low in magnitude, the episodic nature of this hazard poses a risk to development in close proximity to the bluff edge. As SLR increases, wave energy will reach the bluff toe more frequently during high-tide and storm conditions, increasing the frequency and severity of episodic bluff failures. Projected bluff retreat extents for Area 1 are shown in Figure 19.

Table 7 Historic bluff-top and bluff-face retreat rates for Area 1

Time Period	Bluff Section (# km from the California-Mexico Border)		
	572-573	571-572	570-571
Mean Bluff Top Retreat Rate (ft/yr)			
1998 - 2010	0.12	0.17	0.25
2010 - 2016	0.10	0.04	0.16
2016 - 2023	0.01	0.08	0.20
Mean Bluff Face Retreat Rate (ft/yr)			
1998 - 2010	0.14	0.25	0.42
2010 - 2016	0.21	0.07	0.20
2016 - 2023	0.16	0.19	0.20

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Figure 19 ***Bluff erosion projections based on SIO historical erosion rates for north end of Area 1: Sunset Palisades / The Bluffs / South Palisades***

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Figure 20 ***Bluff erosion projections based on SIO historical erosion rates for south end of Area 1: Sunset Palisades / The Bluffs / South Palisades***

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Beach Loss and Shoreline Erosion

At Pirates Cove Beach, CoastSat data indicates the shoreline is relatively stable with an average trend of beach growth of approximately +0.13 ft/yr (accretion). However, this modest rate of accretion is unlikely to fully offset the erosional effects of sea level rise over the near term. Bruun Rule calculations for Pirate's Cove indicate recession rates ranging from approximately -0.5 to -1 ft/yr for near-term and mid-term SLR scenarios.

At South Palisades Park Beach, existing conditions are already narrow and experience seasonal erosion to the bluff face. SLR will likely exacerbate the seasonal beach loss resulting in a smaller subaerial beach area. Under these seasonally eroded conditions, wave energy would reach the coastal accessways with no beach buffer, exposing them to more frequent wave interactions and potential damage.

Coastal Access and Recreation Assets

Future bluff erosion is expected to impact coastal access and recreational resources progressively across Area 1:

– Near term: The staircase near Beachcomber Drive (large staircase) in the South Palisades Park area will likely be at risk of damage due to undercutting and loss of bluff support. Segments of the Shell Beach Bluff Trail near the bluff edge may also experience erosion-related closures. The Smuggler's Cave / Cave Landing area is expected to experience limited erosion, though the unpaved Pirates Cove parking area at the bluff edge remains vulnerable to surface runoff-driven erosion during storm events.
– Mid term: Staircases are likely to become unusable due to increased wave exposure. A large portion of South Palisades Park — estimated at approximately 25% of the trail network concentrated around Beachcomber Drive — is projected to be lost to bluff erosion. Trail segments near Ebb Tide Road and Silver Shoals Road would also become hazardous for public use.
– Long-term: Bluff erosion is expected to progressively reduce the stability and usable width of bluff-top trail networks, requiring trail realignment or closure of vulnerable segments to maintain public safety and coastal access. Existing beach access stairways may also become increasingly difficult to maintain as the bluff face and beach profile evolve; over the long term, replacement or reconstruction of access stairs will likely be needed.





Figure 21 South Palisades Park beach access stairways

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Stormwater Infrastructure

There are 13 stormwater outfalls in Area 1 that are located within the bluffs. Outfalls at lower elevations are likely to be the most vulnerable to storm wave damage in the near-term. For example, outfalls near Searidge Ct and Silver Shoals are among the most exposed (Figure 21). As beach width narrows and wave interaction with the bluff toe increases, additional outfalls are expected to experience greater exposure to wave action, localized erosion, and potential structural damage over time.

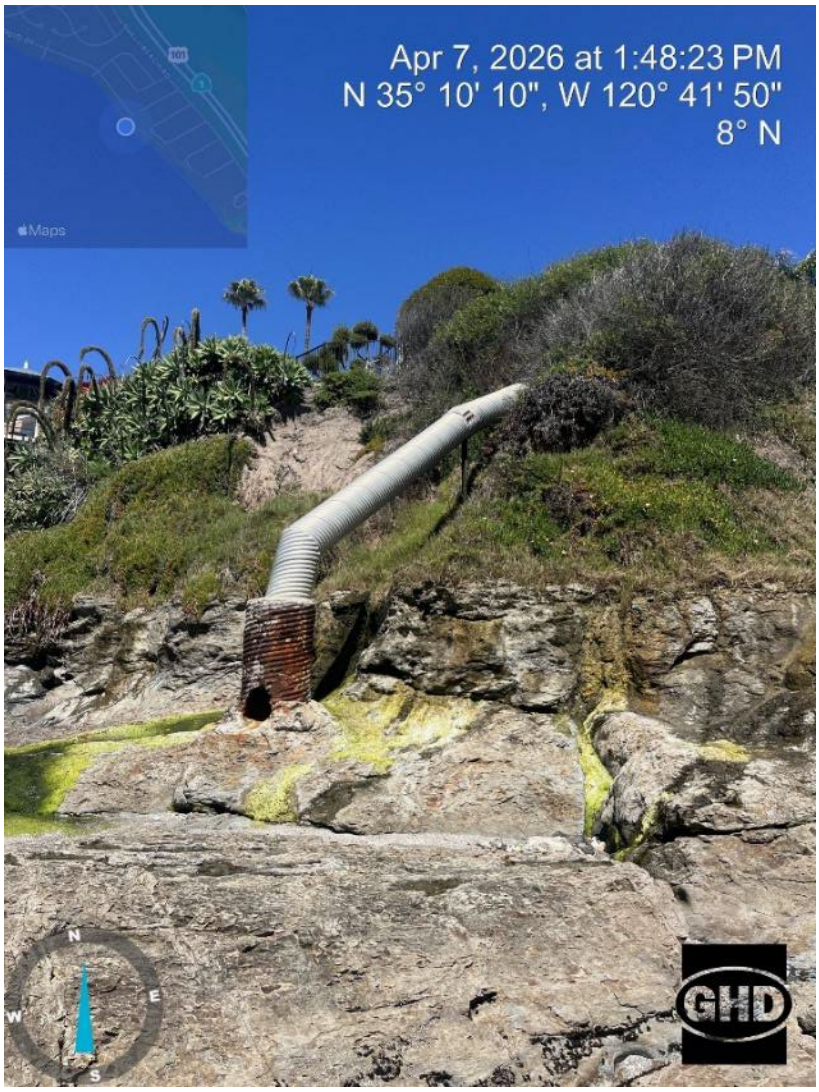


Figure 22 Stormwater outfall in Area 1 at the end of Searidge Ct

Residential Properties

Approximately 11 residential properties are expected to be at risk of damage due to bluff erosion in the near-term (2050). These properties are largely concentrated between km 571–572 along Indio Drive, where limited bluff-top setbacks and inconsistent shoreline protection increases exposure to bluff erosion.

In the mid-term (2080), approximately 28 residential properties are projected to be at risk of damage due to bluff erosion. Exposed properties are grouped together with the greatest concentration in km 571–572 and 570–571.

Long-term bluff erosion (2100+) is projected to extend farther landward into properties that are already exposed, with the estimated number of properties at risk of damage increasing to approximately 35. Due to the length of the planning horizon and the larger amount of sea level rise expected over this period, the actual extent and timing of erosion will vary substantially from parcel to parcel. Key factors influencing future erosion include bluff composition and condition, the presence and performance of shoreline protection, storm frequency and intensity, beach width and sediment response, drainage conditions, and site-specific development patterns.

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6.2 Area 2: North Spyglass / Spyglass

The North Spyglass and Spyglass area contains a mix of visitor-serving commercial uses, hotels, residential neighborhoods, and community-serving amenities. The North Spyglass area includes a 50-foot-wide lateral access corridor along the coastal bluffs which supports park space, trails, and public beach access opportunities. The Spyglass area includes residential development along the bluff edge with beach access provided at Spyglass Park. Dramatic ocean views and shoreline access are defining features of the area, while exposure to bluff erosion and coastal storm impacts represents an ongoing hazard to recreational facilities and private development located near the bluff edge.

6.2.1 Existing Conditions

Area 2 includes a mix of bluff-backed shoreline and pocket beaches, with residential development, hotel properties, and public recreational amenities located along the bluff top. Pocket beaches in this area provide important recreational and ecological value but are inherently constrained by adjacent headlands and existing armoring, limiting their ability to migrate landward under rising sea levels (Moffatt & Nichol, 2019). The area has been broken up into two subareas to describe bluff conditions, land uses, and coastal assets (Figure 22).

Ebb Tide Park to Spyglass Drive (Section 570–571)

- Bluff-backed shoreline with bluff elevations of approximately 70 to 80 ft NAVD88.
- Three large hotel properties set back from the bluff edge and buffered by relatively wide landscaped areas.
- Public coastal trail and underlying stormwater infrastructure located close to the bluff edge.
- Shoreline protection is limited to a few scattered features at the southern end of the segment.
- One stormwater pipeline discharges to the ocean from the bluff face.

Spyglass Drive to Spyglass Park (Section 569–570)

- Steep coastal bluffs fronting a rocky, largely inaccessible shoreline. Residential blufftop elevations of approximately 70 to 80 ft NAVD88; Spyglass Park at approximately 65 ft NAVD88 (Figure 23).
- A manmade trail at Spyglass Park leads down to a pocket beach hosting the Spyglass Beach Tide Pools — a popular surfing location.
- Scattered shoreline protection structures stabilize the lower bluff in front of some residential properties.
- Beach access within this segment is limited; no developed public access points to the shoreline west of Spyglass Park.
- Two stormwater pipelines discharge to the ocean from the bluff face.

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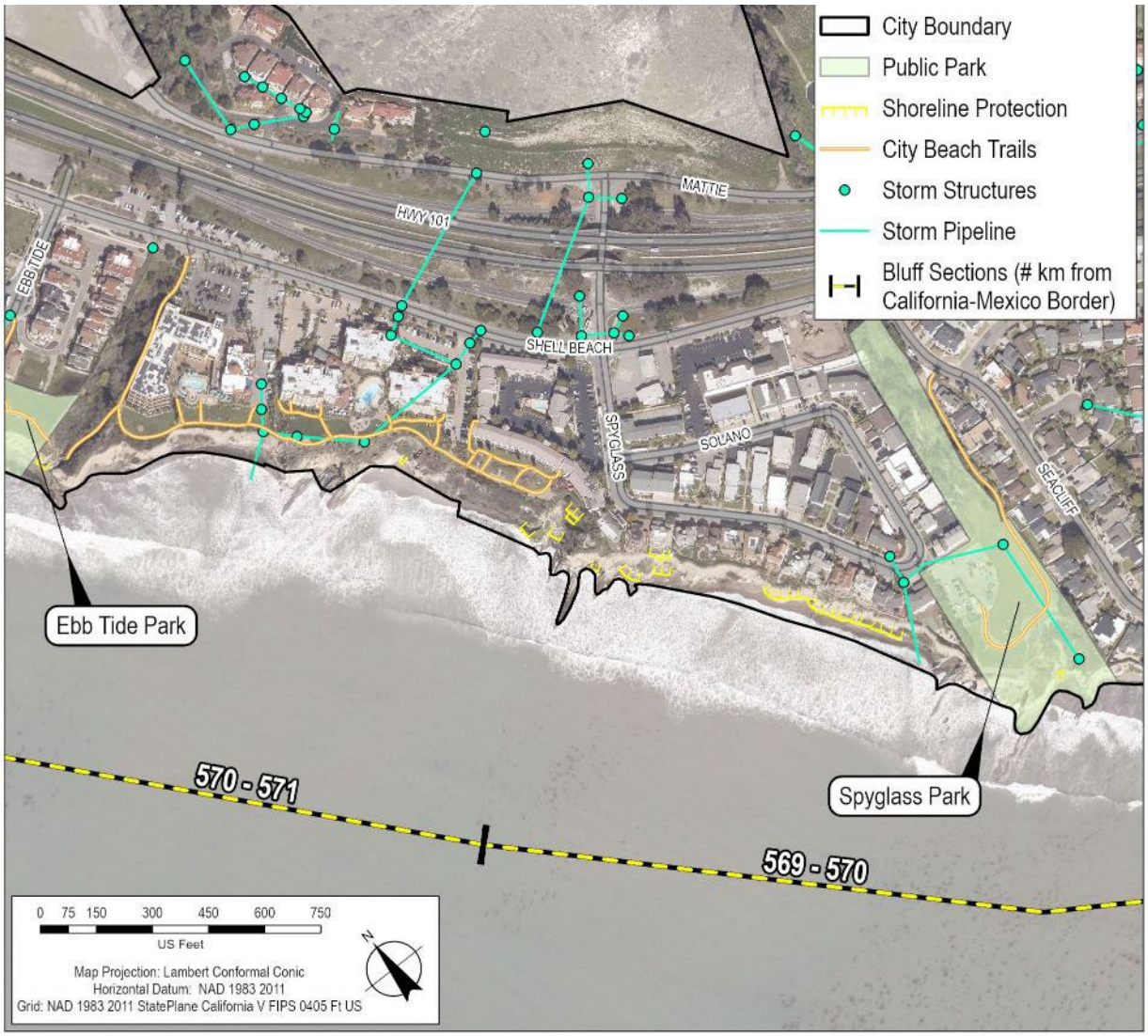


Figure 23 Existing Conditions for Area 2: North Spyglass / Spyglass

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Figure 24 *Area 2 Ground photos (1) pocket beach at Spyglass Park, (2) steep bluff faces and rocky shoreline below.*

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6.2.2 Future SLR Vulnerabilities

The primary SLR hazards along the shoreline in Area 2 include bluff erosion and flooding of pocket beaches. Vulnerability in this area reflects the combination of moderate-to-high exposure (bluff-edge homes, public access amenities, and the Spyglass Park pocket beach), high sensitivity (pocket beaches that cannot migrate landward because they are constrained by headlands and existing armoring), and low adaptive capacity (limited setback options and a constrained shoreline). A loss of public pocket-beach access also carries equity implications, since Spyglass Park is one of the few free public access points in this part of the City. Vulnerabilities by hazard type are described below.

Coastal Bluff Erosion

Updated data from the SIO Coastal Processes Group provide retreat rates for the 1-km bluff section within Area 2 (Table 8). Across all monitoring periods, bluff-face retreat rates in km 569–570 have consistently exceeded bluff-top retreat rates (0.15 to 0.22 ft/yr face retreat versus 0.03 to 0.23 ft/yr top retreat), indicating ongoing wave-driven undercutting at the bluff toe that may precede future blufftop instability.

As SLR increases, storm waves will reach the bluff toe more frequently during high-tide and storm conditions, increasing the frequency and severity of episodic slope failures. Future hazards in Area 2 are therefore expected to manifest first as localized undercutting and steepening of the bluff face, elevating risk to bluff-edge infrastructure, especially areas without bluff protection in place. Projected bluff retreat extents for Area 2 are shown in Figure 24.

Table 8 ***Historic bluff-top and bluff-face retreat rates for Area 2 (North Spyglass / Spyglass), based on SIO Coastal Processes Group analyses.***

Time Period	Bluff Section (# km from the California-Mexico Border)
	569-570
Mean Bluff Top Retreat Rate (ft/yr)	
1998 - 2010	0.04
2010 - 2016	0.23
2016 - 2023	0.03
Mean Bluff Face Retreat Rate (ft/yr)	
1998 - 2010	0.22
2010 - 2016	0.15
2016 - 2023	0.20

Beach Loss and Shoreline Erosion

The narrow bluff-backed beaches within the Spyglass area are highly sensitive to SLR. Bruun Rule analysis for 1.6 ft of SLR (near-term) suggests shoreline retreat of 20-40 feet which will result in more frequent wave action at the bluff toe, and fewer recreational opportunities as the beaches become submerged and/or eroded for large parts of the year.

Coastal Access and Recreation Assets

Future bluff erosion and beach loss are expected to impact coastal access and recreational resources progressively across Area 2:

– Near term: Access to pocket beaches, Spyglass Park tide pools, and surf breaks become more hazardous as the shoreline retreats to the bluff toe. In Section 570–571, landscaping and pedestrian pathways close to the bluff edge may be exposed to localized erosion or slope instability.
– Mid term and Long-term: Continued bluff retreat may result in more substantial erosion of hotel landscaping and pedestrian pathways along the bluff top.

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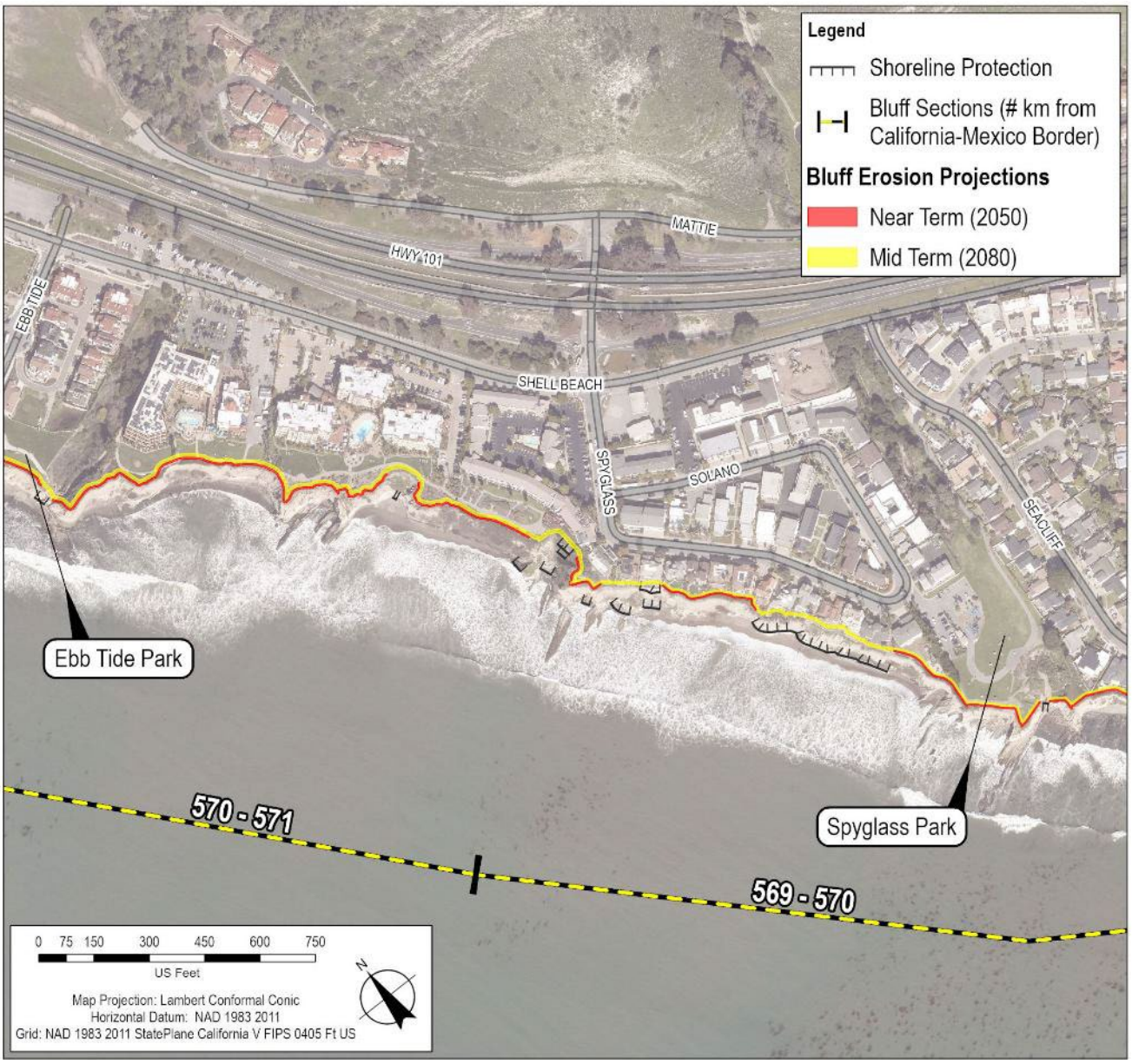


Figure 25 ***Bluff erosion projections based on SIO historical erosion rates for Area 2: North Spyglass / Spyglass***

Stormwater Infrastructure

The three stormwater outfalls in Area 2 discharge along the bluff face. At Spyglass Park, localized slope erosion due to runoff was evident above the large stormwater outfall structure (Figure 25). As beach width narrows and wave interaction with the bluff toe increases under future SLR, stormwater outfalls at the base of bluff are expected to experience greater exposure to wave action, localized scour, and potential structural damage.

Residential and Commercial Properties

In the near-term (2050), approximately 6-8 residential properties along Spyglass Drive will be vulnerable to bluff erosion. Some of these properties have shoreline protection at the bluff toe so extent of vulnerability will depend on the structures continued performance under increased wave attack and scour potential due to SLR.

In the mid-term (2080), approximately 14 residential properties may be exposed to more pronounced erosion and potential damage as bluff-face retreat and undercutting continue. Mid-term SLR will likely exceed the design capacity of existing structures resulting in stability concerns or wave overtopping issues, both of which will increase the rate of bluff erosion.

Long-term bluff erosion (2100+) is expected to extend farther landward than in the mid-term scenario, although the number of residential properties identified as potentially at risk is expected to remain the same. The primary long-

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term concern is the increased extent of erosion into already exposed parcels, where future impacts will depend on site-specific conditions such as bluff composition, drainage, beach width, and the condition and effectiveness of existing shoreline protection. Long-term erosion could also place portions of the Spyglass Inn buildings at risk of damage if existing protective structures are unable to maintain their intended level of performance over the full planning horizon.



Figure 26 Outfall at Spyglass Park

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6.3 Area 3: St. Andrews / Spindrift

The St. Andrews Tract and Spindrift area is characterized by predominantly residential development interspersed with open-space lands and public facilities. The planning area contains bluff-top open space and public access opportunities that provide important recreational and scenic resources. Steep coastal topography and proximity to the shoreline contribute to its unique character but also increase vulnerability to bluff instability and coastal erosion.

6.3.1 Existing Conditions

Area 3 consists of steep coastal bluffs and a narrow pocket beach at Memory Park. Below is a description of current bluff conditions, land uses, and coastal assets (Figure 26).

Seacliff Drive to Park Place (Spindrift) (kms 568–570)

- Mix of armored and unarmored bluff-backed sections exist along Seacliff Drive.
- A seawall/slope stabilization project was installed at Memory Park to protect wastewater infrastructure (St. Andrews Lift Station). This project built in a public staircase providing beach access to the pocket beach and surfing resources in this vicinity (Figure 27).
- Bluff elevations of approximately 50 to 60 ft NAVD88 near Memory Park, decreasing to approximately 35 to 45 ft NAVD88 south of the park.
- The beach in this area consists primarily of rocky substrate and is bounded to the southeast by a prominent cliff face/headland.
- Seven stormwater pipelines discharge from the hardened bluff sections, with large outfall pipes extending from the bluff face directly onto the rocky beach below (Figure 27).

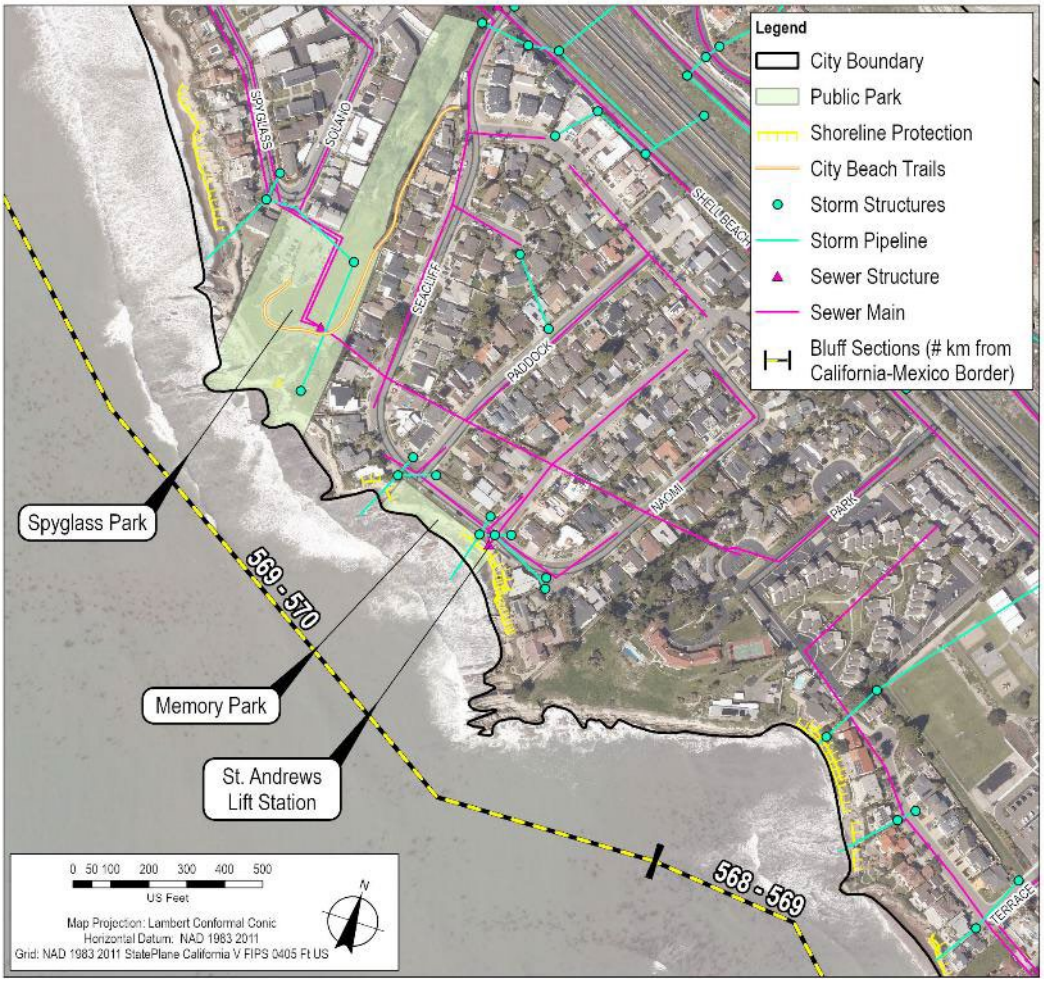


Figure 27 Existing Conditions for Area 3: St. Andrews / Spindrift

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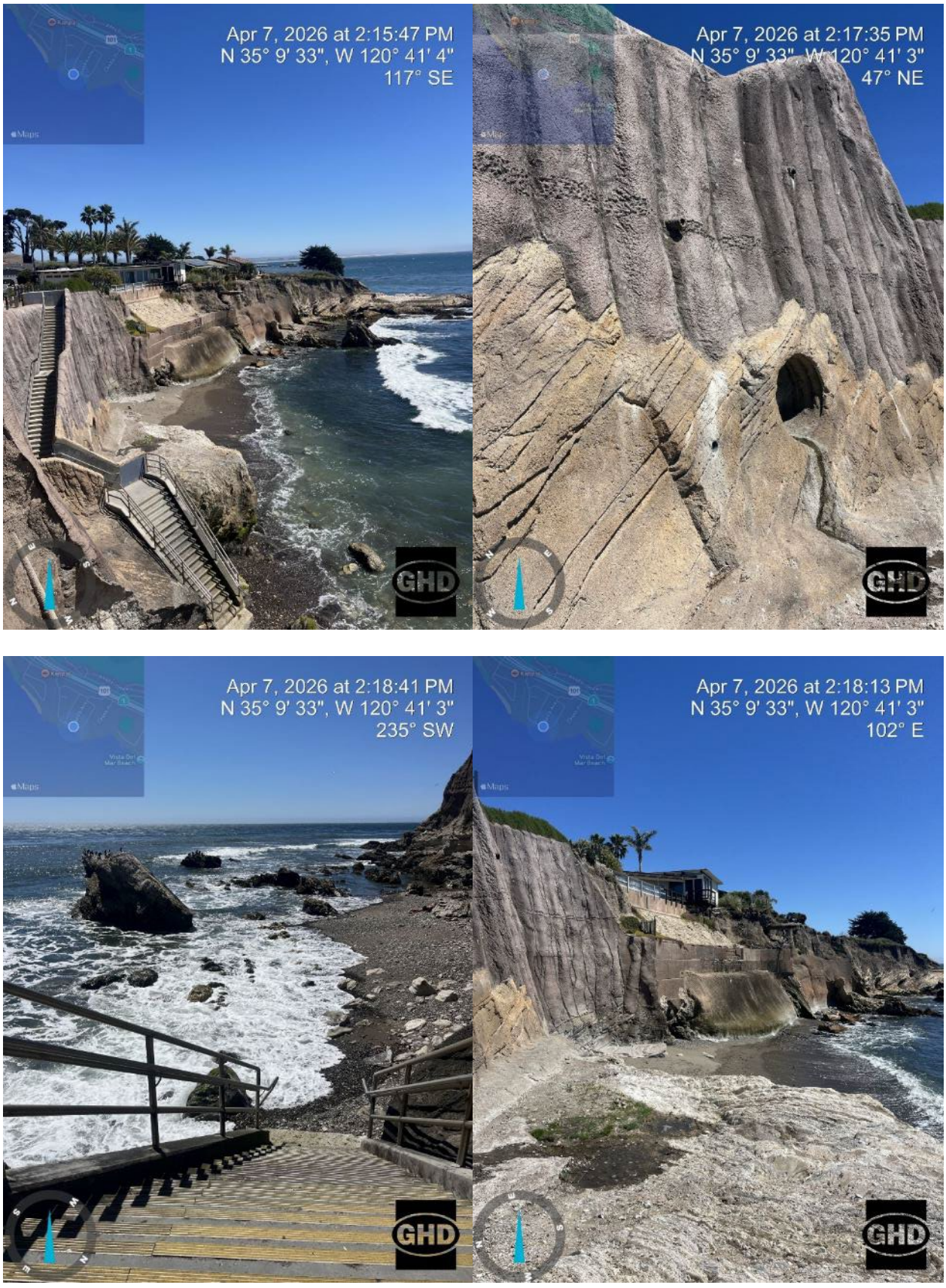


Figure 28 ***Area 3 Ground photos showing Memory Park (1) hardened bluff faces, (2) stormwater outfall, (3) beach access stairway, and (4) rocky, narrow beach below the bluff.***

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6.3.2 Future SLR Vulnerabilities

The primary SLR hazards in Area 3 are bluff erosion and increased exposure to wave runup as sea levels rise. Vulnerability reflects the combination of high exposure (residential and access infrastructure located close to the bluff edge), high sensitivity (stormwater outfalls and the Memory Park stairway with limited tolerance for erosion), and low adaptive capacity (reliance on armoring of various types & lifespans). The 2019 assessment identified this area as sensitive due to limited beach width and the proximity of development to the shoreline (Moffatt & Nichol, 2019). Recent storm events in this area (Section 3.4) resulted in bluff cracking, localized erosion, and temporary public safety closures near Memory Park, a reminder that bluff erosion is an active process and unprotected areas will continue to erode.

Coastal Bluff Erosion

Updated data from the SIO Coastal Processes Group provide retreat rates for the 1-km bluff section within Area 3 (Table 9). Mean bluff-face retreat rates in km 569–570 (0.15 to 0.22 ft/yr) consistently exceed bluff-top retreat rates, indicating ongoing undercutting of the bluff face that may precede future bluff-top instability. Future hazards are therefore expected to manifest first as localized undercutting and steepening of the bluff face, increasing the likelihood of episodic slope failures rather than gradual landward retreat. This pattern elevates risk to bluff-edge infrastructure, public access features, and recreational assets before impacts to primary residential structures are observed. Projected bluff retreat extents for Area 3 are shown in Figure 28.

Table 9 ***Historic bluff-top and bluff-face retreat rates for Area 3 (St. Andrews / Spindrift), based on SIO Coastal Processes Group analyses.***

Time Period	Bluff Section (# km from the California-Mexico Border)
	569-570
Mean Bluff Top Retreat Rate (ft/yr)	
1998 - 2010	0.04
2010 - 2016	0.23
2016 - 2023	0.03
Mean Bluff Face Retreat Rate (ft/yr)	
1998 - 2010	0.22
2010 - 2016	0.15
2016 - 2023	0.20

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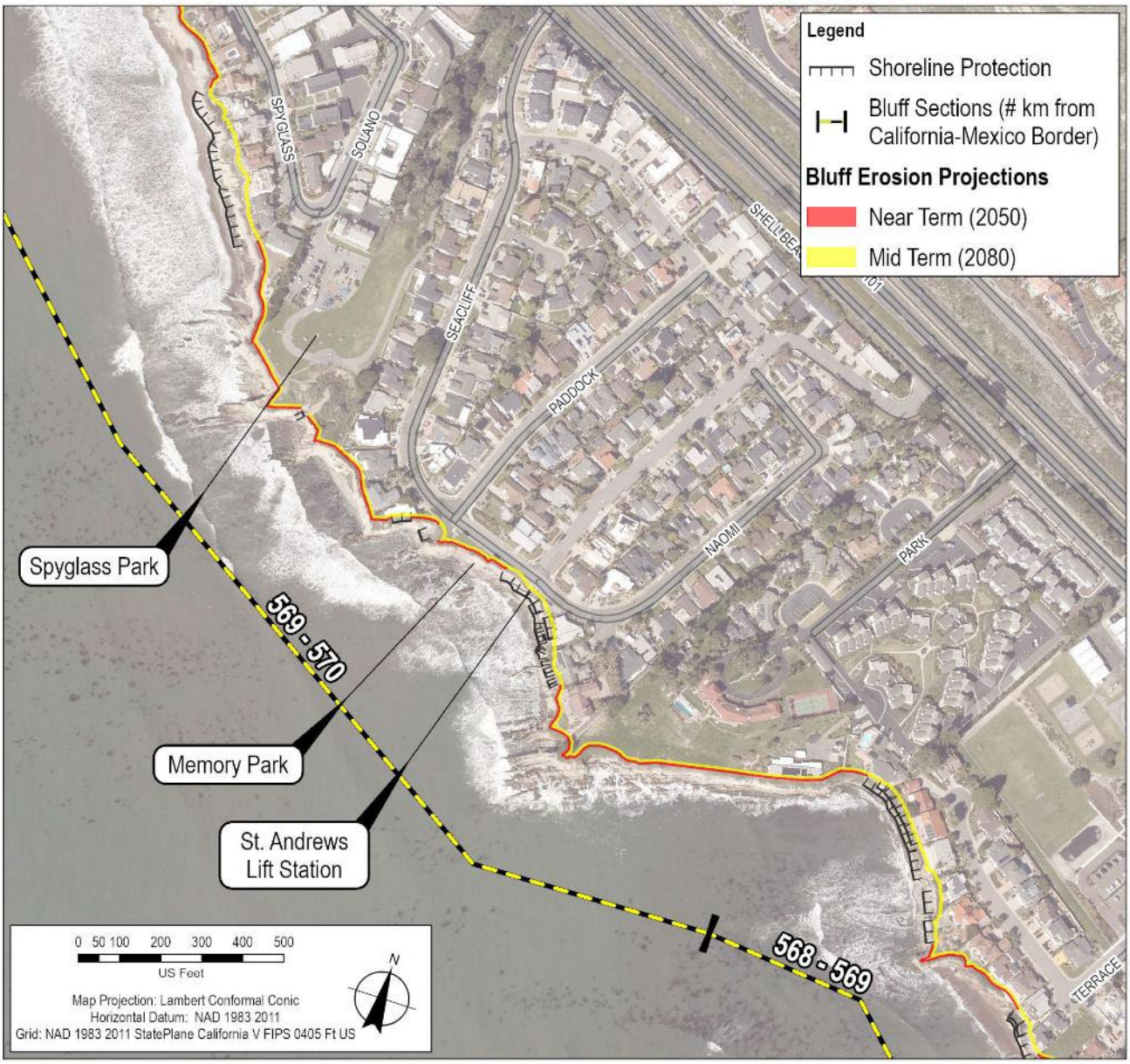


Figure 29 ***Bluff erosion projections based on SIO historical erosion rates for Area 3: St. Andrews / Spindrift***

Beach Loss and Shoreline Erosion

Beach conditions in Area 3 are already narrow and predominantly rocky, providing limited capacity to dissipate wave energy. Under future SLR, continued shoreline retreat will further reduce available beach area and increase direct wave interaction with the bluff.

Coastal Access and Recreation Assets

Future bluff erosion is expected to impact coastal access and recreational resources progressively across Area 3:

– Near term: The Memory Park stairway and other public access features located near the bluff edge may be exposed to increased wave runup and erosion during storm events. Memory Park itself may experience continued erosion of areas outside of the stabilized bluff segment.

– Mid term and Long-term: Continued bluff-face retreat is expected to increase erosion-related risks to Seacliff Drive, which may be exposed to erosion or damage as retreat migrates landward. Unprotected segments of Memory Park will continue to experience erosion. The combination of hardened bluff sections and limited beach width is expected to constrain natural shoreline adjustment, potentially increasing erosion rates adjacent to armored areas.

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Utilities and Stormwater Infrastructure

The seven stormwater outfalls in Area 3 are embedded within hardened bluff sections and discharge along the bluff face. As sea levels rise and beach width narrows, these structures are expected to experience increased exposure to wave action, scour, and localized erosion. The St. Andrews Lift Station (near Memory Park) has been recently protected via bluff armoring and is well protected from bluff erosion.

Residential Properties

In the near term (2050), approximately 4-6 residential properties that lack sufficient bluff-top buffer or shoreline protection may be exposed to bluff erosion.

In the mid-term (2080), continued bluff face retreat is expected to place approximately 8-10 properties at risk of erosion-related damage, along with adjacent infrastructure including Seacliff Drive.

Long-term bluff erosion hazards (2100+) are expected to increase the extent of erosion-related damage to already exposed residential properties, although the total number of properties identified as vulnerable is not anticipated to increase relative to the mid-term planning horizon. Continued bluff retreat could progress farther into affected parcels, increasing the potential for damage to yards, accessory improvements, foundations, or structures located near the bluff edge. Actual impacts will vary by parcel depending on bluff composition and condition, existing shoreline or slope stabilization, drainage conditions, and the localized response of the beach and bluff system to future sea level rise and coastal storm events.

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6.4 Area 4: Terrace Ave / Shell Beach / Dinosaur Caves

The Terrace Avenue, Shell Beach and Dinosaur Caves area is one of the community's most recognizable coastal neighborhoods, consisting of historic residential areas, visitor-serving uses, public parks, and numerous shoreline access points. Recreational resources include the shoreline bluffs, pocket beaches, Dinosaur Caves Park, and other public coastal viewpoints that attract residents and visitors alike. The Terrace Avenue area is home to Shell Beach Elementary School and a mix of low, medium and high density residential uses (City of Pismo Beach, 2026). The area's strong connection to the shoreline also creates exposure to coastal erosion, bluff retreat, and sea level rise impacts that may affect public accessways, park facilities, and residential development over time.

6.4.1 Existing Conditions

Area 4 features elevated coastal bluffs, a rocky shoreline, and a series of blufftop parks and scenic overlooks that provide some of the most heavily used public coastal access along the City's northern shoreline. Residential development and coastal roadways run parallel to the bluff edge. The area has been broken up into two subareas to describe bluff conditions, land uses, and coastal assets (Figure 29).

Park Place to Castaic Avenue (km 568-569)

- Heavily modified bluff-backed shoreline with extensive shoreline protection. Vista Del Mar Beach occupies much of this reach and is backed by a large seawall transitioning to a mix of vertical seawalls, rock revetments, and aging timber structures.
- Bluff elevations range from approximately 35 to 45 ft NAVD88 near the shoreline; 45 to 60 ft NAVD88 where residential development is present.
- Nine stormwater outfalls discharge from the bluff face, some extending seaward and others embedded within hardened surfaces.
- A public beach access stairway provides access to Vista Del Mar Beach; visible scour at the base of the structure indicates frequent wave runup reaching the lower portion of the stairway.
- Eldwayen Ocean Park (elevations ~25 to 35 ft NAVD88) shows visible evidence of active bluff erosion. Portions are currently under construction with temporary barriers; observed conditions include cracked pavement, downward settlement, and removal of bluff-edge amenities. The City has initiated an Eldwayen Ocean Park Sidewalk Re-route project ($75,000) to relocate pedestrian sidewalks away from the bluff edge.
- Additional seawalls and revetments extend toward the Chapman Estate, where severe scour is evident at the bluff base, potentially undermining a portion of the upper bluff seawall (Figure 30).
- The City completed removal of the damaged Pier Avenue beach access stairs in December 2025 ($180,000) following erosion-related instability, resulting in a temporary loss of public coastal access at that location.

Castaic Avenue to Dinosaur Cave Park (km 567-568)

- Predominantly unarmored bluff-backed shoreline with limited coastal infrastructure.
- Residential development is set back from the bluff edge and separated by a roadway at elevations of approximately 45 to 60 ft NAVD88.
- Bluff elevations increase southward along Dinosaur Caves Park from approximately 60 ft to over 100 ft NAVD88.
- Shoreline consists of large, complex cliff formations with caverns, arches, and undercut sections shaped by wave action and weathering.
- Seven stormwater outfalls discharge from the bluff face.

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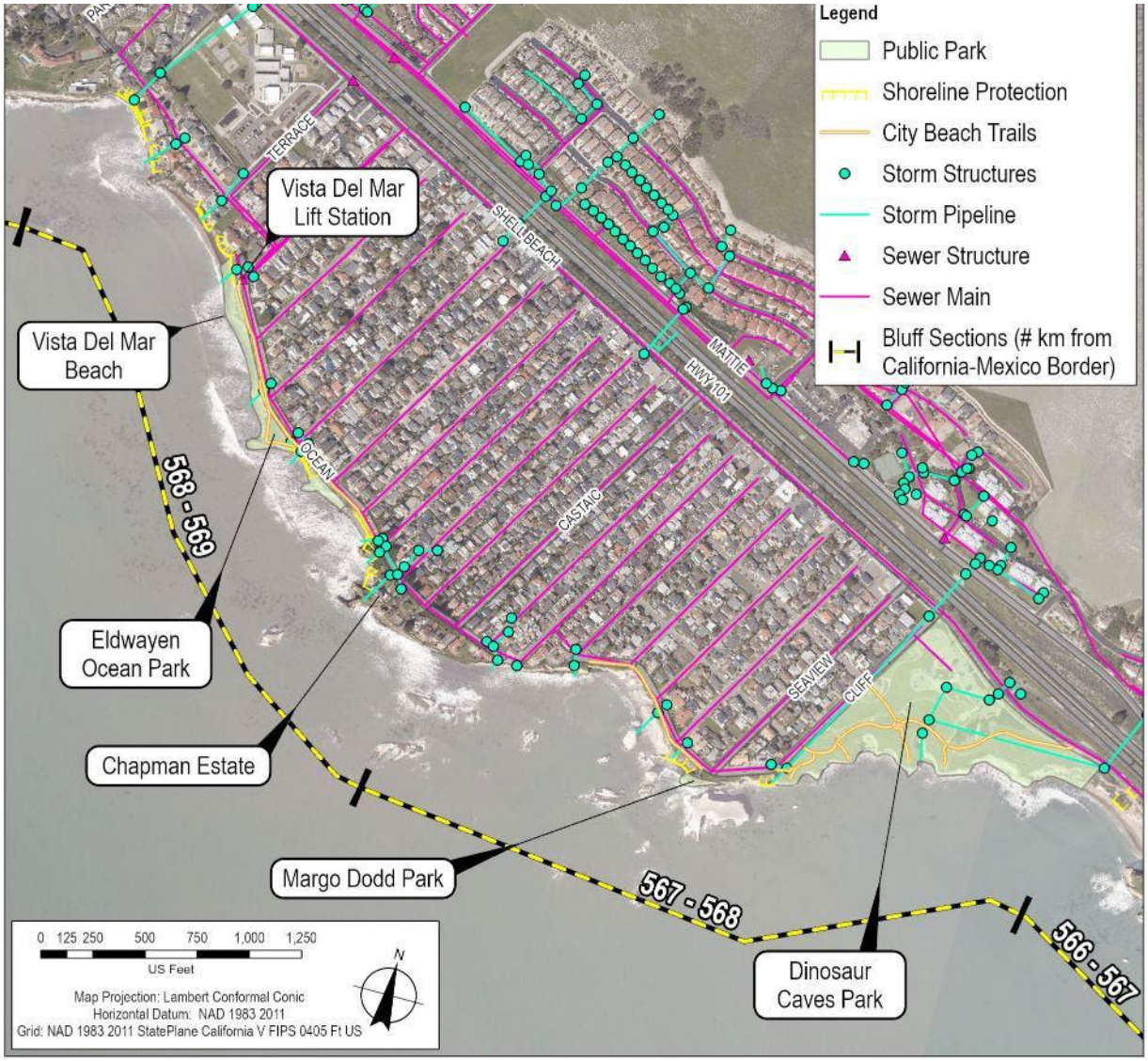


Figure 30 ***Existing Conditions for Area 4: Terrace Ave / Shell Beach / Dinosaur Caves***

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Figure 31 ***Area 4 Ground photos showing (1) Vista Del Mar Beach seawalls and revetments, (2) Eldwayen Park bluff edge damage, (3) stormwater outfalls discharging from the bluff face, and (4) Chapman Estate shoreline protection with visible scour.***

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6.4.2 Future SLR Vulnerabilities

The primary SLR hazards in Area 4 are bluff erosion and the long-term stability of blufftop infrastructure rather than chronic coastal flooding. Vulnerability reflects the combination of moderate-to-high exposure (blufftop parks, roadways, and bluff-edge residential properties), high sensitivity (stairways, outfalls, and armored shoreline segments to wave action), and moderate adaptive capacity in unarmored Section 567–568 (where setbacks exist) but low adaptive capacity in heavily developed Section 568–569. The 2019 assessment noted that beaches in this area are already narrow or intermittently absent, increasing reliance on blufftop parks as points of coastal access (Moffatt & Nichol, 2019).

Coastal Bluff Erosion

Updated data from the SIO Coastal Processes Group provide retreat rates for the three 1-km bluff sections within Area 4 (Table 10). Bluff-face retreat rates consistently exceed bluff-top retreat rates across all sections, indicating wave-driven undercutting at the bluff toe is the dominant erosion mechanism. The pattern is most pronounced in Section 567–568, where bluff-face retreat has ranged from 0.12 to 0.53 ft/yr — the highest rates in the City.

As SLR increases, wave energy will reach the bluff toe more frequently during high-tide and storm conditions, increasing the frequency and severity of episodic bluff failures. Future hazards are likely to manifest as undercutting and episodic slope failures rather than gradual landward retreat. Projected bluff retreat extents for Area 4 are shown in Figure 31 and Figure 32.

Table 10 Historic bluff-top and bluff-face retreat rates for Area 4 (Terrace Ave / Shell Beach / Dinosaur Caves), summarized by SIO bluff section.

Time Period	Bluff Section (# km from the California-Mexico Border)		
	568-569	567-568	566-567
Mean Bluff Top Retreat Rate (ft/yr)			
1998 - 2010	0.04	0.30	0.22
2010 - 2016	0.03	0.26	0.00
2016 - 2023	0.04	0.06	0.00
Mean Bluff Face Retreat Rate (ft/yr)			
1998 - 2010	0.17	0.34	0.20
2010 - 2016	0.07	0.12	0.02
2016 - 2023	0.21	0.53	0.27

Beach Loss and Shoreline Erosion

Beaches in Area 4 are already narrow or intermittently absent, providing limited buffering capacity against wave energy. Under future SLR, further shoreline retreat is expected to eliminate remaining beach areas, allowing waves to directly interact with the bluff and shoreline protection structures. This will likely increase erosion rates, exacerbate scour around armored features, and further reduce natural shoreline resilience throughout the area.

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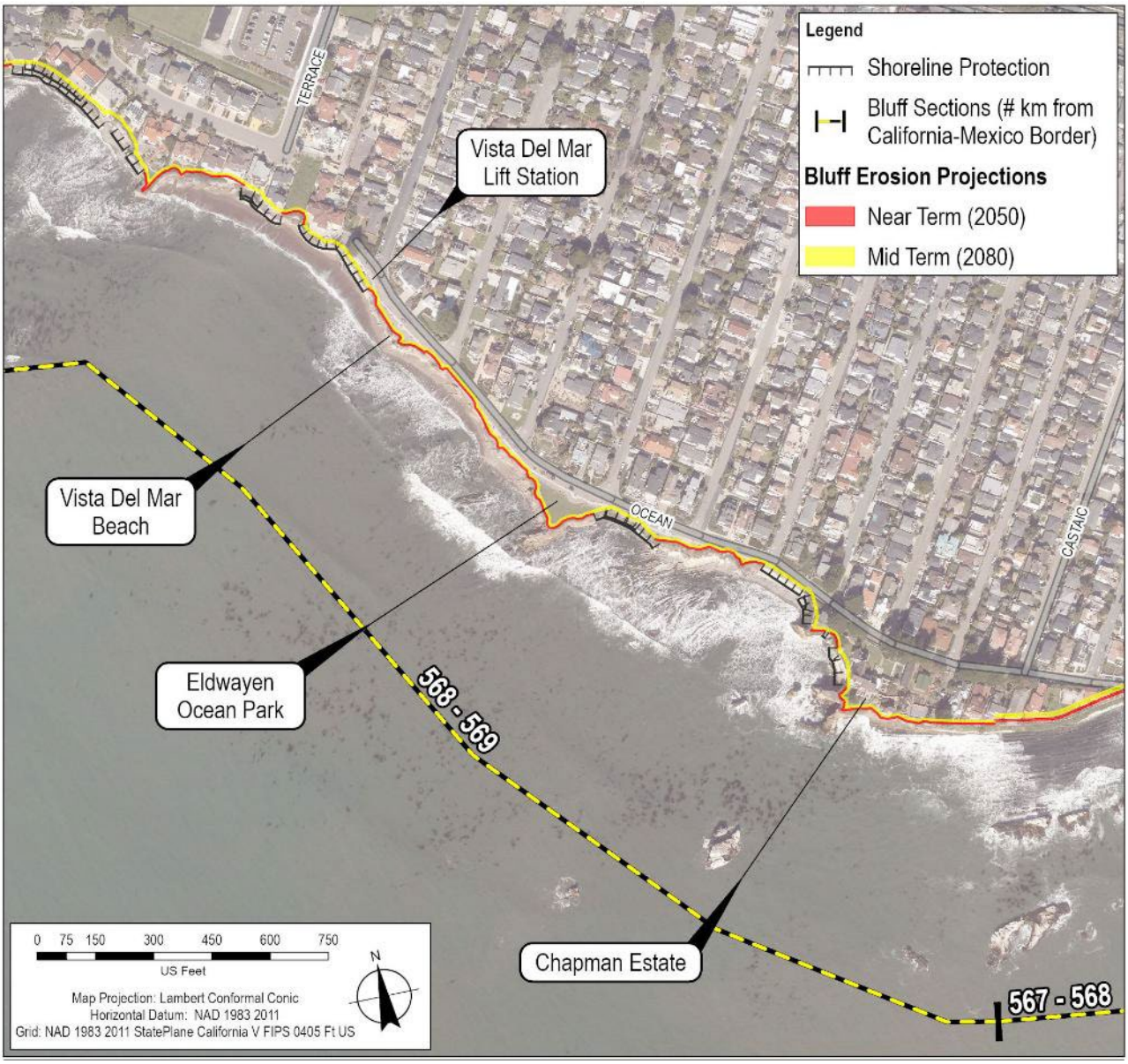


Figure 32 ***Bluff erosion projections based on SIO historical erosion rates for north end of Area 4: Terrace Ave / Shell Beach / Dinosaur Caves***

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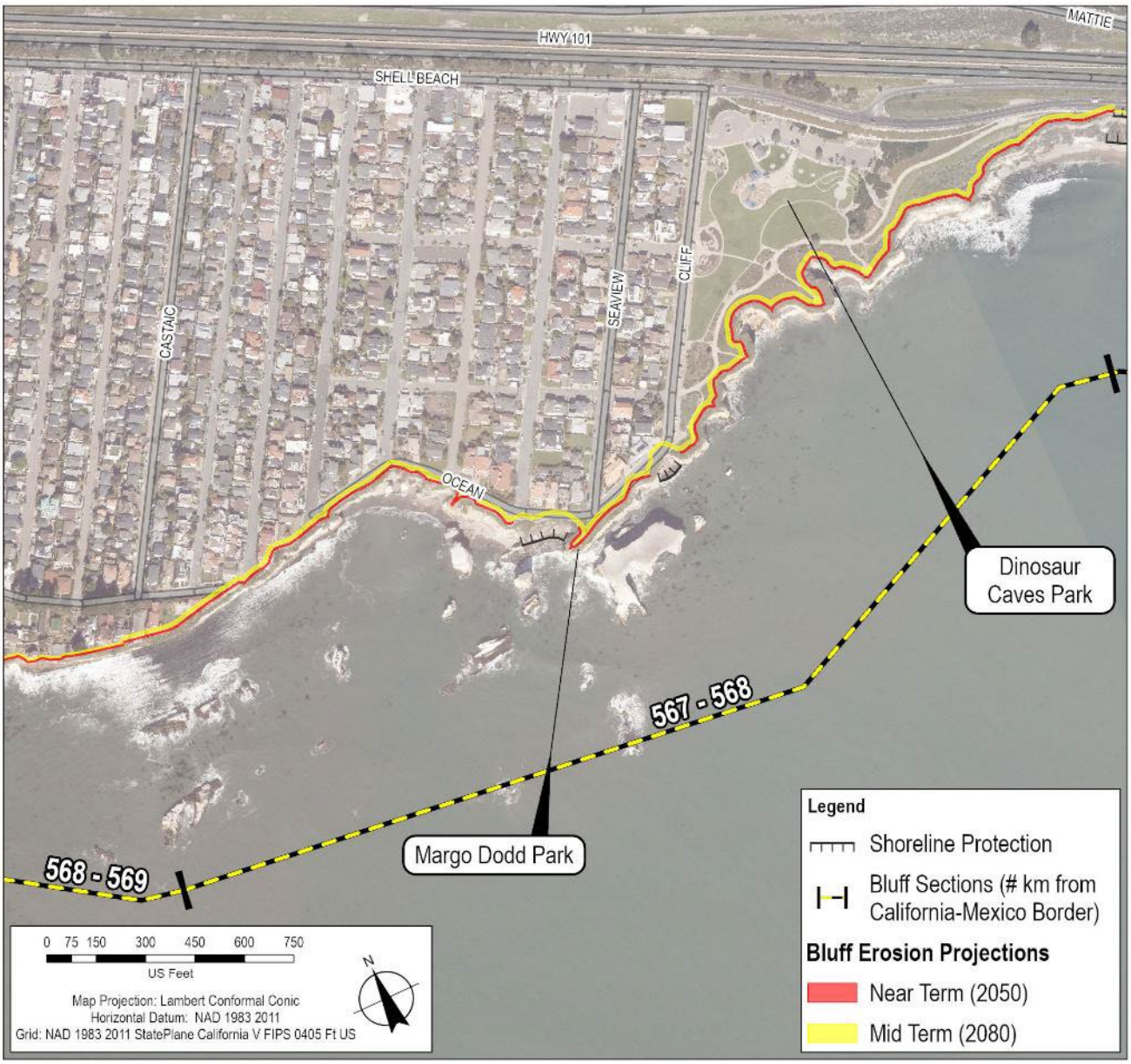


Figure 33 ***Bluff erosion projections based on SIO historical erosion rates for south end of Area 4: Terrace Ave / Shell Beach / Dinosaur Caves***

Coastal Access and Recreation Assets

Future bluff erosion is expected to impact coastal access and recreational resources progressively across Area 4:

– Near-term: In Section 568–569, the Vista Del Mar Beach access stairwell is at high risk of damage due to undermining of the support pile foundation (Figure 33). Eldwayen Ocean Park may experience erosion affecting the existing bluff-top trail. In Section 567–568, Margo Dodd Park and Dinosaur Caves Park will experience continued erosion that may result in closure or relocation of trails/overlooks and other park amenities. The Pier Avenue stairs have already been removed.

– Mid-term: In Section 568–569, the Vista Del Mar Beach access stairwell faces an even higher risk of damage, and Eldwayen Ocean Park may experience substantial erosion affecting the trail and potentially reaching Ocean Boulevard in areas without bluff protection. In Section 567–568, Margo Dodd Park and Dinosaur Caves Park may experience substantial erosion of landscaping and trails/overlooks, and the Shell Beach Coastal Conservancy Preserve access stairwell may experience damage.

– Long-term: Bluff erosion is expected to undermine large portions of Eldwayen Ocean Park and Margo Dodd Park, including access stairways, parking areas, overlooks, and adjacent bluff-top improvements, with erosion potentially extending into portions of Ocean Boulevard. At Dinosaur Caves Park, long-term erosion is expected to undermine bluff-edge trails, overlooks, and recreation areas, likely requiring adaptation of the trail

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network and relocation or modification of these features to maintain safe public access and recreational use over time.



Figure 34 Scour below Vista Del Mar beach access stairway foundation

Utilities and Stormwater Infrastructure

The 16 stormwater outfalls in Area 4 are concentrated along armored bluff sections and typically discharge over or through the bluff face. Depending on their elevation and structure these outfalls may experience greater exposure to wave action potentially requiring more frequent maintenance and repair. The Vista del Mar Lift Station (near Eldwayen Ocean Park) has recently been protected via bluff armoring so future vulnerability will depend on the performance of this structure.

Residential Properties

In the near term (2050), approximately 6-10 residential properties, in addition to the Chapman Estate, are at risk of damage due to bluff erosion, primarily where development is located close to an unprotected bluff edge, or where existing bluff protection structures are susceptible to damage from undermining, disrepair or other factors. Properties along Ocean Blvd and east of Windward Ave (km 567–568) are set back further from the bluff edge and have reduced near-term exposure to bluff erosion.

In the mid term (2080), approximately 10-17 residential properties are at risk of damage from bluff erosion. Properties in Section 568–569 — closer to the bluff edge and supported by shoreline protection — face increasing maintenance demands particularly for aging structures which may not have been designed for mid-term SLR scenarios. Even properties set back further from the bluff edge along Ocean Blvd could experience access disruptions and other challenges associated with damage to Ocean Blvd.

Over the long-term (2100+), progressive bluff erosion is projected to affect approximately 27 parcels. In addition to direct erosion-related risks for bluff-edge properties, many parcels that are set back from the bluff may still experience significant disruptions if continued bluff retreat undermines portions of Ocean Boulevard. These impacts could limit property access, affect emergency response and utility service, and require roadway or access adaptations even where residential structures are not directly reached by the erosion hazard.

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6.5 Area 5: Motel District

The Motel District is a prominent visitor-serving corridor characterized by hotels, motels, restaurants, and supporting commercial uses situated along the oceanfront bluffs. Some medium-density residential uses along Franklin Drive, Wilmar Ave, and Habor View Ave. Public accessways, bluff-top pathways, and panoramic coastal views contribute significantly to the area's recreational and economic value. Because development is concentrated near the bluff edge, coastal hazards such as bluff erosion, wave attack, and sea level rise pose potential risks to development, supporting infrastructure, public access facilities, and recreational resources.

6.5.1 Existing Conditions

Area 5 has been broken up into two subareas according to the shoreline geomorphology. The west segment consists of several pocket beaches and steep coastal bluffs. The east segment transitions to a wider sandy beach (Pismo Beach) backed by coastal bluffs.

Dinosaur Caves Park to Pacific Point Resort (km 566–567)

- Predominantly bluff-backed coastline with limited public beach access.
- Development concentrated immediately landward of the bluff edge — motels, roadways, and parking areas — and adjacent to Price Street resulting in constraints on each side.
- The bluffs are largely unarmored, with the exception of a rock revetment providing bluff stabilization for Price Street (at Pismo Beach Rock Beach) and several bluff protection structures providing localized stabilization at each development (Inn at the Cove, Ventana Restaurant and Pacific Point Resort).
- Several pocket beaches exist along this segment, but access is limited.
- Four stormwater outfalls discharge at the bluffs.

Pacific Point Resort to Kon Tiki Inn (km 565–566)

- Steep coastal bluffs transition to flatter vegetated bluff faces as sandy beach widens toward the south.
- Bluff faces are set back from the active wave runup zone and are predominantly vegetated, indicating limited recent wave erosion at the bluff toe.
- No continuous seawalls or rock revetments are present.
- Public access is available via stairways at the SeaCrest Oceanfront Hotel, Wilmar Ave and the Kon Tiki Inn.
- The absence of hardened structural reinforcement at these stairways indicates limited historic wave impact (Figure 35).
- Residential and hotel development is present near the bluff edge, and stormwater drainage infrastructure extends from the bluff face.
- Eleven stormwater outfalls discharge at the bluffs.

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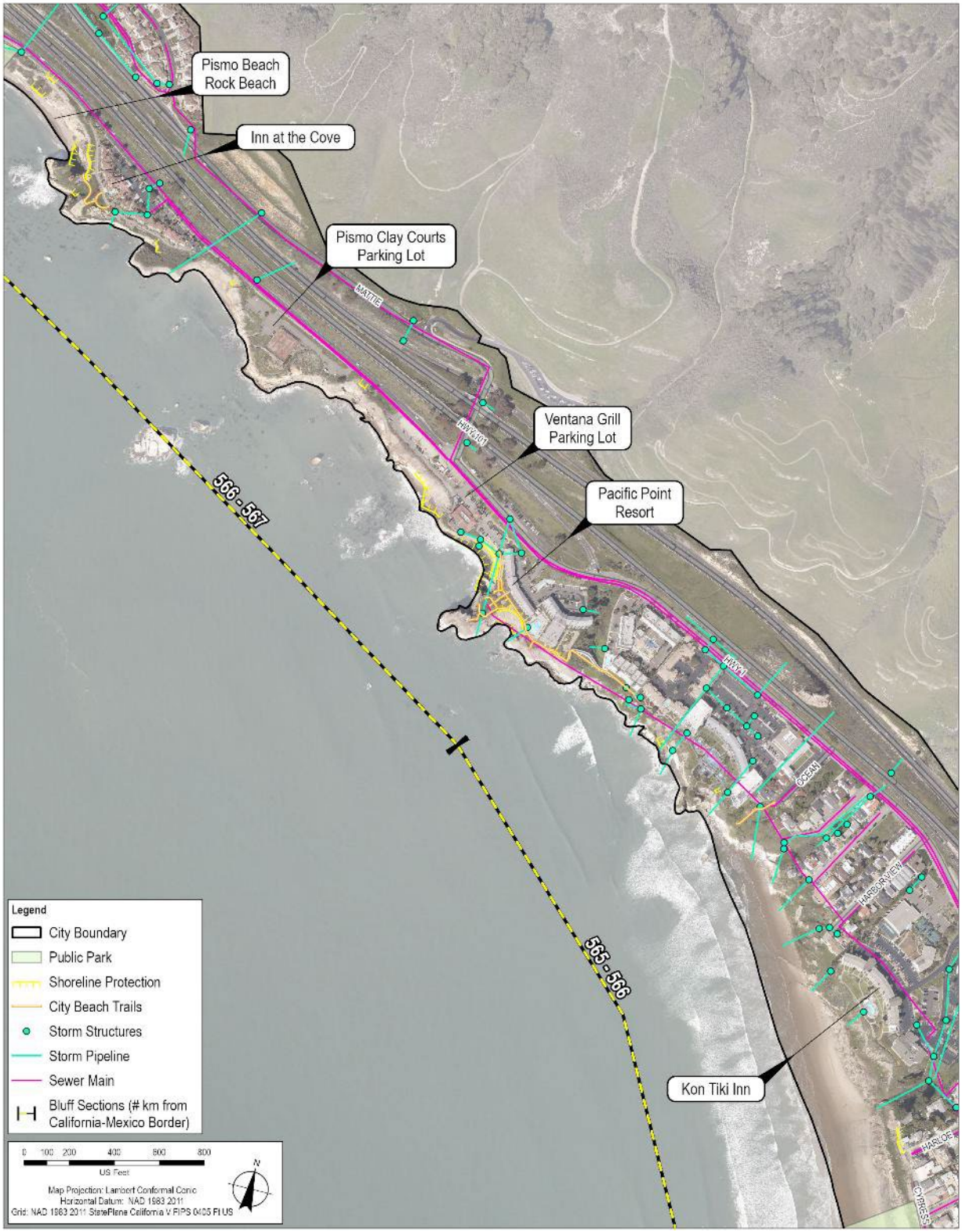


Figure 35 Existing shoreline, bluff, and development conditions for Area 5: Motel District.

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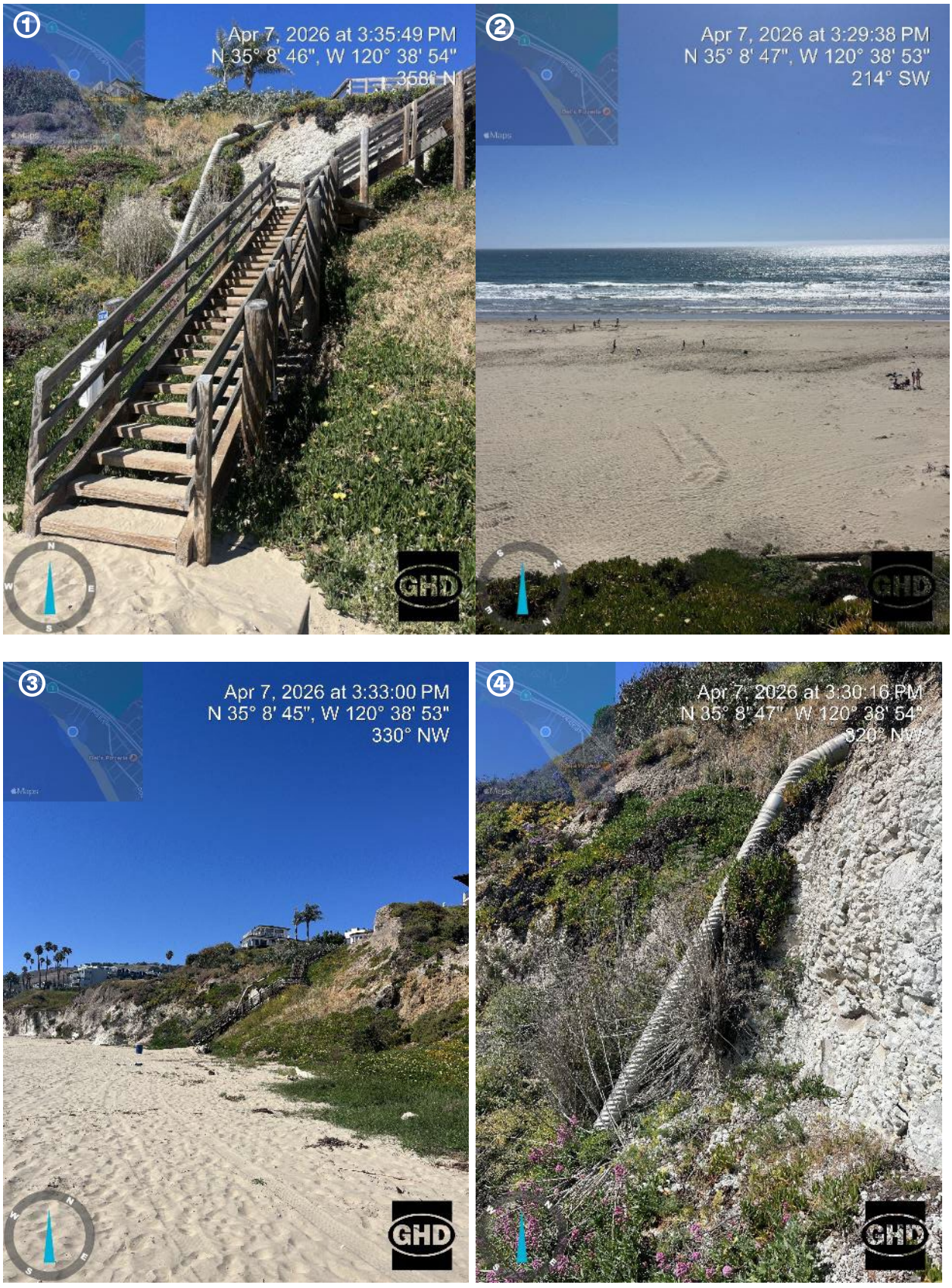


Figure 36 ***Area 5 Ground photos showing (1) Wilmar Avenue stairway and vegetated bluff face, (2) wide sandy beach at the north end of Pismo Beach, (3) transition from steep bluff to flatter vegetated bluff slope, and (4) drainage infrastructure extending over the bluff face.***

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6.5.2 Future SLR Hazards

The primary SLR hazards in Area 5 are shoreline erosion affecting pocket beaches and the north end of Pismo Beach, and bluff erosion across the entire area. Vulnerability in this area reflects the combination of high exposure (visitor-serving infrastructure located immediately landward of the bluff edge), high sensitivity (pocket beaches, stairways, and low-lying drainage to even moderate shoreline retreat), and low adaptive capacity (development constrained between bluff edge and Price Street with limited setback options). Vulnerabilities by hazard type are described below.

Coastal Bluff Erosion

Updated data from the SIO Coastal Processes Group provide retreat rates for two 1-km bluff segments within Area 5 (Table 11). Bluff-face retreat rates exceed bluff-top retreat rates in segment 566–567 (0.02 to 0.27 ft/yr face retreat). This pattern suggests active undercutting processes that may precede future blufftop instability. In segment 565-566 the bluff transitions to a flatter and well-vegetated slope less prone to wave-induced erosion. The bluff top retreat rate are greater than bluff-face retreat in this segment and could result from localized stormwater runoff or other factors at the top of bluff. As SLR increases, wave energy will reach the bluff toe more frequently, increasing the frequency and severity of episodic slope failures. Projected bluff retreat extents for Area 5 are shown in Figure 36.

Table 11 ***Historic bluff-top and bluff-face retreat rates for Area 5 (Motel District), summarized for bluff sections adjacent to visitor-serving development.***

Time Period	Bluff Section (# km from the California-Mexico Border)	
	566-567	565-566
Mean Bluff Top Retreat Rate (ft/yr)		
1998 - 2010	0.22	0.26
2010 - 2016	0.00	0.00
2016 - 2023	0.00	0.00
Mean Bluff Face Retreat Rate (ft/yr)		
1998 - 2010	0.20	0.06
2010 - 2016	0.02	0.01
2016 - 2023	0.27	0.06

Beach Loss and Shoreline Erosion

Shoreline erosion in Area 5 varies between the bluff-backed pocket beaches and the north end of Pismo Beach.

– Pismo Beach Rock Beach (bluff-backed pocket beach) varies from 30-60 feet in width in response to seasonal wave conditions. CoSMoS-COAST projections for the 1.6-ft SLR (near-term) scenario indicate shoreline retreat to the bluff toe which is consistent with the Bruun Rule analysis that indicates shoreline retreat of 20-40 feet. This scenario will result in more frequent wave action at the bluff toe, and fewer recreational opportunities as the beach becomes submerged and/or eroded for longer durations.

– North end of Pismo Beach: CoastSat analysis indicates a long-term accretionary trend, with an average shoreline advance of approximately +1.88 ft/yr and significant seasonal variability. Under near- and mid-term conditions, the beach is expected to remain relatively stable and keep pace with SLR, assuming the accretion trend continues throughout these planning horizons. Under long-term SLR (4.9 ft), the Bruun Rule analysis indicates shoreline retreat from SLR would outpace accretion trends and shift the beach to an erosion trend, reducing the storm wave buffer provided by a wide sandy beach.

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Figure 37 Bluff erosion projections based on SIO historical erosion rates for Area 5: Motel District

Coastal Flooding and Groundwater Emergence

USGS CoSMoS flood projections indicate that, while much of Area 5 sits on elevated bluff terrain that limits direct flooding from coastal storms or groundwater emergence. Coastal groundwater emergence is expected to play a

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more limited role in Area 5 than in the low-lying creek and marsh areas (Area 7), given the bluff-backed setting and locally steep topography.

However, in low-elevation pockets near the north end of Pismo Beach rising groundwater tables coupled with elevated ocean water levels may prolong post-storm beach flooding and increase saturation of soils supporting bluff-top development and infrastructure. At mid-term and long-term planning horizons, these processes are likely to shorten the recovery window between storm events, accelerate corrosion and damage to stairwell foundations and drainage infrastructure that extend to the bluff toe.

Coastal Access and Recreation Assets

Future bluff erosion is expected to impact coastal access and recreational resources progressively across Area 5:

– Near-term: The California Coastal Trail provides unique bluff-top access along Area 5 and will be exposed to bluff erosion outside of protected areas. Bluff erosion could result in temporary or permanent closures of the path depending on location. Several trail segments are already constrained alongside Price Street.
– Price Street is a key transportation corridor that provides vehicular access along Area 5. Several segments of the roadway are near the bluff edge, with one location already stabilized with rock revetment.
– Mid-term and Long-term: Continued bluff retreat will further jeopardize the California Coastal Trail. Additionally, beach access stairways will be exposed to greater wave forces as SLR is expected to diminish the width of already narrow pocket beaches.

Stormwater Infrastructure

The 15 stormwater outfalls in Area 5 discharge along the bluff face and several extend to the base of bluff. As sea levels rise and beach width decreases, these systems will be increasingly exposed to wave action and erosion. Depending on their elevation and structure these outfalls may experience greater exposure to wave action, potentially requiring more frequent maintenance and repair.

Residential & Commercial Properties

Most residential properties within Area 5 are generally set back from the bluff edge and are unlikely to be vulnerable to coastal bluff erosion hazards in the near-term. There are 4-5 properties near the existing bluff edge, but this segment of bluff is well vegetated and hasn’t been subject to the active bluff erosion observed to the west. The vulnerability of this development over mid- and long-term planning horizons will depend on how the beach and bluff erosion processes respond to SLR. If accretion trends continue the sandy beach will provide an effective buffer against rising sea levels and increased wave runup. If the shoreline trend reverses (i.e. becomes erosional), then SLR will likely cause increased wave attack at the bluff toe and higher bluff retreat rates than observed recently.

Although many commercial properties in Area 5 are located along or near the bluff edge, most primary buildings are set back from the existing and projected future hazard zones or are located behind bluff stabilization features that reduce near-term exposure to erosion hazards. As a result, the greatest vulnerability at many visitor-serving properties is expected to occur outside the main building footprints, where public access amenities, bluff-top pathways, patios, parking areas, drainage features, and landscaped areas are closer to the bluff edge. These features may be increasingly affected by bluff retreat, localized slope instability, loss of beach buffer, and more frequent wave interaction at the bluff toe as sea levels rise.

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6.6 Area 6: Downtown Core

The Downtown Core serves as the commercial, civic, and recreational heart of Pismo Beach, supporting a vibrant mix of retail, dining, visitor-serving accommodations, residential uses, and public gathering spaces. Key recreational assets include the Pismo Beach Pier, beachfront promenade, public plazas, and direct beach access that attract both residents and visitors throughout the year. In contrast to the bluff-backed northern shoreline areas, this area transitions from bluff-top development to low-lying topography adjacent to Pismo Creek. Low elevation areas are more susceptible to flooding associated with coastal storm events, sea level rise, and fluvial hazards (Pismo Creek).

6.6.1 Existing Conditions

Area 6 (Downtown Core) marks the transition from the bluff-backed shoreline to the north into the lower-elevation, highly developed downtown waterfront and wide sandy beach system to the south. This transition in coastal setting and backbeach topography strongly influences both existing and future hazard exposure.

- North of Pismo Pier, medium-density residential development along Cypress Street extends close to the bluff edge. Bluff elevations in this area generally range from approximately 40 to 60 ft NAVD88, and the bluffs have been relatively stable compared with other parts of the City, although localized upper-bluff protection is visible in some areas.
- At Pier Plaza, the shoreline transitions to a hardened backshore condition where a perimeter seawall protects visitor-serving commercial development and primary coastal access features, including the pier approach, promenade, parking areas, ramps, and beach access stairs.
- Pier Plaza generally lies at an elevation of approximately 20 to 24 ft NAVD88, which is lower than the adjacent bluff-backed areas but still elevated above ocean water levels. The seawall and elevated plaza provide an important line of defense under existing conditions; however, this area remains sensitive to wave runup, overtopping, and storm-driven damage during high surf events, particularly as sea levels rise and reduce the vertical clearance between ocean water levels and the backshore improvements.
- Pismo Beach Pier extends seaward from Pier Plaza and is one of the City's most important coastal access, recreation, and visitor-serving landmarks. The pier provides over-water public access and fishing opportunities and functions as a defining feature of the Downtown waterfront. A major renovation of the Pier was completed in 2018 with deck elevations that range from ~20 feet NAVD88 at the seawall to ~28 feet NAVD88 at the offshore end.
- South of the Pier, commercial development continues along the back beach at similar elevations and is protected by a series of seawalls and other shoreline protection structures extending toward Park Avenue.
- At the southern end of the area, the Addie Street beach parking lot provides an important coastal access amenity and serves as one of the lowest developed areas in the Downtown Core, with elevations of approximately 15 ft NAVD88.
- Several stormwater outfalls are located at the Pier Plaza, Oceanview Ave and Addie St.
- A continuous pedestrian boardwalk provides lateral coastal access from Pier Plaza to Addie St.

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Figure 38 Existing Conditions for Area 6: Downtown Core

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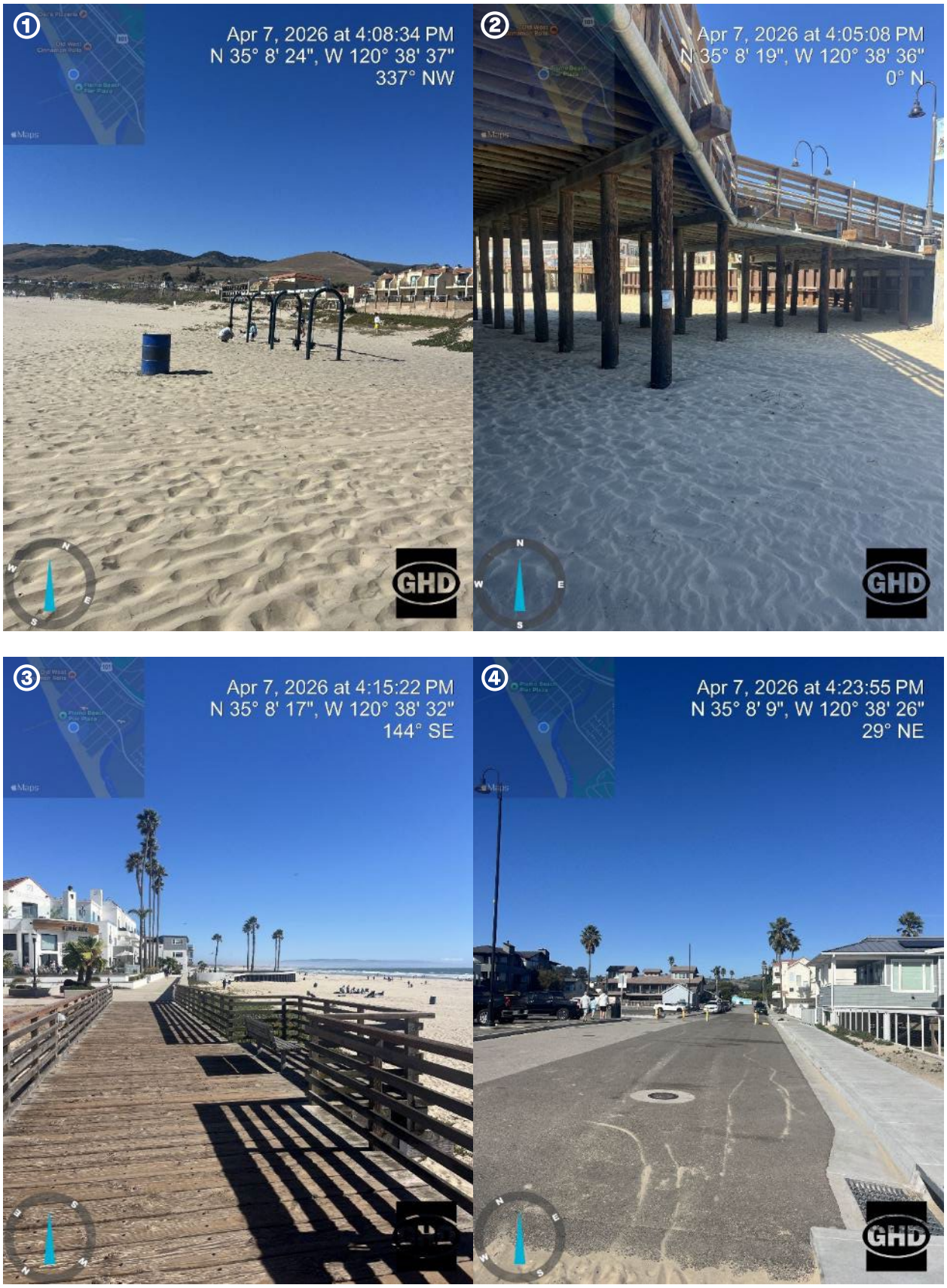


Figure 39 ***Area 6 Ground photos showing (1) the wide, gently sloping beach fronting bluffs north of the Pier; (2) the Pier Plaza seawall and elevated Pier deck; (3) Downtown beachfront development/boardwalk/public access points; and (4) low-lying parking lot at Addie Street.***

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6.6.2 Future SLR Hazards

The primary SLR hazards in Area 6 are shoreline retreat along Pismo State Beach, coastal storm flooding of low-lying areas, and increased wave impacts on seawalls and other backshore infrastructure. Vulnerability is driven by high exposure (low elevation and history of storm damage), high sensitivity (concentration of commercial and residential development), and low adaptive capacity in the near term due to dense development.

Coastal Bluff Erosion

SIO data for the northern edge of Area 6 is represented by segment 565-566 where the bluff transitions to a flatter and well-vegetated slope less prone to wave-induced erosion. These rates are summarized in Table 11 since they also applied to the southern segment of Area 5. The bluff top retreat rate is greater than bluff-face retreat in this segment (1998-2010) and could result from localized stormwater runoff or other factors at the top of bluff. As SLR increases, wave energy will reach the bluff toe more frequently, increasing the frequency and severity of episodic slope failures.

In the near-term, localized and episodic bluff erosion is anticipated along Cypress Street, potentially resulting in temporary closures and repairs to maintain parking and vehicular access. In the mid-term, increased bluff erosion is anticipated as coastal storm waves are more likely to reach the backbeach and could undermine the bluff toe. In the long-term, potential permanent closures of Cypress Street and erosion damage to bluff-edge residential properties are anticipated.

Beach Loss and Shoreline Erosion

As described in Section 5.2.1, Pismo Beach has historically exhibited a strongly seasonal shoreline response, with beach width fluctuating substantially between the wider summer/fall profile and the narrower winter/spring profile as shown in Figure 39 where wave runup reached the backshore in January 2024, but the beach recovered by September 2025 increasing in width by ~350 feet. CoastSat analysis indicates that the Downtown shoreline has remained broadly accretionary over the long term, and the observed rate of shoreline advance is expected to partially offset the near- and mid-term effects of sea level rise. As a result, incremental changes in the long-term shoreline trend associated with SLR are not expected to be as noticeable or immediately impactful as the much larger seasonal and storm-driven fluctuations in beach width that already occur under existing conditions.



Figure 40 Large seasonal shoreline change at Pismo Beach

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During stormy winters, particularly during strong El Niño conditions, elevated wave energy can narrow the beach profile, temporarily shifting the shoreline landward by hundreds of feet and producing very narrow or submerged beach conditions at high tide. These episodic winter conditions are the primary mechanism by which shoreline change affects the Downtown Core today because the loss of the dry beach buffer allows waves to run farther landward and interact more directly with the backshore bluffs, seawalls, beach access structures, Addie Street parking area, and other low-lying public access and visitor-serving facilities.

With future SLR, the same seasonal and storm-driven erosion cycles will occur from a higher baseline water level. Near- and mid-term SLR may not produce a visually obvious chronic retreat trend during typical beach conditions if ongoing accretion continues; however, higher water levels combined with heavily-eroded winter profiles will reduce the effective freeboard of coastal structures. Under these conditions, wave runup and overtopping are more likely to reach the backshore and cause flooding, sediment deposition, access closures, and damage to beachfront amenities. Consequently, the most important shoreline erosion vulnerability in Area 6 is not gradual year-to-year beach narrowing, but the increased frequency and severity of temporary beach loss during high-energy storm periods. Coastal flooding from such extreme events is evaluated in the following section.

Over the long term, higher SLR scenarios are expected to reduce the ability of the beach to maintain its current positive sediment balance. If the rate of SLR exceeds the natural accretion trend, the Downtown beach may transition toward progressive narrowing and more persistent shoreline retreat. This transition would reduce the protective function of the wide sandy beach, increase the duration of narrow or submerged beach conditions following winter storms, and expose the backshore more frequently to coastal flooding, wave runup, and overtopping hazards.

Coastal Flooding

Coastal flooding in Area 6 was evaluated using site-specific wave runup and overtopping results for six representative transects extending from Addie Street (Transect A) to Main Street (Transect F), supplemented by mapped 100-year storm flood extents shown on Figure 40. The results indicate that Area 6 is already vulnerable to wave overtopping during an extreme coastal storm, and that overtopping severity increases rapidly with each increment of SLR. Under existing conditions, the highest estimated overtopping rates occur at the lower-elevation backshore features, including Addie Street beach access, Park Avenue beach access, and Ocean View Avenue seawall. Existing-condition overtopping rates generally exceed the 1 L/s/m pedestrian safety threshold described in Section 5.3.2 at several locations and approach or exceed levels that may create hazardous conditions for people using the boardwalk, Pier Plaza, parking areas, and beach access routes during major storm events.

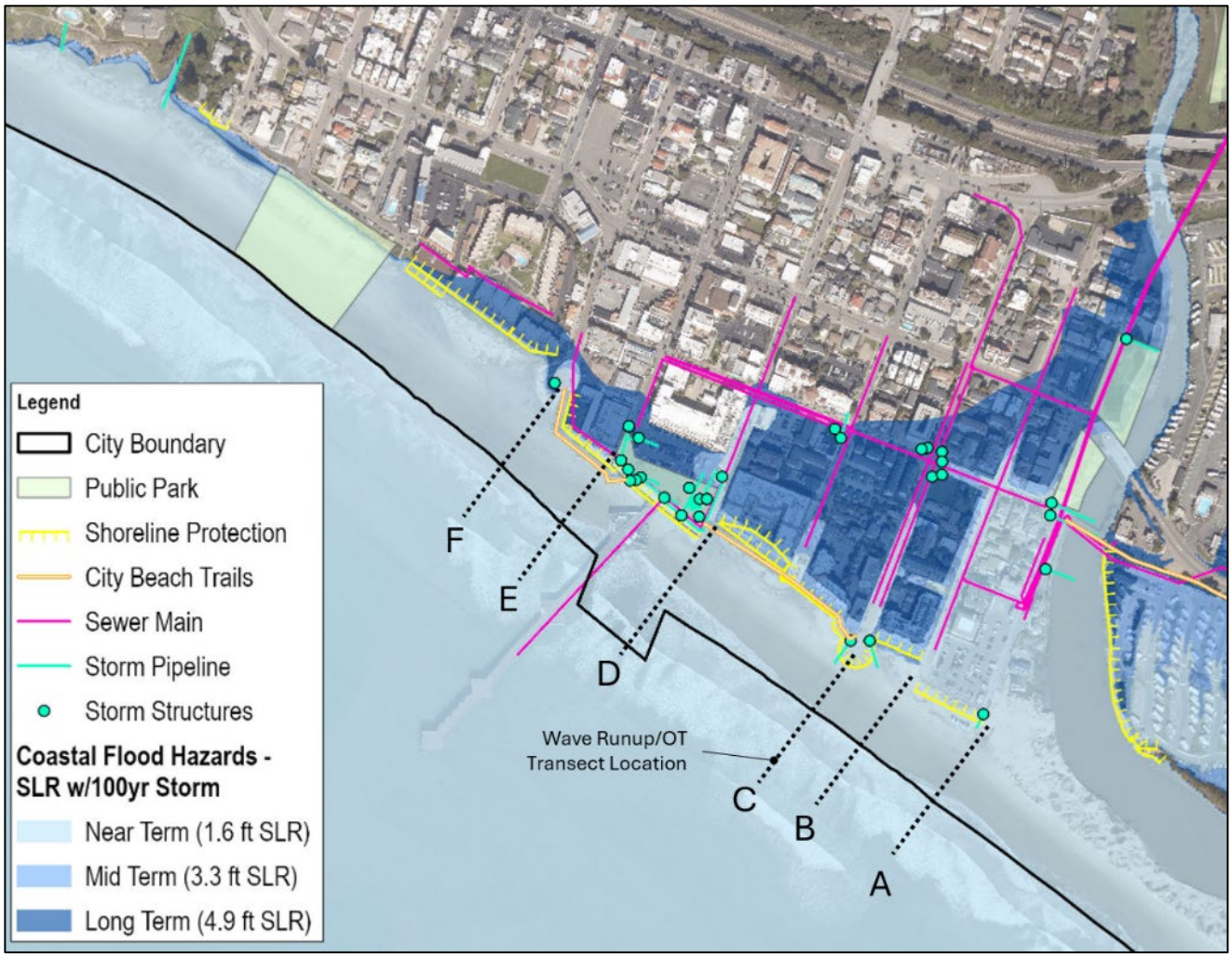
With 1.6 ft of SLR (near-term scenario), overtopping rates increase substantially and become hazardous across nearly the full Downtown shoreline. Estimated rates range from approximately 4 to 50 L/s/m across the evaluated transects, with Addie Street reaching the 50 L/s/m structural damage threshold and Park Avenue and Ocean View Avenue exceeding the 10–20 L/s/m vehicle safety threshold. At this planning horizon, overtopping is expected to create major flooding across the Addie Street parking lot, likely damage the beach restroom and low-lying backshore facilities, and produce extensive flooding in adjacent low-lying residential areas. Significant overtopping at Ocean View Avenue would create hazardous conditions for vehicles and pedestrians, while Pier Plaza and the boardwalk would become unsafe for pedestrian use during the design storm. As shown on Figure 41, flood extents under the near-term scenario are expected to expand landward from the beach access corridors and low points in the backshore, affecting parking, access, and visitor-serving areas that currently function as important connections between Downtown and the beach.

With 3.3 ft of SLR (mid-term scenario), overtopping rates increase to levels associated with widespread damage and loss of function for backshore infrastructure. Estimated overtopping rates range from approximately 30 to 250 L/s/m, exceeding the 50 L/s/m structural damage threshold at most evaluated locations, including Addie Street, Park Avenue, Ocean View Avenue, Hinds Avenue, and Main Street. Pier Plaza also reaches approximately 30 L/s/m, which exceeds pedestrian and vehicle safety thresholds and indicates conditions that would be unsafe for public access and operational use. Under this mid-term scenario, backshore infrastructure south of Pier Plaza would likely be overwhelmed by wave overtopping, with floodwaters and wave hazards extending well into adjacent developed areas (Figure 40).

With 4.9 ft of SLR (long-term scenario), overtopping rates become extreme throughout Area 6, ranging from approximately 100 to 650 L/s/m across the evaluated transects. These rates far exceed the pedestrian safety, vehicle safety, and structural damage thresholds described in Section 5.3.2 and indicate conditions capable of producing severe coastal flood damage, widespread sediment and debris transport, and substantial damage to

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backshore facilities and shoreline protection structures. The highest rates are projected at Addie Street and Park Avenue, where the relatively low backshore crest elevations allow wave overtopping to pass landward at very high discharge rates. Under this long-term scenario, flood hazards would extend farther into the Downtown neighborhoods, behind Pier Plaza, and especially through the southern portion of Area 6 where low-lying access points and parking areas provide direct pathways for wave-driven flooding. Figure 40 should be interpreted as a planning-level representation of these flood extents; actual flooding during an extreme storm would depend on the seasonal beach profile, storm duration, wave conditions, tide level, and the condition of shoreline protection and other infrastructure or adaptation strategies implemented over the coming decades.



				100-yr Wave Overtopping Rates (l/s/m)			
Transect	**Backshore Type**	**Transect Description**	**Backshore Crest Elevation (ft, NAVD88)**	**no SLR**	**1.6 ft SLR**	**3.3 ft SLR**	**4.9 ft SLR**
A	Berm	Addie St beach access	15.2	2	50	250	650
B	Berm	Park Ave beach access	16	1	30	200	550
C	Seawall	Ocean View Ave Seawall	16.7	3	20	80	250
D	Ramp	Hinds Ave beach access ramp	19	0	7	80	280
E	Seawall	Pier Plaza	20.8	1	7	30	100
F	Ramp	Main St beach access ramp	20	0	4	50	220

Figure 41 Wave overtopping results & estimated 100 year coastal storm flooding for Area 6: Downtown Core

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Pismo Beach Pier

As documented in the prior Sea Level Rise Vulnerability Assessment, the Pismo Beach Pier has experienced significant damage during past extreme storm events, including the 1982-1983 El Niño winter, when a portion of the pier collapsed and required reconstruction (Moffatt & Nichol, 2019). The pier was rebuilt in 1984-1985, with a landing deck elevation of approximately 20.9 feet NAVD88, rising to approximately 26 feet NAVD88 over the first 200 feet, and then gradually increasing to approximately 28.5 feet NAVD88 near the seaward end. Subsequent rehabilitation in 2016-2017 included structural improvements, including replacement of wooden piles seaward of the first 200-foot segment with steel piles.



Figure 42 Low Tide at Pismo Pier

Pier exposure to future wave-related damage was evaluated using CoSMoS water levels and wave heights for large coastal storm events in combination with sea level rise. The assessment considered the pier vulnerable where calculated maximum wave crest elevations reached or exceeded the pier deck elevation, because wave impact on the deck can generate substantial uplift and lateral forces on the deck, piles, and connections. Wave-related damage may also be exacerbated by scour around piles, excessive wave-induced loading on aging structural elements, and debris impacts during major storm events.

For each sea level rise scenario, wave crest profiles were developed from the significant wave height associated with the CoSMoS 100-year coastal storm event and compared against the pier deck profile. These profiles represent the estimated elevation of the upper portion of storm waves along the length of the pier and were used as a screening-level indicator of where waves could reach the deck and cause direct structural loading or damage. The prior analysis concluded that any amount of sea level rise would increase the potential for storm-related pier damage, with vulnerability increasing substantially under sea level rise scenarios of 3.3 feet and higher (Moffatt & Nichol, 2019).

Groundwater Emergence

USGS CoSMoS groundwater modeling indicates that rising sea levels may increase groundwater elevations in coastal areas. Although widespread direct flooding from groundwater emergence is unlikely in Area 6, elevated groundwater levels could still increase vulnerability by raising the depth of liquefiable soils, increasing buoyancy forces on below-ground infrastructure, and reducing the ability of subsurface systems to drain following storm events. These effects are most likely to become consequential during severe local or regional earthquakes or during coastal and fluvial flood events, when higher groundwater levels may increase pore-water pressures, reduce soil strength, reduce subsurface drainage capacity, increase the persistence of flooding, and contribute to geotechnical instability affecting utility vaults, lift and pump stations, parking structures, and other buried or partially buried infrastructure.

Coastal Access and Recreational Assets

Coastal access and recreational assets within Area 6 are highly exposed to storm-driven beach loss, wave runup, and overtopping because many access features are located directly along the backshore or connect low-lying public spaces to the beach. The most vulnerable access assets are the wood stairways at Pismo Pier and Pier Plaza, where recent high-surf events have already caused damage requiring repair and temporary loss of public access. These stairways are particularly sensitive because they are located at the transition between the elevated plaza and the active beach, where seasonal beach lowering and storm wave runup can expose foundations, damage wood members, and accelerate deterioration.

As sea levels rise, similar storm conditions are expected to occur from a higher baseline water level, increasing the likelihood that these stairways will experience more frequent damage, closure, or replacement needs. Other backshore access features, including the boardwalk, ramps, promenade connections, and lateral access paths that follow the shoreline between Pier Plaza and Addie Street, are vulnerable primarily to the wave overtopping

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hazards described above. During high-energy winter storms, overtopping can make these routes unsafe for pedestrians, deposit sand and debris, damage railings or surface treatments, and interrupt continuous public access along the Downtown waterfront.

Utilities and Stormwater Infrastructure

Stormwater and wastewater systems in the Downtown Core are sensitive to SLR due to their reliance on gravity flow and outfall discharge. As sea levels rise, reduced outfall capacity, increased backwater effects, and wave interaction with discharge points may affect system performance. Flooding and wave action may also increase maintenance demands and reduce reliability during storm events. Multiple pump and lift stations in the Downtown area are already exposed to flooding hazards during extreme fluvial storm events; the FEMA 100-year floodplain in this area includes the Addie Street Pump Station at the northeast corner of the beach parking lot, a buried lift station near the southern landing of the Cypress Street Bridge, and additional lift stations northeast of Dolliver Street. Tidal flooding is not expected to reach these pump stations until a long-term SLR scenario, but rising groundwater will increase uplift forces on below-ground infrastructure well before then.

Residential & Commercial Properties

Residential and commercial property vulnerability in Area 6 is driven primarily by extreme coastal flooding associated with wave runup and overtopping, as described above. Under the near-term scenario, the first row of commercial development south of Pier Plaza is vulnerable to damage from extreme wave runup and overtopping, with approximately four commercial properties exposed where development is located immediately landward of the beach and shoreline protection structures. In addition, approximately 15 to 20 residential properties along Addie Street and Park Avenue are vulnerable to coastal flood damage, including some multi-unit residential complexes located within low-lying areas.

Under the mid-term scenario, more extensive damage is expected along the first row of commercial development, and residential properties (~20-30) between Stimson Avenue and Addie Street become vulnerable as overtopping rates increase and flood extents expand farther landward into the Downtown backshore.

Under the long-term scenario, extensive coastal flooding is projected to extend back toward Cypress Street and farther inland along the Pismo Creek corridor, affecting a much larger portion of the Downtown Core. At this planning horizon, approximately 100 to 200 commercial and residential properties may be exposed to coastal flood impacts, including direct flood damage, wave-driven debris and sediment deposition, access disruptions, and potential utility failures during extreme coastal storm events.

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6.7 Area 7: Pismo Creek / Pismo Marsh

The Pismo Creek and Pismo Marsh area is a low-lying coastal planning area separated from Downtown Core by Pismo Creek. The area contains three primary land use types: commercial uses, including visitor-serving RV parks; residential mobile home parks; and open space uses, including campground areas, the Monarch Butterfly Grove, Pismo Marsh, creek corridors, trails, and associated habitats. These uses support coastal recreation, visitor access, affordable and lower-cost coastal accommodations, and important biological resources, but their low elevation and proximity to Pismo Creek make them particularly vulnerable to compound flooding from coastal storms, fluvial storms, groundwater emergence, and future sea level rise. Balancing commercial recreational use, residential mobile home park resilience, public access, habitat conservation, and long-term flood risk reduction is a key consideration within this planning area.

6.7.1 Existing Conditions

Area 7 includes the area between Pismo Creek and the southern City limit, including development along Pismo Marsh that extends upstream along Meadow Creek (Figure 42). This is the only planning area in Pismo Beach without coastal bluffs. Coastal hazards in this low-lying area influenced by both coastal (tides, storm surge, wave-driven water levels) and fluvial (watershed runoff) processes. This area is characterized by:

– A channelized lower reach of Pismo Creek, with partially stabilized banks consisting of small rock revetments interspersed with wetland vegetation.
– Pismo Creek mouth experiences seasonally variable berm/inlet dynamics; CoastSat data indicate an overall accretionary trend with significant variability in beach width and berm conditions (Figure 46).
– Two vehicular bridges connect this planning area to the Downtown Core: Cypress Street bridge supports both vehicular and pedestrian traffic, and the bridge at Dolliver Street/Pacific Coast Highway (PCH) includes a parallel pedestrian crossing.
– Commercial recreational land uses (RV Parks) line the south bank of Pismo Creek
– Residential mobile home parks are located east of Dolliver St/PCH and bordered by the railroad tracks which bisect the planning area.
– Multiple sewer lift stations service these areas: one located near the Cypress Street bridge, and two along Dolliver St/PCH which service the mobile home parks.
– Stormwater is assumed to be largely conveyed via surface flow since the available GIS data indicate only very limited storm drain infrastructure.
– Pismo State Beach – North Beach Campground occupies some of the lowest-lying topography in the planning area, located behind the coastal dunes and adjacent to Monarch Butterfly Grove.
– Pismo Marsh is located east of railroad tracks. Development adjacent to Pismo Marsh includes a mobile home park and commercial land uses (Pismo Premium Outlets and 5 Cities Shopping Area) which are higher in elevation.

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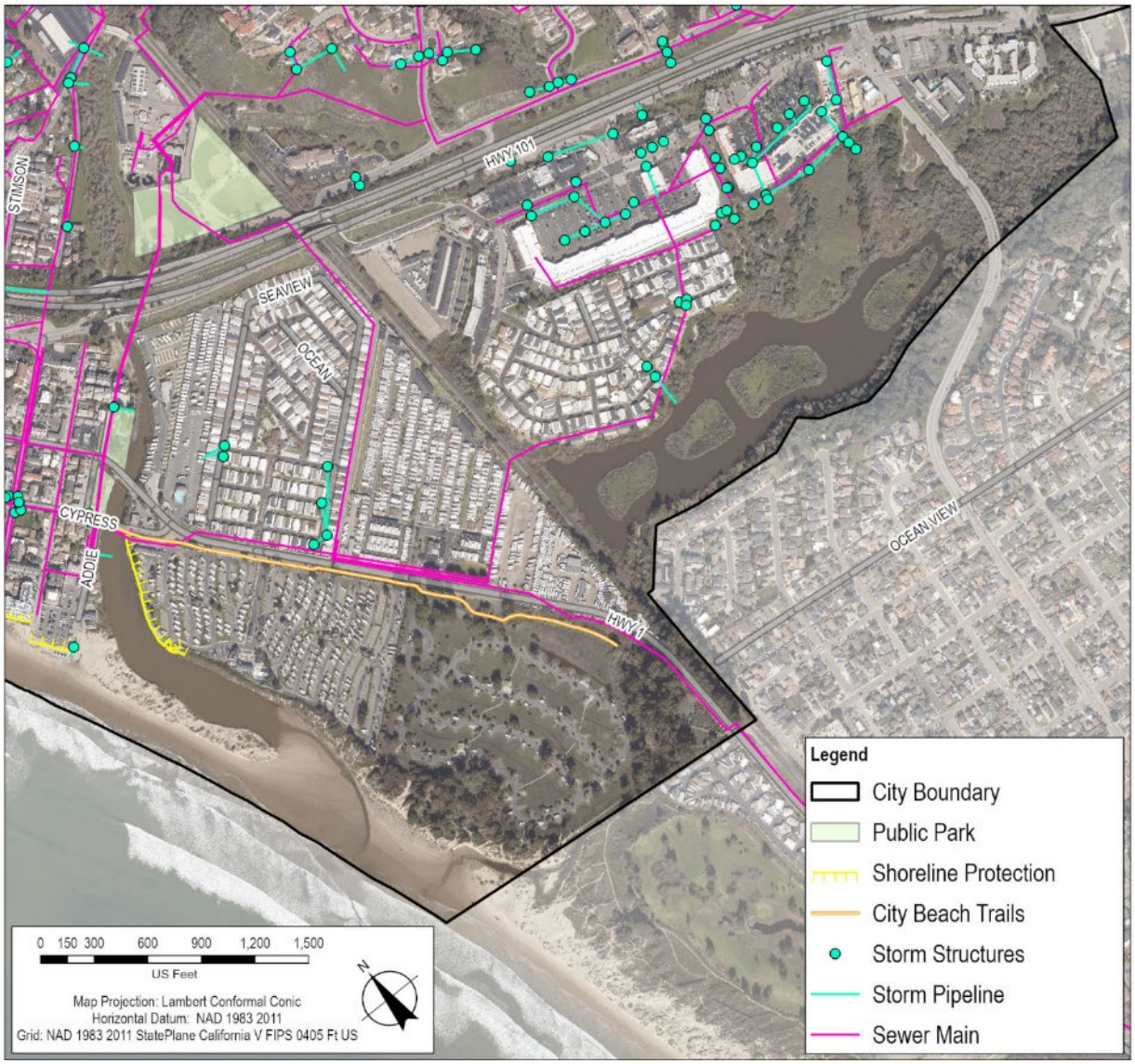


Figure 43 Existing Conditions for Area 7: Pismo Creek / Pismo Marsh

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Figure 44 *Area 7 Ground photos (1) Pismo Creek mouth, looking south; (2) Dolliver St/PCH bridge; (3) Cypress Street bridge (4) bank stabilization along Pismo Creek.*

6.7.2 Future SLR Hazards

The following subsections evaluate the range of future SLR-related hazards affecting Area 7, where low-lying recreational, residential, commercial, and open space uses are influenced by the combined effects of ocean water levels, creek flows, groundwater, and beach and creek-mouth dynamics. Hazards evaluated include tidal flooding during king tide conditions, changes in shoreline and creek-mouth behavior, coastal flooding from extreme storm events, compound flooding associated with Pismo Creek and Meadow Creek fluvial events, groundwater emergence, and related effects on stormwater and utility infrastructure, coastal access and recreational assets, and residential and commercial properties. Because these hazards interact within the Pismo Creek/Pismo Marsh system, vulnerability in Area 7 is driven not only by future SLR, but also by creek conveyance limitations and backwater conditions sensitive to changing coastal processes.

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Tidal Flooding

Tidal flooding in Area 7 was evaluated using the hydraulic model described in Section 5.4.1, which simulates water levels within Pismo Creek, Meadow Creek, and adjacent low-lying areas under representative king tide conditions with future SLR. Results indicate limited flooding during a king tide event under the near-term scenario with 1.6 ft of SLR, with inundation largely confined to the creek channels, creek mouth, and back beach areas. This suggests that, under near-term tidal-only conditions, most developed areas remain outside the primary tidal flood extent, although low-lying areas adjacent to the creek channels may experience reduced drainage efficiency and more frequent nuisance flooding during high tides.

Under the mid- and long-term SLR scenarios, modeled tidal flooding extends beyond the creek channels and back beach into adjacent low-lying recreational areas, including the RV park and campground. These results indicate that these visitor-serving and lower-cost recreational accommodations will require adaptation strategies to mitigate tidal flood hazards at these planning horizons.

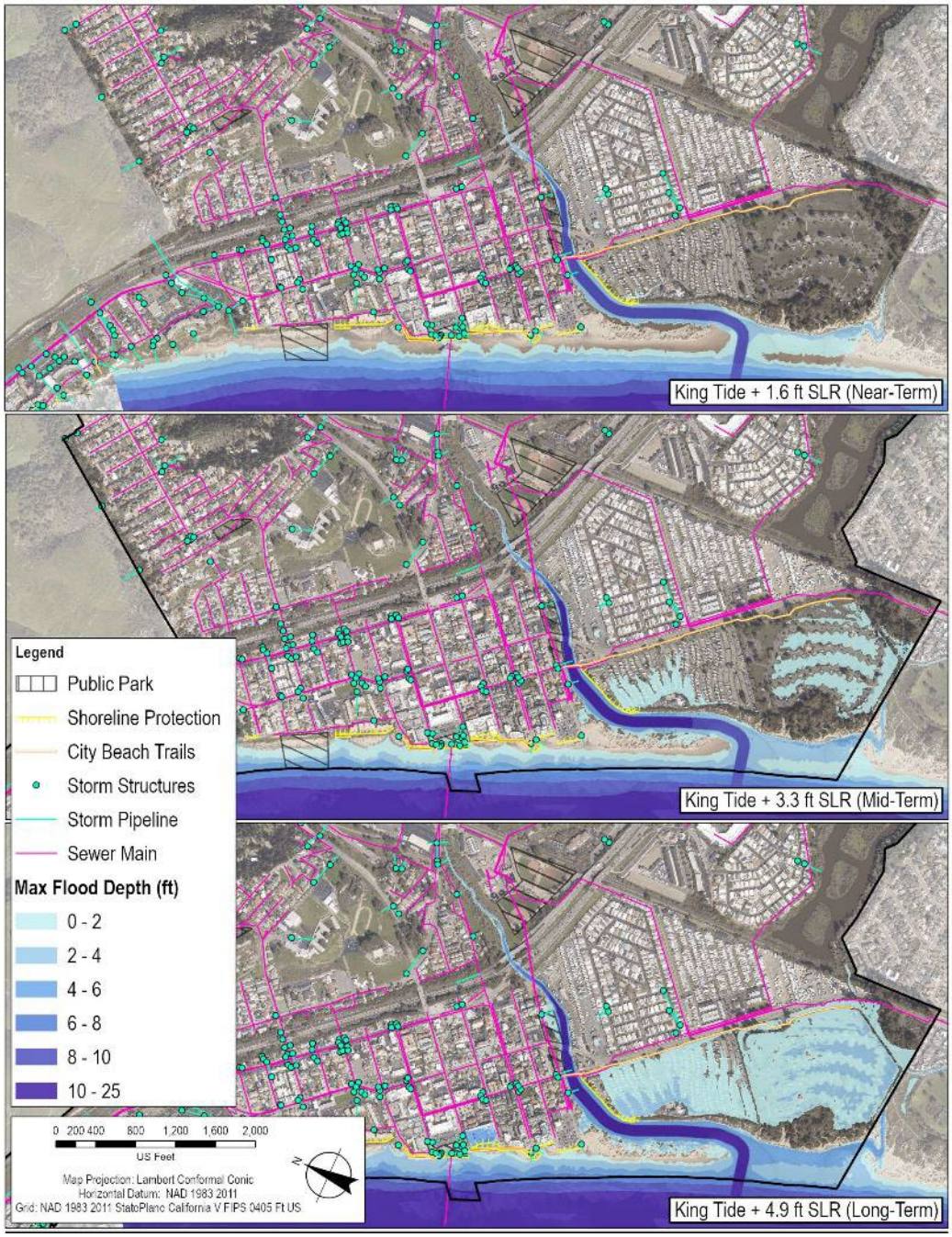


Figure 45 King tide flooding with SLR at Pismo Creek/Pismo Marsh

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Beach and Creek Mouth Dynamics

Shoreline behavior near the Pismo Creek mouth is an important control on flood behavior because beach width, berm elevation, and inlet breaching influence whether high water levels are confined to the channel or spread across adjacent low-lying areas. Similar to Area 6, CoastSat data indicate that this portion of Pismo Beach experiences substantial seasonal and inter-annual shoreline variability, with winter storm erosion followed by beach recovery and accretion during calmer periods. Near- and mid-term SLR-induced erosion may be partly offset by the historically accretionary trend along Pismo Beach; however, higher water levels will reduce the effective beach and berm buffer during storm events and are expected to increase the frequency and severity of temporary beach loss, wave runup, and backshore flooding. Over the long term, higher SLR scenarios are expected to shift beach profile dynamics toward more persistent landward migration and reduced berm stability.

Coastal processes in Area 7 are further complicated by the interaction of Pismo Creek and Meadow Creek, which typically confluence on the back beach before discharging to the ocean. These fluvial processes interact with coastal processes that can act in opposing directions. During coastal storm events, waves can push sand higher and farther landward into the creek mouth and lower channel, as observed during the January 2024 storms (Figure 45 and Figure 46). This wave-driven sand deposition can partially block or constrict the creek outlet and reduce channel conveyance capacity, a condition evident in the September 2025 aerial image (Figure 46) where the beach and dune system has recovered but now occupies the former creek channel. The influence of the beach berm is evident on fluvial processes of both creeks. The Pismo Creek channel is constrained at the back beach alongside the RV Park with algae visible on the surface which could be a result of stagnant water in the estuary. Meadow Creek channel is entirely blocked in the September 2025 image. The sand deposition observed does not cause a permanent loss in flood conveyance but it will result in temporary backwater effects (higher creek water levels) until the sand berm is breached. This process looks to have occurred by October 2025 as both creeks have re-established a larger hydraulic connection to the ocean.



*Figure 46 January 2024 coastal storm at Pismo Creek (Dronesey: **https://www.youtube.com/watch?v=SsmdVRc_fpY**)*

This tension between wave-driven sand deposition and creek-driven breaching is expected to become more pronounced with SLR. Higher ocean water levels will allow waves to deposit sand farther landward and at higher elevations within the creek mouth and lower channel. Sand deposition does not represent a permanent loss of flood conveyance because the berm can breach during sufficiently large creek flows; however, it can temporarily reduce conveyance and create backwater effects until breaching occurs. The threshold for when these backwater effects will occur when the beach berm/dune elevations exceed the elevations of the creek bank alongside the RV Park and campground. During these periods, water levels in Pismo Creek and Meadow Creek may rise higher and persist longer, increasing the likelihood of flooding in adjacent low-lying areas. Under the near-term SLR scenario, these dynamics are expected to result in more frequent flooding adjacent to both Pismo Creek and Meadow Creek. Under mid- and long-term SLR scenarios, larger shifts in beach profile and berm dynamics are expected, and active management of the berm elevation or other interventions (i.e. flood protection or other strategy) may be needed to maintain flood conveyance capacity in the creek channels.

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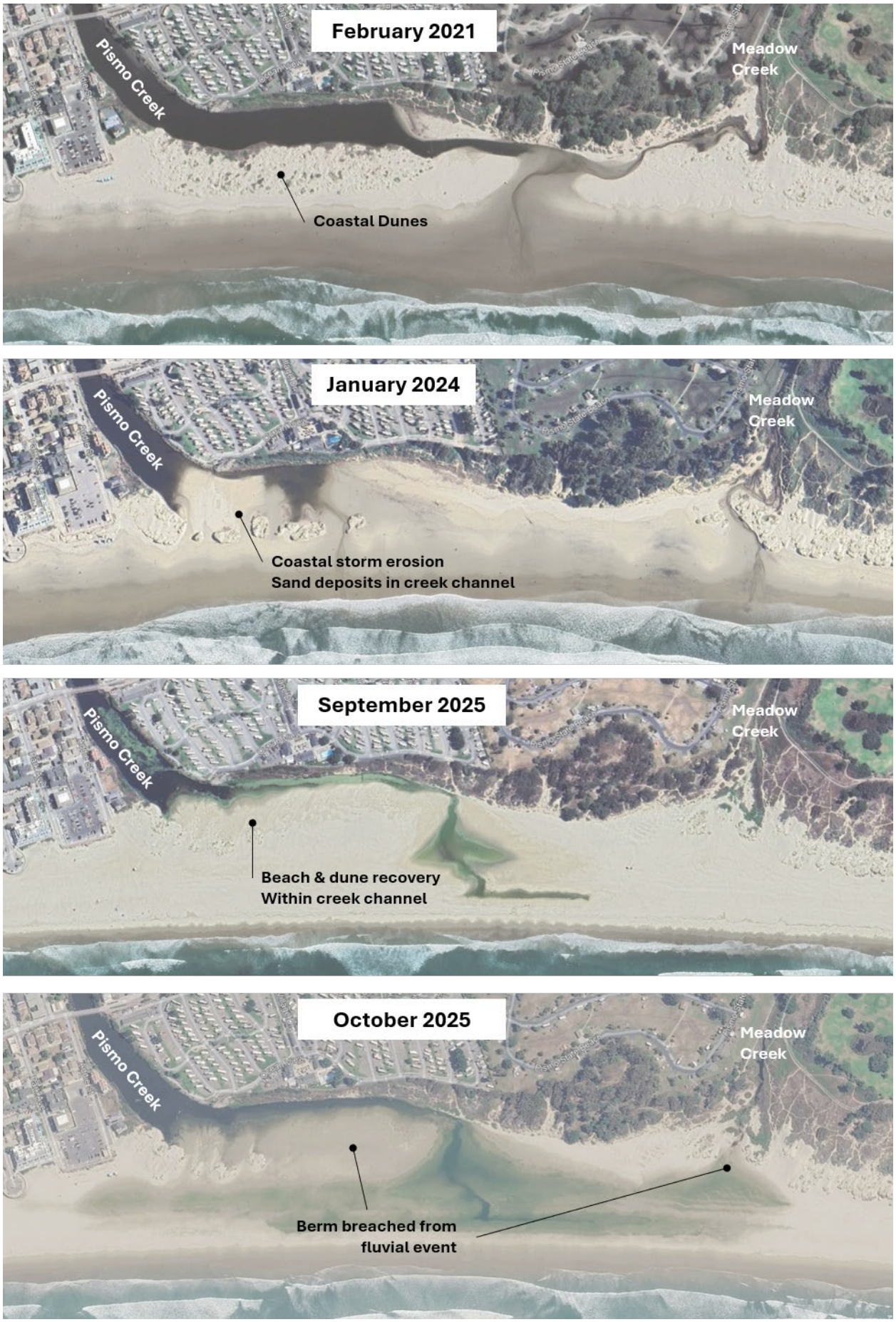


Figure 47 *Pismo Creek Mouth dynamics – 2024 coastal storm erosion & recovery*

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Coastal Flooding

Coastal flooding in Area 7 was evaluated using USGS CoSMoS results for the 100-year coastal storm event under the near-, mid-, and long-term SLR scenarios. Under the near-term scenario, wave-driven flooding is expected to overtop the Pismo Creek bank and extend into the adjacent RV park. This indicates that even with 1.6 ft of SLR, the combination of elevated coastal water levels and storm waves may be sufficient to flood low-lying commercial recreational areas along the south bank of Pismo Creek.

Under the mid-term scenario, coastal flood extents are projected to reach Dolliver Street/PCH, resulting in flooding of the entire RV park and campground in this area. At this planning horizon, flooding would affect key visitor-serving and lower-cost recreational accommodations and may disrupt access along the primary transportation corridor between the Downtown Core and the Pismo Creek/Pismo Marsh area. Under the long-term scenario, CoSMoS results indicate that coastal flood extents would reach the railroad corridor and cause widespread flooding of mobile home parks and surrounding land uses.

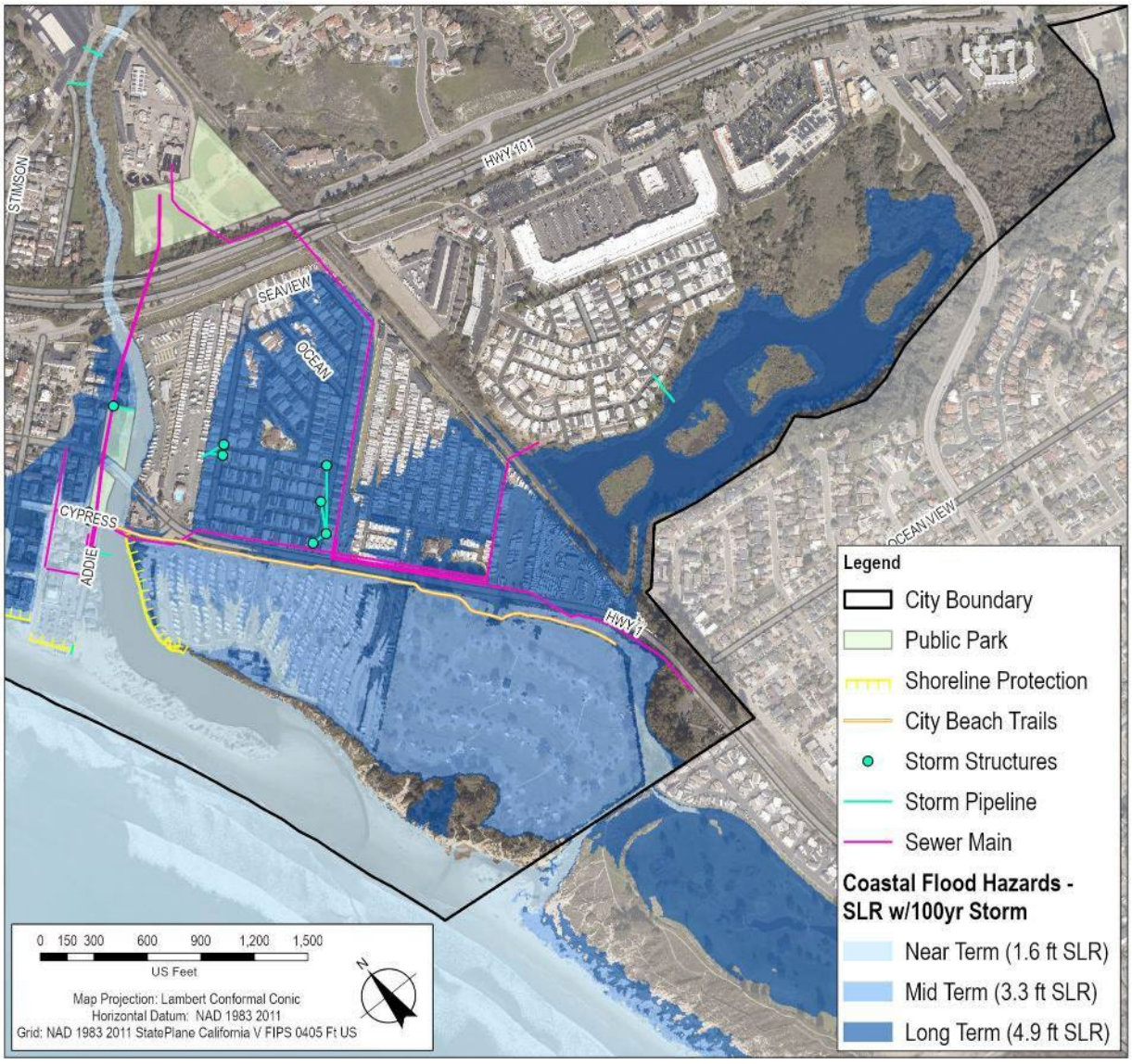


Figure 48 USGS CoSMoS 100-year coastal storm conditions Area 7

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Compound Flooding

Compound flooding in Area 7 was evaluated using the hydraulic model described in Section 5.4.1 to assess fluvial flood hazards and their sensitivity to SLR. The modeling considered both 10-year and 100-year fluvial events under existing and future ocean water level conditions.

Results for the 10-year fluvial event without SLR indicate widespread flooding downstream of Dolliver Street/PCH, with flood depths of up to 2 ft within the RV park and 4-6 ft within the campground (Figure 48). These flood extents are similar in overall footprint to the projected coastal storm flooding with 3.3 ft of SLR; however, the 10-year fluvial event has a much higher probability of occurrence than the future combination of mid-term SLR and an extreme coastal storm. This is an important finding because it indicates that fluvial flooding is a higher-probability and potentially higher-risk hazard for this planning area than coastal flooding driven solely by future SLR and extreme coastal storm conditions.

Model results for the 10-year fluvial events with 1.6 ft and 3.3 ft of SLR are very similar, indicating low sensitivity to higher ocean water levels during these extreme fluvial events. Based on these findings, extreme fluvial flooding in Area 7 appears to be driven primarily by limited conveyance capacity within Pismo Creek and Meadow Creek rather than by elevated downstream ocean boundary conditions. Higher ocean water levels may still affect creek-mouth berm dynamics, drainage efficiency, and the duration of backwater conditions during lower-flow events, but they do not significantly increase flood extents or depths during the modeled extreme fluvial events. These results suggest that adaptation strategies for Area 7 should prioritize maintaining and improving creek conveyance capacity, managing sediment and berm conditions at the creek mouth, and reducing exposure of low-lying recreational and residential uses to recurring fluvial flood hazards.

Results for the 100-year fluvial event indicate widespread flooding throughout Area 7 downstream of the railroad corridor, including portions of Area 6 along Pismo Creek (Figure 49). Flood depths generally range from approximately 2 to 6 ft within the RV parks and mobile home parks downstream of the railroad. These results are consistent with the FEMA Flood Insurance Rate Map shown in Figure 14, which identifies extensive 100-year flood hazard areas along the lower Pismo Creek and Meadow Creek floodplain. Similar to the 10-year fluvial event, inclusion of higher downstream ocean water levels to represent SLR did not significantly change the modeled 100-year flood extents or depths. This indicates that creek channel conveyance capacity, rather than elevated ocean water levels, is the primary factor driving widespread flooding during extreme fluvial events in this planning area.

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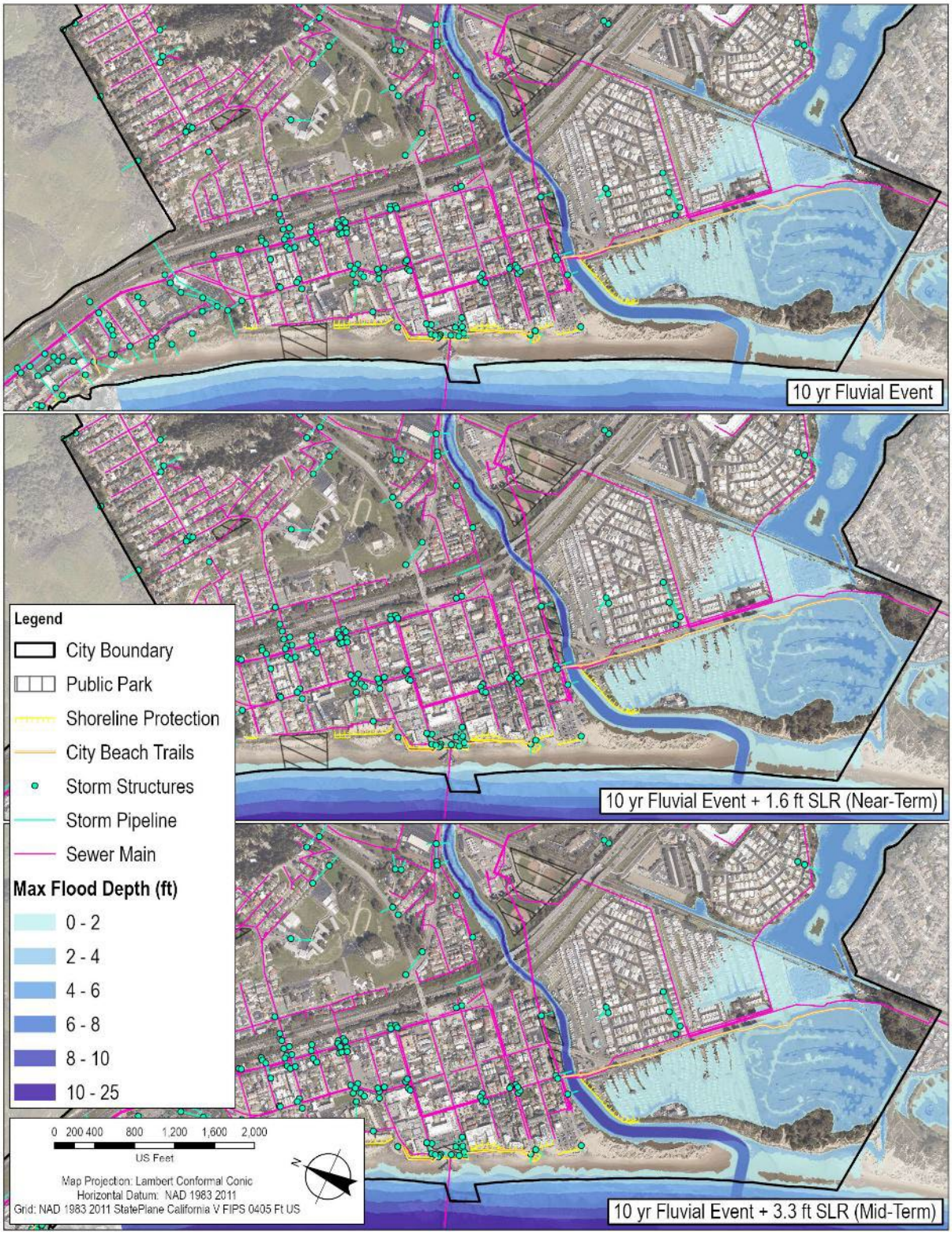


Figure 49 Compound flooding for 10-year fluvial event on Pismo Creek

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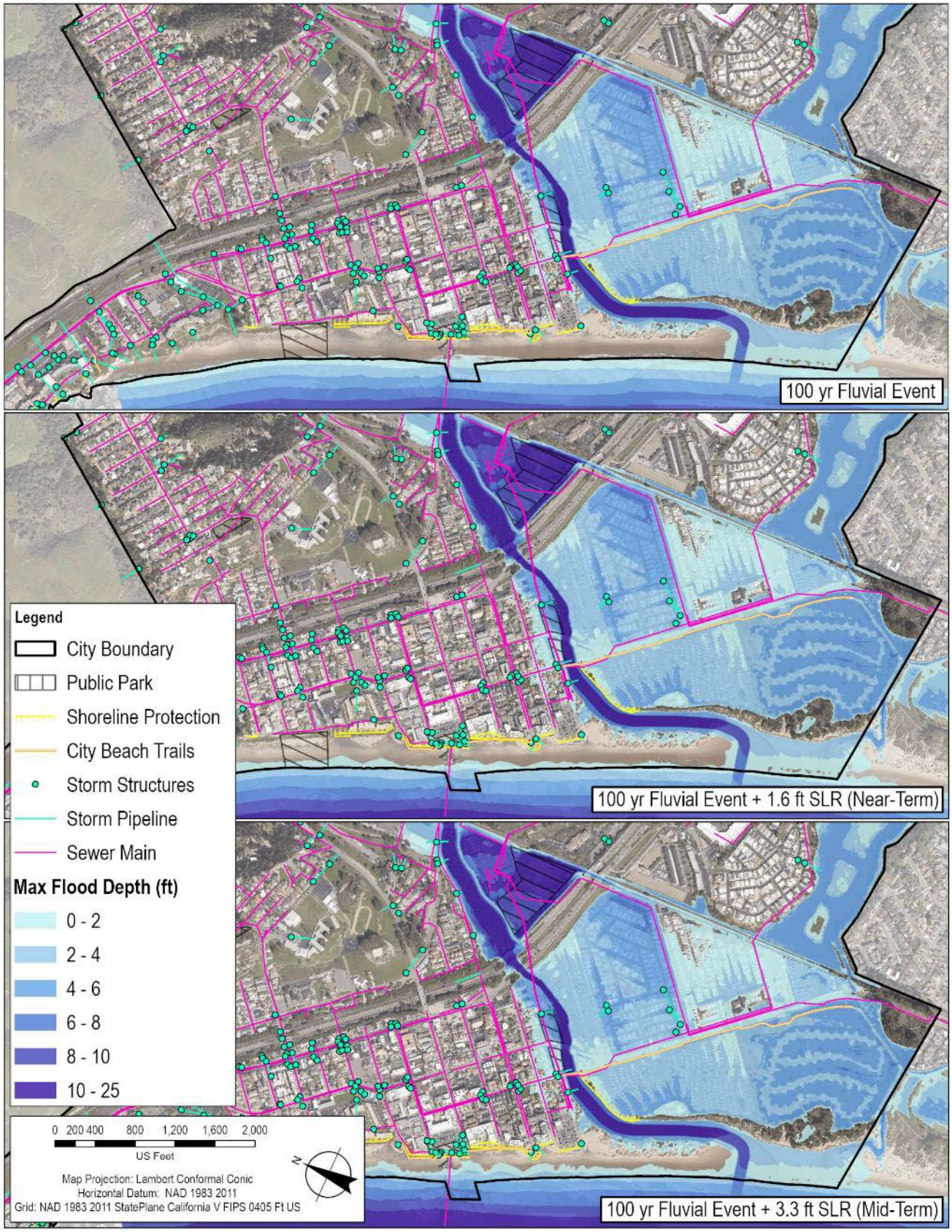


Figure 50 ***Compound flooding for 100-year fluvial event on Pismo Creek***

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Groundwater Emergence

USGS groundwater modeling indicates that under moderate subsurface conditions:

– At approximately 1.6 ft of SLR, shallow groundwater and localized emergence may occur, particularly near Pismo State Beach North Campgrounds and along creek-adjacent areas (Figure 50).
– At approximately 3.3 ft of SLR, results indicate emergent groundwater throughout the campground and Pismo Marsh (Figure 51). This suggests that persistent flooding may require substantial modifications to campground configuration and use patterns to maintain safe and functional recreational access.
– At approximately 4.9 ft of SLR, more widespread groundwater emergence and persistently shallow groundwater conditions are projected south of Pismo Creek (Figure 52).

Elevated groundwater levels may reduce drainage efficiency, increase the duration of flooding, and create persistently saturated ground conditions affecting access routes, recreational uses, and overall site usability.

Higher groundwater levels may also alter the hydrology of Pismo Marsh by changing the frequency, duration, and spatial extent of saturated or inundated conditions. These changes could affect salinity gradients, vegetation communities, and habitat function as the marsh ecosystem responds to higher water levels and changing freshwater-saltwater interactions.

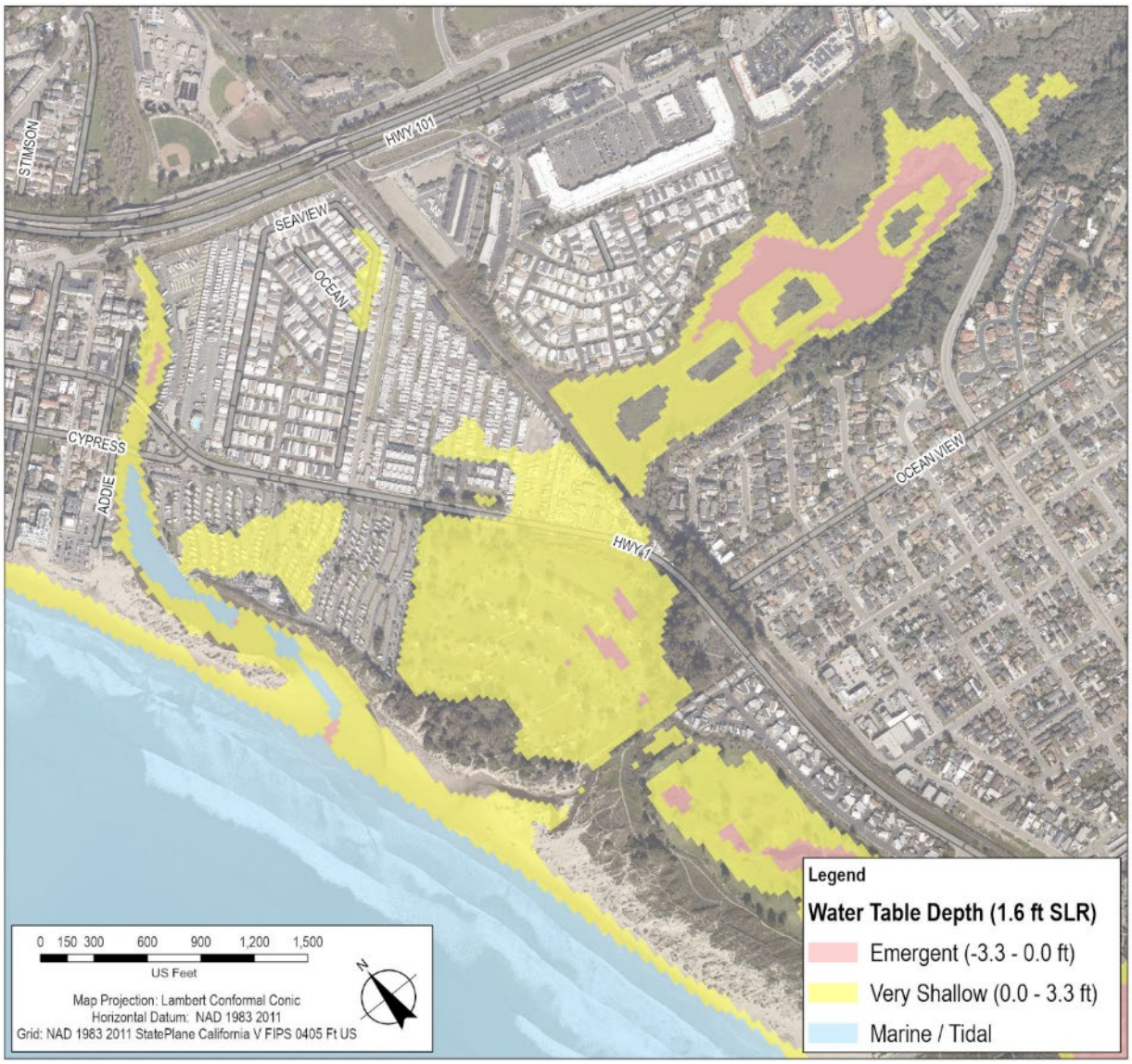


Figure 51 USGS groundwater depth and emergence projections with 1.6 ft SLR for Area 7: Pismo Creek / Pismo Marsh

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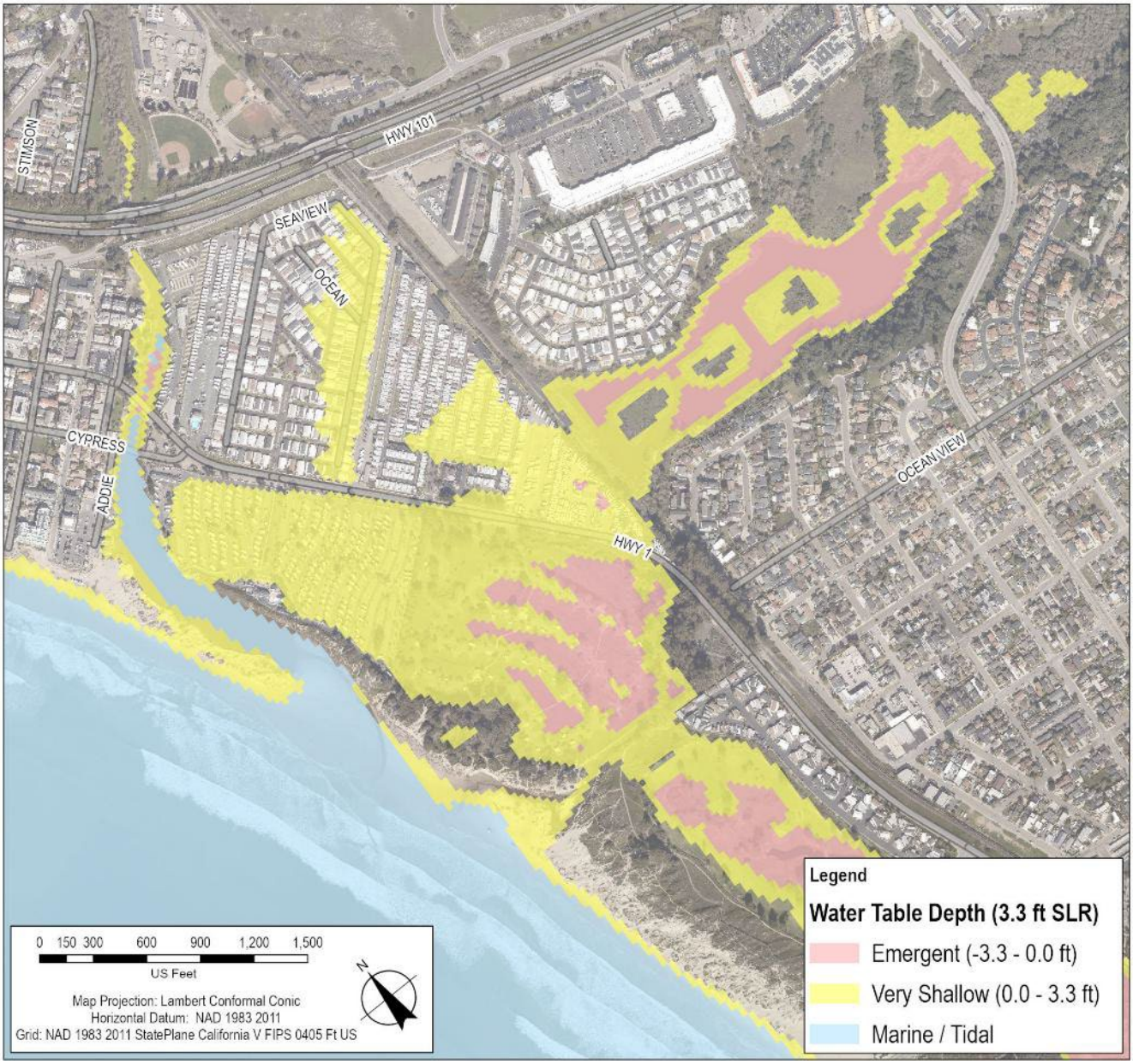


Figure 52 USGS groundwater depth and emergence projections with 3.3 ft SLR for Area 7: Pismo Creek / Pismo Marsh

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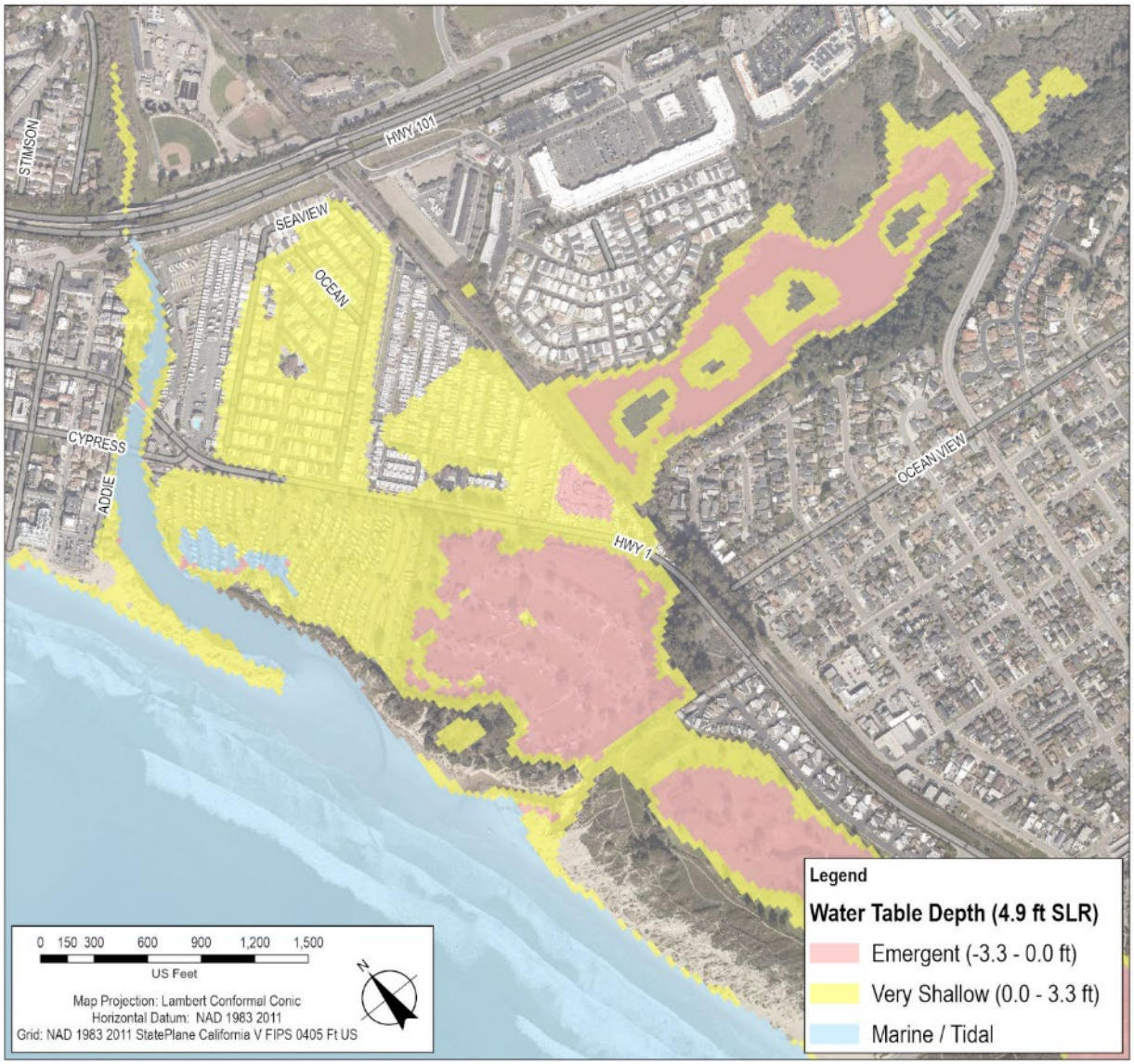


Figure 53 USGS groundwater depth and emergence projections with 4.9 ft SLR for Area 7: Pismo Creek / Pismo Marsh

Coastal Access and Recreational Assets

Future impacts to coastal access and recreational resources progress as follows:

– Near term: Shallow groundwater emergence near the North Campgrounds and backwater flooding during storms cause periodic access disruptions and saturation of low-lying recreational areas, mostly around the campground and RV Park.
– Mid term: Tidal flooding affects RV facilities southwest of Dolliver St/PCH during normal conditions; access disruptions and reduced usability during high-water conditions increase. Loss of low-cost camping/RV access carries equity implications for regional access to coastal resources.
– Long term: Tidal flooding affects nearly the entirety of RV facilities southwest of Dolliver Street; groundwater emergence is widespread south of Pismo Creek; habitat function within the marsh corridor shifts due to changing inundation patterns.

Stormwater and Utility Infrastructure

Wastewater infrastructure in Area 7 is sensitive to both surface flooding and elevated groundwater. The lift station near the southern landing of the Cypress Street Bridge, and two additional lift stations northeast of Dolliver St/PCH already lie within the FEMA 100-year floodplain and these facilities are essential to maintaining service to the RV Parks and mobile home parks of Area 7. Below-ground systems (utility lines, lift stations, vaults) face increased risk from higher groundwater levels, reduced soil strength, and prolonged saturation under each SLR scenario.

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Strategies that focus on flood proofing and redundancy will improve the resilience of this infrastructure to fluvial and coastal hazards.

Surface flow systems that rely on gravity drainage may also become increasingly vulnerable under future SLR scenarios. As downstream water levels in Pismo Creek, Meadow Creek, and the marsh rise during high tides, coastal storms, or fluvial events, the available hydraulic gradient for drainage will be reduced, shortening the duration and effectiveness of gravity-flow conveyance. This can increase ponding in low-lying areas, and compound flooding impacts where surface drainage must discharge to channels already affected by elevated tailwater, tidal backwater, or creek-mouth berm conditions.

Residential and Commercial Properties

Residential and commercial property vulnerability in Area 7 is driven primarily by exposure to flooding from extreme fluvial and compound flood events, with increasing contributions from coastal water levels, creek-mouth dynamics, and groundwater emergence over time. As described in Section 6.7.1, development downstream of the railroad corridor includes commercial recreational uses along the south bank of Pismo Creek, including RV parks; residential mobile home parks east of Dolliver Street/PCH and near Pismo Marsh; and supporting commercial land uses adjacent to the marsh and Meadow Creek corridor. These properties are located within a low-lying floodplain influenced by Pismo Creek, Meadow Creek, the back beach, and the creek-mouth berm, making them highly sensitive to changes in channel conveyance, backwater effects, and flood duration.

Commercial and residential development located upstream of the railroad corridor and adjacent to Pismo Marsh, including Pismo Premium Outlets, 5 Cities Shopping Center, and the mobile home park in this area, is outside the project hazard zones and benefits from its relatively higher elevation.

A key finding of the hydraulic modeling is that essentially all development downstream of the railroad corridor is vulnerable to flooding during extreme events, including RV parks, mobile home parks, campground areas, and nearby commercial uses. In the near term, this vulnerability is associated primarily with low-frequency but potentially damaging fluvial flood events, rather than SLR alone. Building resilience to these events will be important to sustaining both commercial recreational and residential uses in Area 7, particularly because flood depths during modeled extreme events are sufficient to damage structures, disrupt access, affect utilities, and temporarily displace residents, visitors, and campground users. Adaptation strategies for these properties should therefore prioritize flood preparedness, protection of critical utilities, evacuation and access planning, and site-specific measures that reduce damage and recovery time following major flood events.

By the mid-term SLR scenario, flood hazards affecting residential and commercial properties are expected to become more frequent as the interaction between coastal and fluvial processes intensifies. Higher ocean water levels, more frequent creek-mouth berm formation or higher berm elevations, reduced drainage efficiency, and backwater effects are expected to increase the frequency, duration, and operational consequences of flood episodes. These more frequent flood episodes may result in recurring access disruptions, damage to low-lying structures and site improvements, utility interruptions, and reduced usability of RV, campground, and mobile home park areas. Over time, maintaining these commercial and residential uses will likely require coordinated adaptation strategies that address both episodic extreme flood resilience and more frequent mid-term flooding associated with the combined effects of SLR, creek conveyance limitations, groundwater rise, and changing beach and creek-mouth dynamics.

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