Wastewater and Water Systems Climate Adaptation Plan

Executive Summary

PUBLIC DRAFT

DECEMBER 2025 CITY OF SANTA BARBARA

CITY OF SANTA BARBARA

Wastewater and Water Systems Climate Adaptation Plan

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Prepared by Water Systems Consulting, Inc. and Environmental Science Associates

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Water Systems Consulting, Inc. would like to acknowledge the significant contributions of the City of Santa Barbara. The primary contributors are listed below.

Melissa Hetrick, Adaptation and Resilience Manager

Kelly Bourque, Senior Project Engineer

Timmy Bolton, Senior Climate Adaptation Analyst

Joshua Haggmark, Director of Water Resources

Bradley Rahrer, Principal Project Manager

Thomas Welche, Wastewater System Manager

Amanda Flesse, former Wastewater System Manager

Matthew Ward, Water System Manager

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The Wastewater and Water Systems Climate Adaptation Plan was prepared by Water Systems Consulting, Inc. The primary authors are listed below.

WSC

Rob Morrow, PE

Patricia Parks, PE

Michelle Heinrichs

Adam Donald, PE

Michael Steele, PE

Cynthia Kahn

ESA

Nick Garrity, PE

Amber Inggs, PE

Annie Roberts, EIT

James Jackson, PE

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS & ABBREVIATIONS

Acronym	Description
AOP	Advanced Oxidation Process
AWPF	Advanced Water Purification Facility
BFE	Base Flood Elevation
CALTRANS	California Department of Transportation
CCC	California Coastal Commission
CCTV	Closed Circuit Television
CFS	Cubic Feet per Second
CIWQS	California Integrated Water Quality System
CMIP6	Coupled Model Intercomparison Project 6
COMB	Cachuma Operation and Maintenance Board
COSMOS	Coastal Storm Modeling System
DFE	Design Flood Elevation
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FT	Feet
GCM	General Circulation Model
HDPE	High-Density Polyethylene
IN	Inch
IPCC	Intergovernmental Panel on Climate Change
I&I	Infiltration and Inflow
LOCA2	Localized Construction Analogue Version 2
MBR	Membrane Bioreactor
MF	Microfiltration
MG	Million Gallons
MGD	Million Gallons per Day
MHHW	Mean Higher High Water
MJHMP	Santa Barbara County Multi-Jurisdictional Hazard Mitigation Plan
MLLW	Mean Lower Low Water

MSL	Mean Sea Level
NPDES	National Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
OPC	Ocean Protection Council
OST	Ocean Science Trust
PRV	Pressure Reducing Valve
PSCA	Pump Station and Chemical Area
PVC	Polyvinyl Chloride
QCM	Quantitative Conceptual Model
RCAMP	Regional Coastal Adaptation Monitoring Program
RCP	Reinforced Concrete Pipe
RCP	Representative Concentration Pathway
RO	Reverse Osmosis
SAFE	Stormwater Adaptive Filtration Equipment
SLIP	Sewer Lateral Inspection Program
SLR	Sea Level Rise
SSO	Sanitary Sewer Overflow
SSP	Shared Socioeconomic Pathways
UPRR	Union Pacific Railroad
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UV	Ultraviolet
VFD	Variable Frequency Drive
WDR	Waste Discharge Requirement
WUCA	Water Utility Climate Change Alliance

Executive Summary

This Wastewater and Water Systems Climate Adaptation Plan evaluates impacts on the City's critical water and wastewater systems from hazards worsened by climate change. It is part of a broader City Adaptation and Resilience Program, which monitors changing conditions and adapts infrastructure in phases. Funded by the California Coastal Commission, Coastal Conservancy, and the City itself, the Plan satisfies state requirements and supports City Council's goals to prepare for the effects of climate change.

What's in the Plan:

- Analysis of impacts from flooding, erosion, sea level rise, changing rainfall, wildfire, drought, extreme heat, and groundwater on all parts of the wastewater and water systems.
- Focuses on low-lying coastal areas that face the greatest threat from flooding and erosion.
- Prioritization of vulnerabilities: the highest risks are impacts to the wastewater system from flooding during heavy rainfall events and coastal storms (high ocean waves and storm surge).
- Recommended actions to improve resilience in phases, based on defined thresholds.

Key Hazard Risks:

- <u>Next 20 years</u>: As the climate warms, rain becomes more intense, and the 100-year rain event is five times more likely and 10-year storm (e.g., January 2023 storm) is twice as likely. During heavy rainfall and high wave events, floodwater can enter the sewer collection system. This can overwhelm both the collection pipes and capacity at the treatment plant (El Estero Water Resource Center), potentially causing sewer overflows. Flooding from moderate rainfall events can also surround and affect access to the plant. During very large rainfall events, some equipment and treatment processes at the plant could also be at risk from onsite flooding.
- <u>20-50 years</u>: Sea-level rise accelerates and, without intervention, the Waterfront area and Cabrillo Boulevard, including underlying utilities, faces significant erosion and flooding from coastal storms El Estero WRC faces significant flooding risk from large rainfall events combined with sea level rise. Without intervention, low-lying areas north of Cabrillo Blvd and south of Highway 101 could also face flooding from coastal storm surge. This increases the risk of significant amounts of seawater getting into the sewer system, which would affect operation of the El Estero Water Resources Center as the plant

treatment process relies on bacteria that can't survive in saline conditions.

- 50+ years: Without intervention, low-lying areas north of Highway 101 could face flooding from coastal storm surge. Additionally, by 4.9 feet of sea level rise (~2100) flooding from regular high tides would extend into low-lying areas north of Highway 101. Significant seawater flows into the wastewater collection system would render the El Estero Water Resources Center unable to treat wastewater for extended periods following inundation events.

Priority Adaptation Actions for Near-Term Implementation:

- Wastewater Collection System: Build on existing projects to seal manholes in low-lying and Waterfront areas, rehabilitate flood-prone sewer lines, and increase collection system and treatment plant storage to handle increased flows from flooding and prevent infiltration of saline water. Make plans to pressurize the sewer system in low-lying areas in phases in the next 20 to 50 years. Customer connections will need to be modified prior to the public sewer mains being pressurized. The City should consider an ordinance in the next five years to require new connections in the low-lying areas to include grinder pumps needed for pressurization and incentives to customers to facilitate conversion of existing sewer connections over the next 20 years.
- El Estero WRC: Develop a formal operations plan for El Estero Water Resource Center during flooding events and implement additional flood protection measures (e.g., floodwalls and elevation of key infrastructure).
- Coastal Erosion: Plan to protect or relocate infrastructure affected by shoreline erosion in near and mid-term (potable water line in Chase Palm Park, desalination weir box, and utilities in Cabrillo Boulevard and Shoreline Drive). Plan for long-term relocation of the West Beach sewer main inland.

- Studies: Develop stormwater system models and options to reduce flooding for low-lying areas and prolong the useful life of existing water and wastewater infrastructure.

Implementation:

- Regularly monitor changes in coastal features and assess infrastructure in flood-prone and coastal areas.
- Update this Plan every 10 years to address changed conditions and new information.
- Plan for funding needs and staff resources. In the next 20 years:
  - $2 to 3 million for studies and design
  - $50 to $130 million in infrastructure modifications
  - Additional staff resources (i.e., engineers, project managers, operators)
- Long-term planning should consider the costs and impacts of protecting El Estero Water Resources Center in place and elevating access roads or relocating the plant by the end of this century. Any potential relocation decision will be informed by future monitoring and extensive coordination with the community and neighboring sanitary agencies to explore opportunities in and outside of the City for potential regional consolidation of treatment facilities. Among properties currently owned by the City that are not anticipated to be impacted by sea level rise, the municipal golf course is one possible location that is large enough to accommodate a new treatment plant.

ES-1 Introduction

This Wastewater and Water Systems Climate Adaptation Plan (Plan) assesses how hazards exacerbated by climate change could impact City of Santa Barbara's (City) wastewater and water infrastructure and outlines a phased approach for adapting these systems over time. Building on the City's 2021 Sea-Level Rise Adaptation Plan (2021 SLR Adaptation Plan) (ESA, 2021) and the 2021 Santa Barbara County Climate Change Vulnerability Assessment (County of Santa Barbara, 2021), it focuses on a range of climate hazards, including sea level rise, increased storm rainfall, coastal flooding and erosion, wave impacts, tidal inundation, and groundwater rise. It includes a detailed analysis of these threats, while providing a higher-level review of drought, extreme heat, and wildfire risks, which are already largely addressed through the City's existing water supply planning and operations.

Asset-specific analysis was conducted for the following critical infrastructure:

- The wastewater collection system, including lift stations.
- The wastewater treatment system, including El Estero Water Resource Center (El Estero WRC) and the treatment plant's outfall system (El Estero outfall).
- The potable water treatment systems, including the Charles E. Meyer Desalination Plant (Desalination Plant) and the associated ocean intake pipeline.
- The potable water distribution system.
- The recycled water system, including the planned potable reuse system.

While the Plan addresses the impacts of climate hazards on the entire wastewater and water systems in the City, special attention is paid to increasing the resilience of the wastewater collection system in the low-lying, prone flood areas of the City that are most at risk in the near-term. Risks and adaptation options are structured into three timeframes: near-term (within the next 20 years), mid-term (20 to 50 years), and long-term (50+ years).

This Plan satisfies permitting and planning requirements of the California Coastal Commission and the City's El Estero WRC National Pollutant Discharge Elimination System (NPDES) permit.

Citywide Adaptation and Resilience Program

This Plan is part of a broader Citywide Adaptation and Resilience Program developed to implement policies in the City's General Plan and Coastal Land Use Plan that address adaptation to hazards worsened by climate change. The program collaborates across all City departments and with regional and state agencies to ensure a unified, proactive approach to climate adaptation. It also supports compliance with state requirements for climate analysis tied to permits, plans, and funding, positioning the City to secure funding and implement resilience projects effectively.

In 2021, City Council adopted the 2021 SLR Adaptation Plan, which outlined priority projects to address current and future coastal hazards. The Plan takes a phased approach, monitoring changing conditions and triggering adaptive actions as needed. Adapting the City's wastewater and water systems was identified as a top priority in the 2021 plan.

The Santa Barbara County Climate Change Vulnerability Assessment (County of Santa Barbara, 2021), also completed in 2021, provides countywide analysis of climate change impacts, including analysis of changes in rainfall patterns and rising heat.

Since 2021, the City's program has advanced implementation efforts and secured funding from the Coastal Conservancy and California Coastal Commission. Current funded projects include:

1) Regional Climate Adaptation Monitoring Program: Development of a regional coastal monitoring program in Santa Barbara and Ventura counties to track how soon actions are needed and the effectiveness of adaptation projects.
2) 30-Year Waterfront Adaptation Plan: A plan to prepare the waterfront for increased storm surges, erosion, and flooding by providing solutions that preserve and enhance recreation, commerce, beach access, habitat, and critical infrastructure for the near-term and future generations.
3) Stormwater Model and Flood Analysis: Preparation of a model of flows of the City's stormwater system, analysis of flooding resulting from a range of intensity of storms including smaller, more frequent storms, and adaptation options for portions of the stormwater system.
4) Airport Climate Vulnerability and Adaptation Plan: Evaluation of climate change vulnerability and potential adaptation options for the City's airport.

Study Area

The study area for this Plan, shown in Figure ES-1, encompasses the City's water and wastewater service areas. It does not include the portion of the City occupied by the Santa Barbara Airport, which is the subject of a climate adaptation plan specific to the Goleta Slough area. Based on the high priority water and wastewater infrastructure risks identified in the 2021 SLR Adaptation Plan, this Plan has more in-depth analysis of a "focused study area," shown in red in Figure ES-2, that generally covers the low-lying waterfront and beach areas and low-lying flood areas between Castillo Street to Milpas Street and inland to the US-101 freeway. This focused study area already experiences flooding during major storm events and is the most at-risk area for increased hazards over time.

Figure ES-1. Citywide Study Area

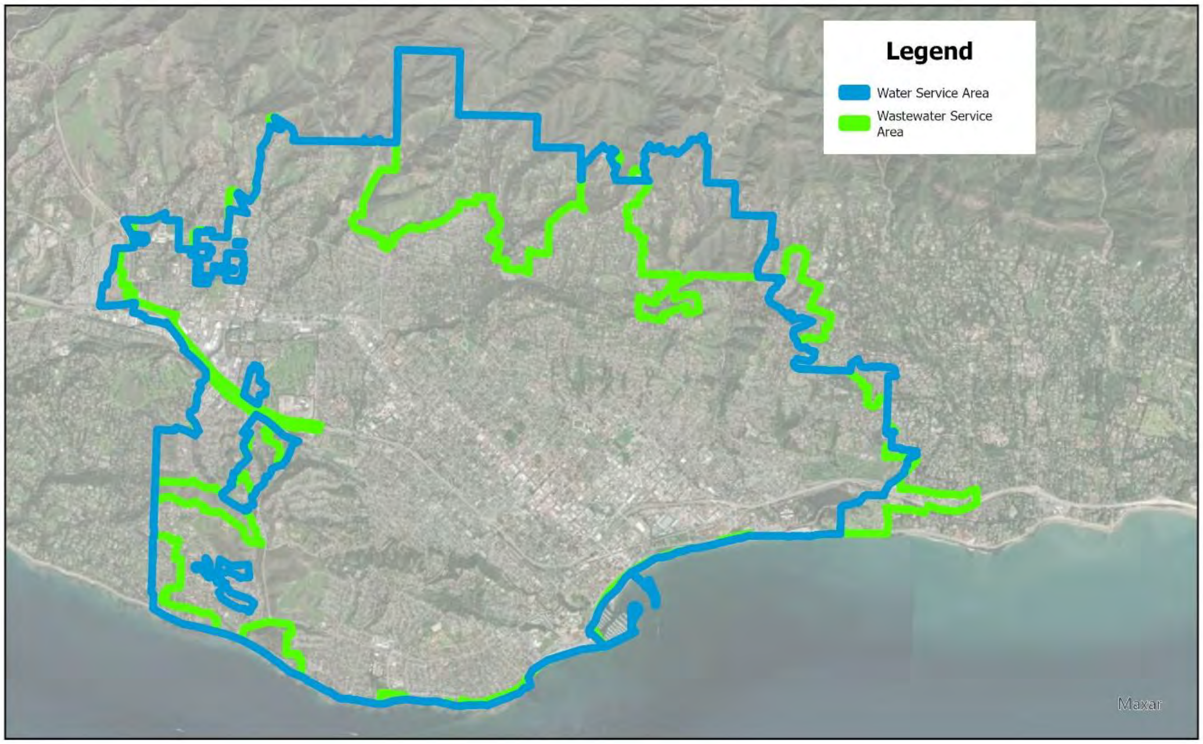
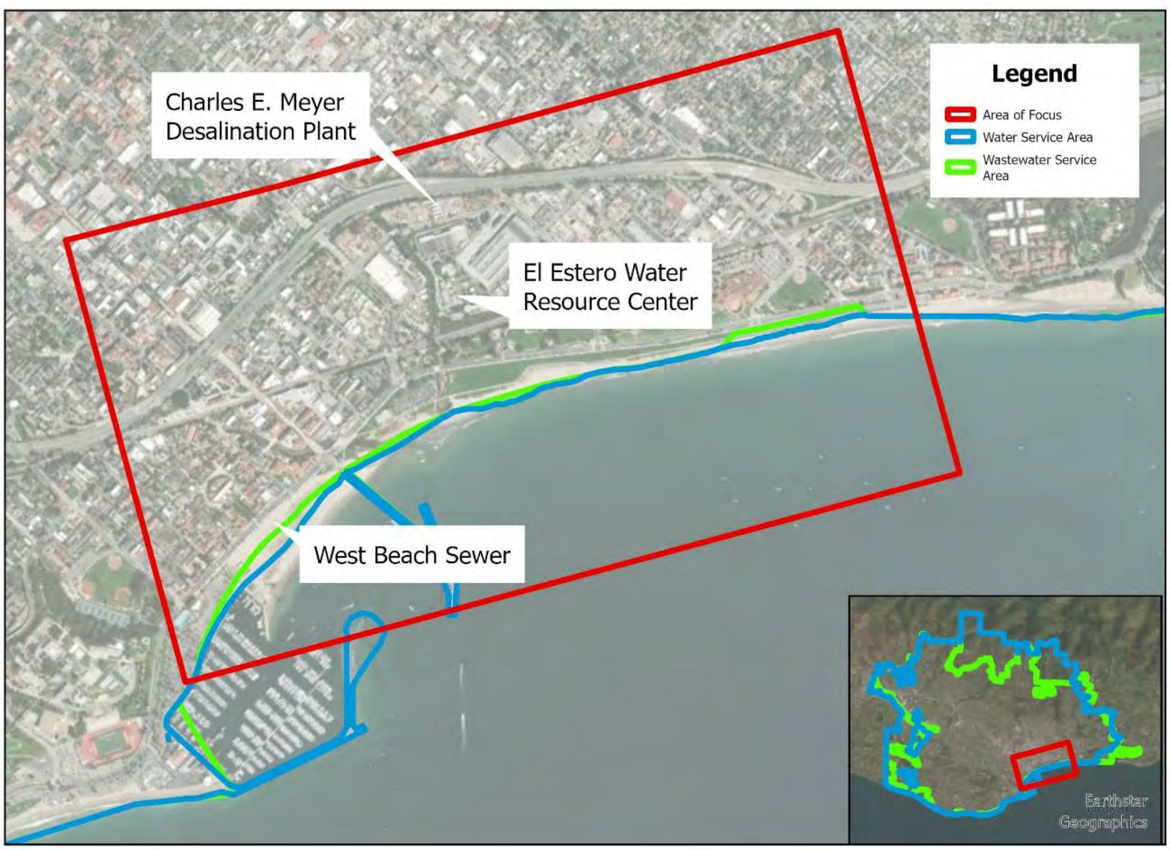


Figure ES-2. Focused Study Area



Adaptation Approach: Prioritization and Phasing

To create this Plan, the first step was identifying climate change hazards in Santa Barbara and assessing their impact on the City's water and wastewater systems. These vulnerabilities were ranked based on the likelihood and severity of potential events, guiding the development of various adaptation options, from protecting existing infrastructure to relocating it. Some options may require further data and analysis for informed decision-making.

This Plan builds to an adaptation strategy that recommends immediate next steps and thresholds for implementation. Near-term (next 20 years) recommendations are the most prescriptive, while mid-term (20 to 50 years) and long-term (50+ years) recommendations provide higher-level guidance.

Projections for sea level rise and other climate changes are regularly updated and refined as new studies emerge, changing conditions are monitored, and models are refined. As a result, the recommendations in this Plan are structured to accommodate future changes to projections and the performance of adaptation measures. Monitoring of changing conditions is a key component to the City's overall approach to planning for climate hazards. Because of the timing uncertainty and range of projections for sea level rise, this Plan provides a framework of planning based on amounts of sea level rise, rather than exactly when those amounts of sea level rise will occur. Adaptation recommendations are phased, with different actions recommended when certain thresholds or triggers are reached on the ground. Lead time to study, plan for, and implement adaptation actions is built into the triggers so that necessary improvements are made prior to major impacts occurring.

This plan is intended to be a living document and recommended to be reevaluated and updated roughly every decade based on:

- Observed climate change impacts and the latest climate change projections, new adaptation approaches, and legal/policy changes.
- Further refinement of the City's overall adaptation plans. Future updates of this Plan will be coordinated with other City climate change planning and adaptation documents to ensure a comprehensive and consistent strategy is implemented over time.

ES-2 Hazard Assessment and Vulnerability Analysis

The following hazards were analyzed in this Plan: stormwater flooding, coastal storm flooding, coastal storm wave run-up, tidal inundation, shoreline erosion, and groundwater rise. This executive summary predominantly focuses on flooding and erosion, due to their potential for high impacts to the City's systems. These hazards were assessed and applied to water and wastewater assets to determine vulnerabilities. Figures were developed that overlay the City's water and wastewater systems with different hazards. The hazards assessment considered both the impacts from rainfall events during storms (stormwater flooding) or from high ocean levels and waves during normal conditions and storm conditions (coastal hazards). Additional analyses estimated future stormwater flooding due to climate change and projected shoreline erosion with future sea level rise. **Note that these hazards represent projected future conditions without taking action as a hypothetical "do nothing" baseline scenario to inform adaptation options**, such as regional flood protection or beach nourishment.

The hazards assessment was completed using Federal Emergency Management Agency (FEMA) Flood Insurance Study and Flood Insurance Rate Maps for stormwater flooding, United States Geological Survey Coastal Storm Modeling System (CoSMoS) 3.0 for tidal inundation and groundwater rise, a shoreline erosion assessment performed for the City's 30-year Waterfront Adaptation Plan (ESA, 2025b), and hydrodynamic modeling of coastal flooding performed for the City's 30-year Waterfront Adaptation Plan (Stantec, 2025). To estimate changes in precipitation, data from the Coupled Model Intercomparison Project 6 general circulation models was used.

Sea Level Rise Scenarios

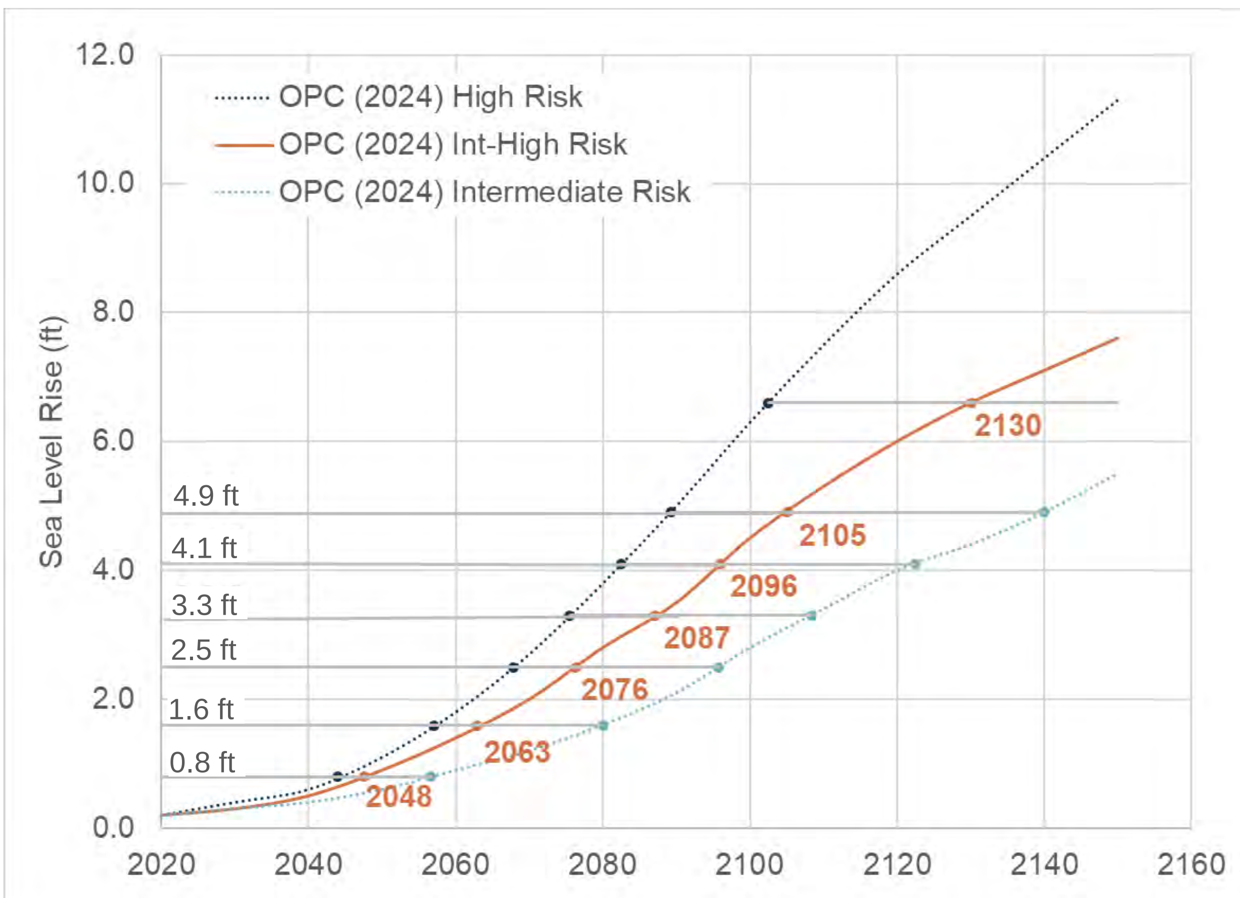
Sea level rise near the City is influenced by factors like ocean thermal expansion, Antarctic ice sheet melting, ocean circulation, and land elevation changes. As research advances, sea level projections are updated based on new knowledge about these processes and greenhouse gas emissions forecasts. Table ES-1 and Figure ES-3 show the latest sea level rise scenarios from the 2024 Ocean Protection Council's (OPC) guidance for Santa Barbara from the baseline year of 2000. These projections vary in likelihood. The analysis in this Plan focuses on the Intermediate-High Scenario, which offers a conservative estimate for sea level rise by 2100 and is appropriate for planning for water and wastewater systems. While cutting global emissions could slow sea level rise, some increase is already inevitable due to past emissions. The key difference between scenarios is the timing of specific sea level milestones, with likelihoods ranging from moderate (Intermediate Scenario) to very low (High Scenario). To address timing uncertainty, this Plan analyzes hazards at the specific sea level rise amounts shown in Table ES-1 because they represent key points relevant to vulnerabilities of the wastewater and water systems. Approximately just under an inch of sea level rise has already occurred relative to the baseline year of 2000.

Table ES-1. Sea Level Rise Scenarios with Timing Based on 2024 OPC Guidance

Sea Level Rise Amount	Sea Level Rise Scenarios (Risk Aversion Application) Projected Dates of Sea Level Rise Amount — Decreasing likelihood of occurrence →		
	Intermediate Scenario (Low Risk Aversion)	Intermediate-High Scenario (Med-High Risk Aversion)	High Scenario (Extreme Risk Aversion)
0.8 ft	2057	2048	2044
1.6 ft	2057	2063	2080
2.5 ft	2096	2076	2068
3.3 ft	2108	2087	2075
4.1 ft	2123	2096	2083
4.9 ft	2140	2105	2089
6.6 ft	After 2150	2130	2103

Note: This Plan is based on the Intermediate-High sea level rise scenario (light blue highlight).

Figure ES-3. Sea Level Rise Scenarios with Timing Based on 2024 OPC Guidance



Stormwater Flooding from High Rainfall Events

Figure ES-4 shows the City's water and wastewater infrastructure and the extent of flooding from intense rainfall, as estimated by FEMA's 100-year flood hazard maps. This flooding overlaps about 41 miles of sewer pipes, 537 manholes, 27 miles of potable water pipes, and 7 miles of recycled water pipes.

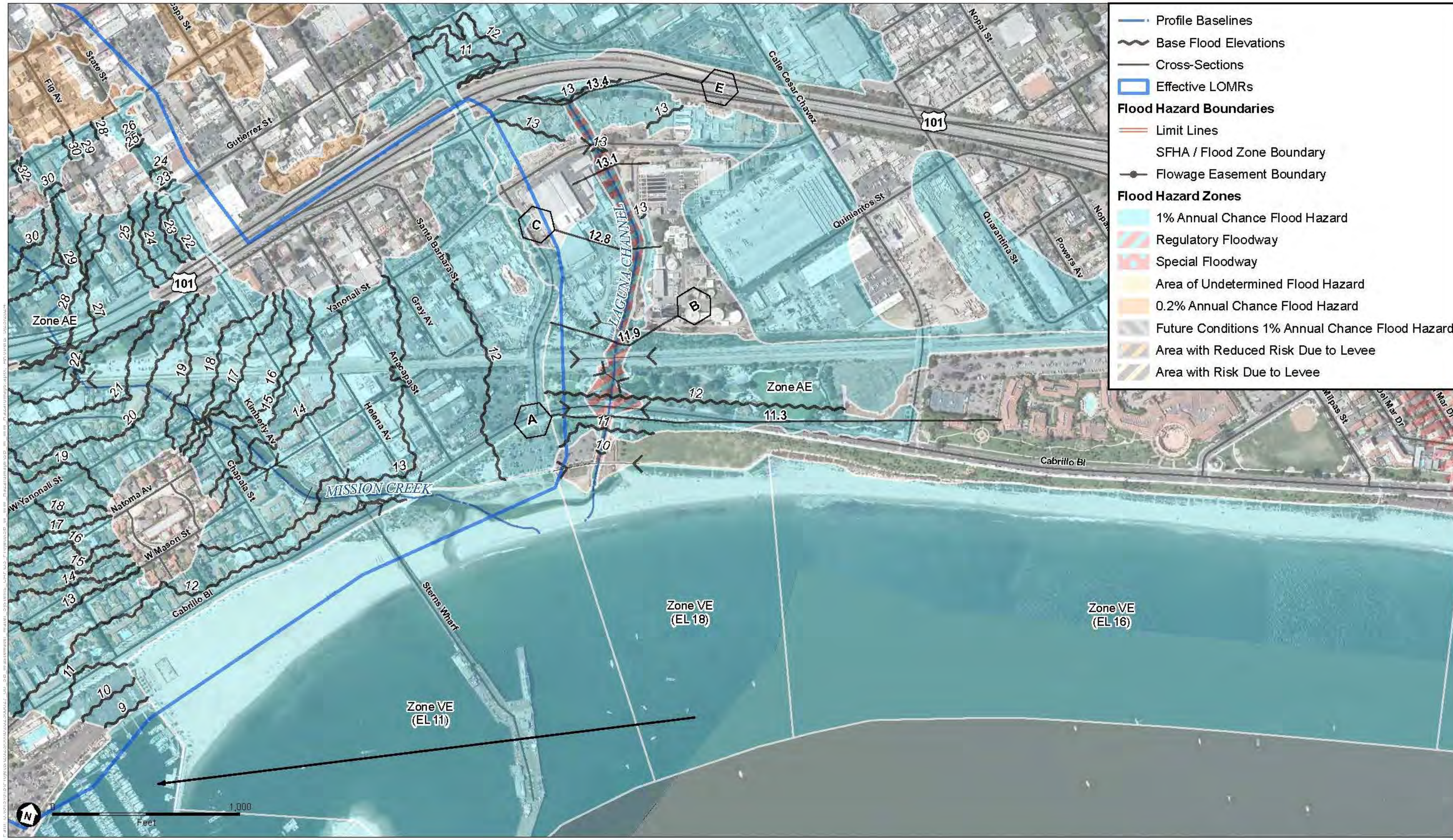
The FEMA 100-year flood hazard zone is an area with a 1% chance of flooding each year, based on past data. However, it doesn't account for climate change impacts. Climate change is expected to increase the frequency and intensity of rainfall. For instance, a storm that once had a 1% chance of occurring (a 100-year event) may soon occur with a 5% to 10% chance annually. These changes are already starting to take place and are expected to increase over time. Recent storms, which were considered 5- to 10-year rainfall events, caused significant flooding and are an example of the more frequent storms expected with climate change.

Table ES-2. Projected 24-hour Rainfall Event Return Interval (and Percent Annual Chance of Occurrence) with Climate Change

Scenario	24-hr Rainfall Event Return Interval (% Annual Chance of Occurrence)				
Past Precipitation	5-year storm (20%)	10-year storm (10%)	50-year storm (2%)	100-year storm (1%)	500-year storm (0.2%)
Future Precipitation with Climate Change (2030 to 2100)	2- to 3-year storm (33%-50%)	5-year storm (20%)	10-year storm (10%)	10- to 20-year storm (5%-10%)	30- to 50-year storm (2%-3%)

FEMA maps do not show flood extents or depths for smaller more frequent storms (e.g., the 5-, 10-, or 50-year storms). In addition, they do not show potential flooding from changes in rainfall patterns from climate change or flooding combining with sea level rise. Preliminary modeling and analysis completed as part of this Plan shows that, with future sea level rise, Mission Creek Lagoon water levels, Laguna Creek backfilling, and Laguna Creek flood frequency and extent are expected to increase due to increasing beach berm height during lagoon closures and increasing high tide levels.

Figure ES-4. FEMA 100-Year Flood Map



SOURCE: FEMA, ESA

D202300027 Santa Barbara Wastewater and Water Systems Climate Adaptation Plan

The highest risk vulnerabilities of the wastewater and water systems from stormwater flooding in the future from climate changes include:

- More frequent and severe floods, along with groundwater rise, are likely to lead to higher flows into the wastewater collection system and at El Estero WRC. Excessive flows during high rainfall events could cause the system to be overwhelmed, resulting in increased possibilities of sanitary sewer overflows.
- Recent storms (approximately 5- and 10-year storms) have prevented access to El Estero WRC because of flooding in local streets surrounding the treatment plant. Larger, more intense storms would prevent access, risk operator safety, impact the timely delivery and export of materials, and reliable plant operations.
- Looking at the combined 100-year rainfall stormwater flooding event with sea level rise, lower areas along the perimeter of El Estero WRC would flood during high rainfall events with 0.8 ft of sea level rise (~2048). By 2.5 ft of sea level rise (~2076), the entire site is projected to flood during the historic 100-year high rainfall event.

The City plans to conduct more detailed modeling through the Stormwater Model and Flood Analysis, focusing on smaller, more frequent storms and evaluating flood impacts and adaptation options, especially for Laguna Creek. Findings from this analysis will inform future updates to this Plan.

Coastal Hazards

Coastal hazards are those caused by high ocean levels and waves during normal and storm conditions. This Plan analyzes five categories of hazards with permanent and temporary impacts as discussed in the following sections.

City water and wastewater infrastructure overlaid with projected coastal storm flooding and tidal inundation for existing conditions through 4.9 ft of sea level rise (~2105) are provided in Figure ES-9 through Figure ES-15 (at the end of this Executive Summary) and compiled in Appendix A. These figures show coastal hazards (but do not include stormwater flooding from high rainfall events or combined events) and are the level of hazard projected without any action taken at a citywide or regional level to reduce flooding and erosion impacts. Shoreline erosion for existing conditions through 4.9 ft of sea level rise (~2105) are provided in Figure ES-16 and Figure ES-17 (at the end of this Executive Summary) and are also compiled in Appendix A.

Coastal Storm Flooding

- Coastal Storm Flooding. Areas experiencing temporary flooding from high ocean water levels caused by coastal storm surge events resulting in significant consequences, such as infiltration of brackish water into unsealed manholes or other open structures designed to provide access into the wastewater and water systems.

Of the coastal hazards, coastal flooding from ocean storm surge impacts the largest amounts of coastal infrastructure, as summarized in Table ES-3. During the 100-year coastal storm and under existing conditions, the Leadbetter, West, and East beaches and Cabrillo Boulevard from Stearns Wharf to Andree Clark Bird Refuge experience flooding. With 0.8 ft of sea level rise (~2048), flooding of Cabrillo Boulevard is projected with a 1-year coastal storm. Coastal storm flooding extends to the railroad under 1.6 ft of sea level rise (~2063) and extends to US-101 under 2.5 ft of sea level rise (~2076). By 3.3 ft of sea level rise (~2087), the 100-year coastal storm is projected to flood portions of downtown north of Highway 101.

Table ES-3. Coastal Infrastructure Impacted by Flooding During 100-Year Coastal Storm under SLR Scenarios

SLR Scenario	Sewer Pipe (miles)	Sewer Manholes (number)	Sewer Connections (number)	Potable Water Pipe (miles)	Potable Connections (number)	Recycled Water Pipe (miles)
Existing	1.7	16	39	2.6	49	2.7
0.8 ft (~2048)	4.3	44	101	4.0	96	3.4
1.6 ft (~2063)	4.6	64	120	4.9	137	3.6
2.5 ft (~2076)	6.0	81	214	6.8	187	3.8
3.3 ft (~2087)	10.8	148	572	11.6	449	4.7
4.1 ft (~2096)	13.2	177	809	14.0	663	4.9
4.9 ft (~2105)	15.5	223	1015	17.0	906	5.1

Tidal Inundation

- Tidal Inundation. Areas regularly flooded by typical monthly spring high tides, leading to permanent impacts and significant consequences due to saltwater infiltration into the wastewater system.

Under existing conditions, developed areas are not tidally inundated under regular, non-storm conditions. By 4.1 ft of sea level rise (~2096), regular high tides are projected to flow up Laguna Creek adjacent to El Estero WRC and spring high tides (occurring approximately twice per month) with typical winter wave conditions are projected to inundate the coastal zone south of the UPRR. By 4.9 ft of sea level rise (~2105), low-lying areas adjacent to Laguna Creek north and south of US 101 are at risk of daily tidal inundation.

Shoreline Erosion

- Shoreline Erosion. If no action is taken, areas in this hazard zone may be completely lost due to erosion, causing permanent impacts and severe consequences as assets are washed away, damaged, or undercut or otherwise compromised structurally. The shoreline erosion analysis is based on long-term erosion each year as well as erosion from a 100-year storm to project shoreline profiles at key pipelines (El Estero outfall, Desalination Plant intake, and the West Beach sewer main). Erosion amounts were projected based on historic erosion rates with additional projected erosion due to sea level rise.

If no action is taken, shoreline erosion along East Beach is projected to reach Cabrillo Boulevard, east of Calle Cesar Chavez, by 1.6 ft of sea level rise (~2063), risking exposure and failure of utilities buried under Cabrillo Blvd. By 2.5 ft of sea level rise (~2076), shoreline erosion risks exposure and failure of utilities buried under Shoreline Drive and erosion into Chase Palm Park will require relocation of the potable water line in the park.

At the current sea level, the El Estero outfall manhole is projected to be exposed with a 100-year storm. The manhole is projected to be exposed 5 ft above the beach surface with 0.8 ft sea level rise (~2048) due to erosion. The El Estero outfall pipeline has the potential to be exposed at 2.5 ft sea level rise (~2076) but is not projected to be undercut by erosion.

The Desalination Plant intake weir box is currently exposed a few feet above the beach and protected by rip rap. During the 100-year storm, the weir box may be fully exposed and the Desalination intake pipeline has the potential to be exposed. With 0.8 ft of sea level rise (~2048), the weir box and pipeline are projected to be exposed.

The West Beach shoreline analysis indicates that West Beach is stable. Future erosion projections show that the West Beach sewer will not be exposed through 4.9 ft of sea level rise (~2105). Monitoring of erosion is recommended to inform adaptation needs at West Beach. The analysis showed that coastal storm flooding and coastal storm wave runup may cause some erosion around the West Beach sewer manholes.

Groundwater Rise

- Groundwater Rise. Areas experiencing regular high groundwater levels with increased salinity from rising sea levels, causing permanent impacts and significant consequences due to infiltration and corrosion of wastewater and water infrastructure.

Groundwater levels were analyzed to identify the extent of shallow groundwater and potential impacts to City assets. Note that the available groundwater data was limited and future updates are recommended to be supplemented with locally collected data to improve data reliability. The City is participating in regional data collection and monitoring programs that are expected to inform future updates of this Plan and better define risks and adaptation needs.

Buried infrastructure either fully or partially submerged by shallow groundwater in the coastal area under sea level rise is summarized in Table ES-4. The depth to groundwater decreases with sea level rise, becoming very shallow in much of downtown with 2.5 ft of sea level rise (~2076) and greater. With 4.1 ft of sea level rise (~2096), larger portions of downtown may experience emergent groundwater.

Table ES-4. Coastal Infrastructure Impacted by Groundwater Rise under SLR Scenarios

SLR Scenario	Sewer Pipe (miles)	Potable Water Pipe (miles)	Recycled Water Pipe (miles)
Existing	18.7	9.8	2.6
0.8 ft (~2048)	19.6	12.2	3.0
1.6 ft (~2063)	20.2	12.8	3.0
2.5 ft (~2076)	21.2	13.6	3.0
3.3 ft (~2087)	22.0	14.0	3.0
4.1 ft (~2096)	22.5	14.0	3.0
4.9 ft (~2105)	22.6	15.6	3.0

Note: Values are for pipes estimated to be fully or partially submerged by shallow groundwater. Note that groundwater depths were estimated using CoSMoS, which may be estimating groundwater levels shallower than current observations. As a result, shallow groundwater monitoring is recommended to update groundwater depth estimates.

Drought, Heat, and Wildfire

Drought, heat, and wildfire can pose significant challenges for water and wastewater infrastructure, such as:

- Droughts can lead to reduced water use, which results in lower wastewater flows with higher solids content, potentially resulting in buildup within pipelines and hydrogen sulfide corrosion. As pollutants build up, wastewater treatment processes may become strained, operate less efficiently, and require adjustments to meet discharge standards.
- Heat and wildfires can strain electrical equipment that may overheat, reduce efficiency, increase maintenance needs, and potentially result in failure and impact service.
- Heat and wildfires may also strain treatment processes by promoting the growth of microorganisms in raw water supplies that may require additional treatment to meet standards.

Because Santa Barbara has been experiencing extreme droughts and intense wildfires in the recent past, the City has largely already addressed these hazards through diversifying the water supply portfolio and employing additional maintenance and treatment methods.

Risk Assessment Results

A risk assessment matrix was employed to prioritize wastewater and water systems' vulnerability to climate change of various coastal water and wastewater system components. A risk matrix is a tool used to assess the level of risk posed by an undesirable event by considering both the likelihood of the event taking place and the severity of the event's consequences.

The highest infrastructure risks in the near-term (now through 0.8 ft of sea level rise (~2048)) are predominantly related to increased frequency and severity of stormwater flooding from high intensity rainfall events and include:

- Exceedance of capacities in the wastewater collection system and El Estero WRC, leading to increased sanitary sewer overflows and potential Clean Water Act violations.
- On-site flooding at El Estero WRC could put wastewater treatment processes and equipment at risk of failures, leading to potential violations of the Clean Water Act.
- Off-site flooding in neighborhoods surrounding El Estero WRC that could prevent access to the plant, leading to staff safety and operational challenges.

The highest infrastructure risks in the mid-term (0.8 ft to 2.5 ft of sea level rise (~2048 to ~2076)) are predominantly driven by shoreline erosion and wave action hazards that threaten the following assets:

- Buried utilities located in Cabrillo Blvd
- Potable water pipeline in Chase Palm Park
- Desalination intake system

These near-term and mid-term risks are spatially presented in Figure ES-1-5. More details on the vulnerability of each asset and potential adaptation options are below.

Figure ES-1-5. Highest Near-Term (Next 20 Years) and Mid-Term (20 to 50 Years) Infrastructure Risks from Climate Change

ES-4 Adaptation Strategy

The analysis of adaptation options for each piece of infrastructure includes information on the timeframe and conditions for triggering the action. **Recommended actions are divided into four timeframes[1]:**

- **Immediate Next Steps** (0 to 5 Years)
- **Near-Term** (5-20 years): now to 0.8 ft SLR (~2048)
- **Mid-Term** (20-50 years): 0.8 ft to 2.5 ft SLR (~2076)
- **Long-Term** (50+ years): 2.5 ft to 6.6 ft. SLR (~2130)

Mid-term adaptation options will generally be dependent upon the success of near-term water and wastewater system adaptation measures, success of citywide and regional adaptation measures to lessen erosion and flooding impacts, and changes in existing and projected conditions. The target time for implementation, as well as the steps required to implement an adaptation option, such as planning, design, and construction, are considered and included in the implementation plan.

This section outlines potential measures to protect assets if citywide adaptation (e.g., flood or shoreline protection) is insufficient. Future flooding in low-lying areas will be influenced by several sources, including rainfall, and coastal flooding due to sea level rise, making full flood protection difficult. Further studies are needed to evaluate citywide flood and erosion control options. While citywide flood control efforts may delay the need for individual infrastructure adaptation projects, infrastructure-specific measures will likely still be necessary due to ongoing flood risks and the critical nature of the wastewater and water systems.

Wastewater Treatment Adaptation Summary

The City's wastewater treatment system consists of El Estero WRC for treatment of wastewater and the El Estero outfall to safely dispose of treated wastewater into the Pacific Ocean. The highest near-term risks identified for El Estero WRC and El Estero outfall are:

- El Estero WRC Onsite Flooding: Portions of El Estero WRC are projected to flood during the 100-year storm at existing sea levels if flood water is allowed to find its way onsite. Vulnerable areas include the primary and secondary clarifiers area which house electrical and controls systems; electrical equipment located throughout the plant in low elevation areas, and the front and back access gates. These areas are likely to flood during the 100-year storm by 0.8 ft of sea level rise (~2048), and most of the site is projected to flood during the 100-year storm by 2.5 ft of sea level rise (~2076).
- El Estero WRC Access from Offsite Flooding: Recent 5- and 10- year storms have temporarily (less than 12 hours) prevented access to the plant due to flooding in local streets. Larger storms could prevent access for over 24 hours, which risks staff safety, timely delivery and export of materials, and reliable plant operations.

[1] Years included with sea level rise levels are associated with the Intermediate-High Sea Level Rise Scenario. As described in Section ES-2, sea level rise amounts could occur sooner or later.

In addition, near-term onsite and offsite flooding risks to El Estero WRC are projected to worsen in the mid-term with higher intensity rainfall during storms and sea level rise. The highest mid-term risk is potential exposure and undercutting of the outfall pipeline due to offshore and beach erosion. Adaptation recommendations for these risks are summarized below.

El Estero WRC On-Site Flooding

- **Immediate Next Steps (0-5 Years):** Additional data collection and analysis are recommended to further define vulnerabilities and build confidence on a path toward adaptation, including:
  - **Stormwater Model and Flood Analysis:** Study high frequency, lower-level rainfall events and associated flooding surrounding El Estero WRC to fill data gaps, such as extent and recurrence of flooding with climate change. Analyze options to modify stormwater system to reduce flooding. This effort is already funded. This Plan will be updated after the stormwater analysis is complete.
  - **El Estero WRC Flood Protection Study:** Evaluate and recommend phasing of flood protection measures considering Stormwater Model and Flood Analysis findings. Compare the merits of protecting or elevating individual treatment processes and/or protecting the whole site with a floodwall system. The study would define a phased approach to provide flood protection through at least 2.5 ft of sea level rise (~2076).
- **Near-Term (Through 0.8 ft SLR (~2048)):** Implement the recommendations from the El Estero WRC Flood Protection Study (e.g., floodwalls and/or elevation of infrastructure). In addition, the City may consider reserving areas in City-owned property as potential sites for long term relocation of wastewater infrastructure due to the limited number of feasible locations.
- **Mid-Term (0.8 to 2.5 ft SLR (~2048 to ~2076)):** Update the El Estero WRC Flood Protection Study considering: 1) updated hazard and vulnerability assessments, especially timing of sea level rise; 2) proficiency of flood protection measures implemented in and around El Estero WRC; and 3) long-term risks for El Estero WRC. Implement the updated study recommendations.

Off-Site Flooding Limiting Access to El Estero WRC

- **Immediate Next Steps (0-5 Years):** Formalize an El Estero WRC Flood Conditions Operations Plan to document operation practices during flood conditions; shift schedule and plant access protocols; resources and accommodations for staff for prolonged shifts; expanded solids storage capacity; and protocols for solids hauling and chemical delivery schedules that account for extended lack of access to the plant.
- **Near-Term (Through 0.8 ft SLR (~2048)):** Reevaluate flood preparations following completion of the Stormwater Model and Flood Analysis, which will better characterize flood risks, to determine if larger investments in road infrastructure are needed to provide access to El Estero WRC up to 0.8 ft of sea level rise (~2048).

- **Mid-Term (0.8 to 2.5 ft SLR (~2048 to ~2076)):** Update the previous flood operations analysis considering: 1) updated hazard and vulnerability assessments, especially timing of sea level rise; 2) proficiency of implemented local and regional measures; and 3) long-term plans for El Estero WRC. Further study long-term options for elevating roads or providing alternate access to El Estero WRC in coordination with analysis of options for potential relocation of the plant.

El Estero Outfall

- **Near-Term (Through 0.8 ft SLR (~2048)):** Shoreline erosion along East Beach is projected to expose the outfall's onshore manhole up to about 5 ft by 0.8 ft of sea level rise (~2048). The outfall manhole could be surrounded by ocean water at low tide by 2.5 ft of sea level rise (~2076). Although the City has not used this manhole for routine pipeline inspections in recent history, it may be valuable for future access and is recommended to be protected in the near-term. Depending on changing climate conditions and operational needs further in the future, potential manhole relocation or abandonment may be investigated.
- **Mid-Term (0.8 to 2.5 ft SLR (~2048 to ~2076)):** The portion of the outfall pipeline under East Beach is projected to be exposed by 2.5 ft of sea level rise (~2076), and it will be fully submerged when the pipeline is eventually exposed. The outfall pipeline is anticipated to be resilient to the impacts of shoreline erosion due to its depth of installation, existing sheet piles on both sides, and significant existing rock armor overlying the pipe. Regular condition assessments, which are required by the NPDES permit, are expected to continue and identify issues as they arise. Such assessments will serve as reoccurring monitoring and data collection points and will inform updated erosion projections to determine future needs for improvements.

El Estero WRC (Long-Term)

El Estero WRC sits at a higher elevation than the areas surrounding it and the more significant issues with the wastewater system in the near- and mid-term are related to flooding events that affect areas surrounding the plant. In the near-term, flood protection investments at the site will be needed and access during flood hazards can be managed in the near-term with limited modifications to existing practices. In the mid-term, more substantial road and site access improvements may be required.

In the mid-term, the City will also need to further study and consider whether to relocate El Estero WRC in the long-term given the costs required to address safe, reliable access during recurrent flooding, and to protect the site from extreme flooding at high amounts of sea level rise. That decision will be part of future updates to this Plan that will benefit from more years of monitoring and additional information on how climate changes are affecting the region and possible adaptation options. Any relocation study would involve close coordination with regional partners to explore opportunities for shared facilities and to identify potential sites of sufficient size across the region. Among properties currently owned by the City, the municipal golf course on Las Positas is large enough to accommodate a new wastewater treatment plant if needed.

Wastewater Collection Adaptation Summary

The City's wastewater collection system includes approximately 254 miles of gravity sewer mains, approximately 5,900 manholes, 7 lift stations, and approximately 2 miles of force main (pressurized sewer main). The City already experiences difficulties managing flows within the existing collection system and capacities at El Estero WRC during high rainfall events due to stormwater inflows and infiltration into pipes and manholes. The City is expected to experience more frequent and severe floods from rain and coastal storms, along with groundwater rise, due to climate change. This is likely to lead to increased infiltration and inflow into the collection system that could lead to exceedance of wastewater treatment capacity and sanitary sewer overflows. In addition, the wastewater treatment system can manage limited volumes of saline water but the combination of increased flooding events with the potential for introduction of saline water - rising groundwater levels, coastal storm events, or tidal inundation - will eventually trigger the need for conversion to a low-pressure collection system in low-lying coastal areas.

The primary risks of climate change are:

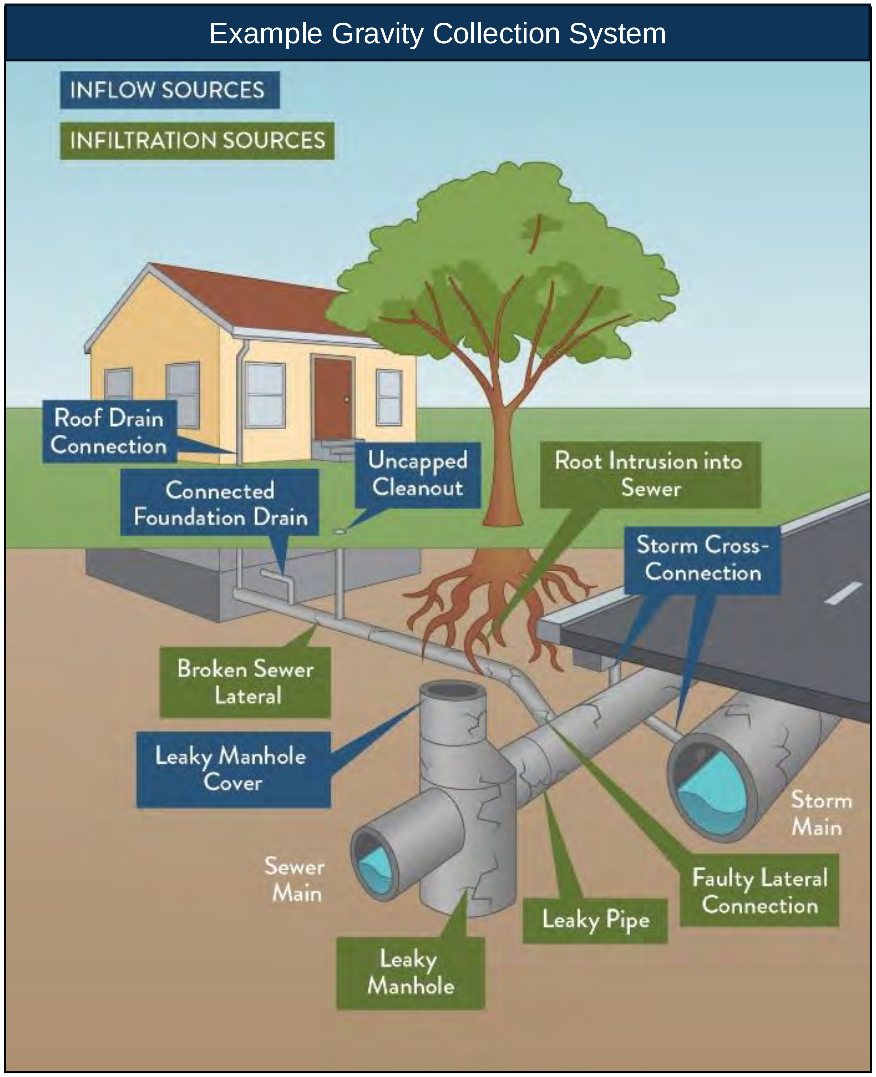
- Exceedance of collection system and El Estero WRC capacities during storm events (both high rainfall events and coastal storms causing storm surge).
- In the mid-term, persistent inflow and infiltration of saline water into the collection system south of Highway 101 from rising groundwater levels, seawater intrusion into surficial groundwater, and ocean inundation during coastal storms and regular high tides due to sea level rise, causing corrosion of infrastructure and trouble treating saline water at El Estero WRC.

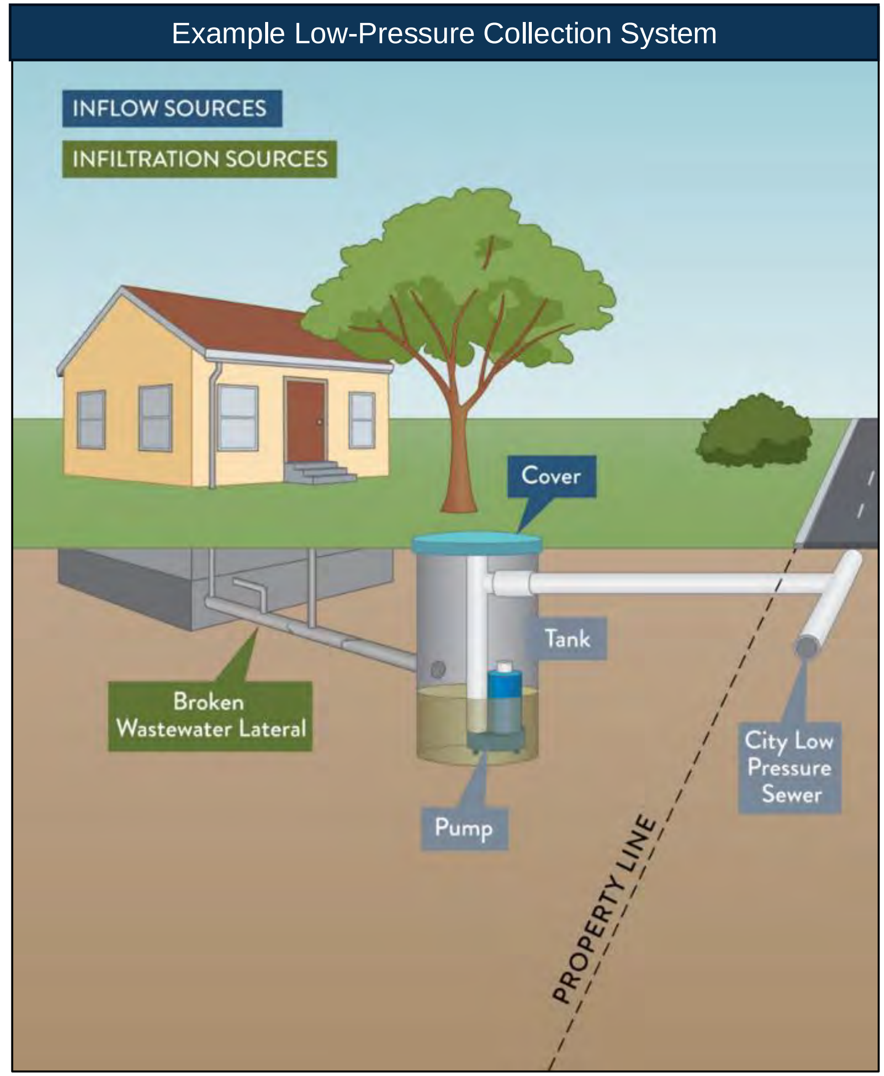
Recommended adaptation measures for the collection system include:

Immediate Next Steps (0-5 Years):

- Seal collection system manholes that could be regularly flooded, including West Beach sewer manholes, to prevent inflow and the possibility of the manhole covers being removed by members of the public during flooding events to act as a drain.
- Complete a Wastewater System Capacity Study to identify the largest sources of existing infiltration and inflow during storms and evaluate options to reduce infiltration and inflow in the collection system and increase storage capacity at El Estero WRC. Potential adaptation options include manhole sealing, sewer and manhole rehabilitation, customer lateral rehabilitation, investigation of illegal connections and removal, and increasing wet weather storage capacity with wastewater storage basins.
- Initiate study and planning should also start for the mid-term conversion of the low-lying coastal portion of the collection system from a gravity fed system to a low-pressure system. This should include changing design and connection requirements in the near-term for new private and public projects in low-lying areas to accommodate a future conversion to a pressurized system. The City should consider an ordinance in the next five years to require new connections in the low-lying areas to include grinder pumps needed for pressurization and incentives to customers to facilitate conversion of existing sewer connections over the next 20 years. A comparison of the City's existing gravity collection system with a low-pressure collection is shown in Figure ES-6.

Figure ES-1-6. Infiltration and Inflow Sources for Gravity and Low-Pressure Collection Systems





These graphics show the typical infiltration and inflow (I&I) sources to two types of sewer collection systems. The City's existing gravity system, shown on the left, has many I&I sources. During heavy rainfall and high wave events, floodwater can enter the sewer collection system, which can overwhelm both the collection pipes and capacity at the treatment plant (El Estero Water Resource Center), potentially causing sewer overflows. Low-pressure sewer collection systems, shown on the right, prevent almost all sources of I&I.

- **Near-Term (Through 0.8 ft SLR (~2048)):** Implement recommended adaptation measures to manage inflows, infiltration, and capacities in the collection system and at El Estero WRC based on the proposed Wastewater System Capacity Study. Implement low-pressure lateral ordinance and facilitate conversion of existing customer sewer connections to low-pressure connections in low-lying coastal areas.
- **Mid-Term (0.8 to 2.5 ft SLR (~2048 to ~2076)):** Update capacity analysis and implement the recommended measures to manage capacity in the collection system and at El Estero WRC. Ensure that Cabrillo Blvd and the utilities located under the street will be protected from shoreline erosion. Install initial phases of low-pressure collection system in areas most impacted by flooding from rain and coastal storms.

In the **long-term**, when flooding from tides is frequent, or elevated groundwater tables persist, the remainder of the existing gravity collection system in the low-lying coastal area should be converted to a low-pressure collection system if large-scale flood prevention measures, such as levees or service levels change, are not capable of fully mitigating flooding hazards from rain and coastal storms. Converting the existing collection system in the coastal area to a low-pressure collection system is an expensive but highly reliable approach to reduce infiltration and inflow from tides, storms, and groundwater entering the existing gravity system. The City expects to closely monitoring flooding in the area to decide in the near-term how to address impacts to the wastewater collection system in the mid- and long-term.

West Beach Sewer Trunk Main Shoreline Erosion

The West Beach sewer trunk main conveys approximately half of the City's dry weather sewer flows to El Estero WRC. It is located beneath West Beach, south of the bike path, crosses Mission Lagoon, and continues along the beach before turning north to follow Laguna Creek to El Estero WRC. Due to its critical role and vulnerable beachfront location, this Plan analyzed adaptation needs for the West Beach sewer main.

West Beach sewer is not projected to be exposed from shoreline erosion through 4.9 feet of sea-level rise. Projected exposure would prompt the need for relocation inland. This would be a major project due to the main's size, importance, and gravity-based flow, and would require new infrastructure to lift flows from low-lying areas. One possible new alignment is from Pershing Park to inland of US 101 to avoid the projected climate vulnerabilities in the coastal area, although studies of impacts to recreational assets would be needed. Ideally, relocation would coincide with any future pressurization of the system and should be planned at least 10 years before projected exposure.

Potable Water System Adaptation Summary

While the vulnerabilities of the whole potable water system were assessed, particular attention was given to those portions of the system in the Focused Study Area (shown in red in Figure ES-2). Potable water distribution assets in this area include buried distribution piping, valves, and equipment vaults, as well as above-ground components including valves, backflow preventers, and hydrants. The Charles E. Meyer Desalination Plant (Desalination Plant) is also located within this area.

The highest **near-term** risk identified for the potable water system is damage to the desalination intake infrastructure caused by loss of cover of sand from erosion and offshore wave action. The highest **mid-term** risk is damage to potable water pipeline segments under Cabrillo Blvd, Shoreline Drive, and Chase Palm Park from shoreline erosion and wave action. The highest **long-term** risks are loss of Desalination Plant site access and infrastructure damage from future flood events caused by high rainfall events, coastal storms or, eventually, tidal inundation.

Also, sea water flooding and brackish groundwater rise are likely to increase soil salinity and cause corrosion of metal pipes and metal pipe components, which could shorten infrastructure lifespans. Consequently, the City should consider replacement of aging pipes in the coastal area with non-metallic materials, such as HDPE or PVC, and implement corrosion prevention methods where metallic pipe or fittings must be installed.

Seawater intrusion into the City's groundwater wells, located inland of US 101, is an issue that City has historically monitored. The City typically increases groundwater pumping during extended droughts, which can cause the seawater / groundwater interface to move slightly inland. However, under normal periods of little or no pumping, the groundwater flow is toward the ocean, which stops intrusion and pushes the seawater interface seaward. Sea level rise will slightly increase to potential for seawater intrusion, but the predominant cause of seawater intrusion will continue to be heavy pumping of the City's groundwater wells. The City will continue to monitor for seawater intrusion and adjust pumping based on observations.

Desalination Intake System Erosion

The weir box, intake pipeline, and intake structure for the desalination system are projected to be impacted by 0.8 ft of sea level rise (~2048). The City is currently designing an intake structure replacement.

- **Near-Term (Through 0.8 ft SLR (~2048)):** The weir box at East Beach likely needs additional protection by 0.8 ft of sea level rise (~2048). The weir box could be abandoned, relocated, or protected as outlined in the Intake Structure Weir Box Relocation Erosion Protection Study (Carollo, 2019).
- **Mid-Term (0.8 to 2.5 ft SLR (~2048 to ~2076)):** A portion of the intake pipeline is projected to be exposed and unsupported between 0.8 and 1.6 ft of sea level rise (~2063), which would require protection or replacement of the pipeline, depending on the planned Desalination Plant operations timeline. Inspection and monitoring of the pipeline will be important to inform decisions.

Potable Water Pipeline Segments Erosion

- **Mid-Term (0.8 to 2.5 ft SLR (~2048 to ~2076)):** Relocate the potable water pipeline in Chase Palm Park further inland. Ensure protection measures are planned for Cabrillo Blvd and Shoreline Drive so that potable water infrastructure in Cabrillo Blvd is protected. The City should consider replacement of aging pipes in the coastal area with non-metallic materials, such as HDPE or PVC, and implement corrosion prevention methods where metallic pipe or fittings must be installed.

Desalination Plant Site Flooding

- **Near-Term (Through 0.8 ft SLR (~2048)):** Determine if new flood protection measures are needed through 2.5 ft of sea level rise (~2076) based on the planned Stormwater Model and Flood Analysis findings. Consider need for flood protection measures for adjacent Annex Yard as well.
- **Mid-Term (0.8 to 2.5 ft SLR (~2048 to ~2076)):** If the plant continues to operate in the mid-term, implement flood protection measures through 2.5 ft of sea level rise (~2076) and update the plant flood vulnerability analysis considering: 1) updated hazard and vulnerability assessments; 2) proficiency of implemented local and regional measures; and 3) long-term plans for the Desalination Plant.

Recycled Water System Adaptation Summary

The City's recycled water system consists of a tertiary treatment system and pump station at El Estero WRC, one recycled water reservoir, and approximately 13.4 miles of recycled water pipeline. In the focused study area, recycled water pipelines in Chase Palm Park may be impacted by shoreline erosion in the near-term (by 0.8 ft of sea level rise (~2048)).

Recycled Water Pipelines

- **Near-Term (Through 0.8 ft SLR (~2048)):** Evaluate and implement regional adaptation efforts such as beach nourishment to reduce erosion concerns in the beach area. Consider and evaluate feasibility of relocation inland.
- **Mid-Term (0.8 to 2.5 ft SLR (~2048 to ~2076)):** Relocate the recycled water pipeline in Chase Palm Park further inland.

General Citywide Adaptation Summary

Monitoring, Conditions Assessments, and Plan Updates

Implementation of this Plan will occur in phases based on changing conditions over time. As such, monitoring and regular updates of the plan are critical. This Plan is intended to be a living document and expected to be regularly updated every decade based on observed climate changes, observed impacts to the wastewater and water systems, new climate change projections, and further refinement of the City's overall adaptation approach over time.

The City is partnering with the coastal cities and counties within BEACON's jurisdiction spanning Santa Barbara and Ventura Counties to track and report shoreline erosion, bluff erosion, and flooding. The City is also working with the County of Santa Barbara on standardized flood and erosion documentation. This Plan highlights the need for the City to coordinate monitoring of salinity and elevations of surficial groundwater in the low-lying portions of the City, in addition to potable groundwater monitoring program that is already occurring. In addition, site specific shoreline erosion monitoring is a high priority given the location of buried infrastructure within West and East beaches. Modeling and monitoring of stormwater flooding in the low-lying area of the city associated with Laguna Creek are particularly important for future decision making regarding El Estero WRC and wastewater collection system assets. This work will begin with the Stormwater Model and Flood Analysis project already funded.

Given changing environmental conditions, the City will need to pay particular attention to condition assessments of wastewater and water infrastructure in the low-lying areas of the City. For example, the City could conduct condition inspection of buried infrastructure opportunistically when they are exposed for other reasons, such as maintenance or repair. Inspections could include visually assessing pipes, testing valves, measuring pipe corrosion, and performing soil corrosivity assessments and pipe failure analysis.

ES-5 Summary of High Priority Actions

Table ES-5 summarizes the highest priority recommended projects and actions for the wastewater and water systems based on timing and phase of implementation. Prioritization is based on the level of associated risk, which considers impact of infrastructure vulnerability, likelihood of impact, and criticality of infrastructure. The highest priority recommendations are presented spatially in Figure ES-7 and shown within an implementation plan in Figure ES-8.

Rough costs for implementation – roughly $50 million to $130 million in wastewater and water infrastructure improvements over the next 20 years – were developed to support initial budgeting but should be updated once studies are completed that include project alternatives analysis and cost estimating. Project implementation will also require additional City staff resources, such as engineers, project managers, and operators.

Note that in the long-term, beyond 2.5 ft of sea level rise (~2076), coastal flooding from the ocean and regular tidal inundation are expected to occur and the pace of sea level rise is projected to increase. Many of the largest infrastructure investments to support climate change adaptation, such as relocation of El Estero WRC and conversion to a low-pressure collection system in the low-lying coastal area, are not projected to be needed until the long-term. Potential long-term adaptation measures will be evaluated as part of the proposed regular updates to this Plan, which will consider the latest climate change projections, monitoring data, effectiveness of adaptation measures, risk tolerance, and City priorities. Potential adaptation measures will also need to consider the useful life of the facilities they are protecting if relocation of El Estero WRC and the Desalination Plant are planned. Finally, large infrastructure projects can take 10 to 20 years from planning through construction, so planning will likely need for many projects to start during the mid-term. More specific timing is expected to be available in future Plan updates.

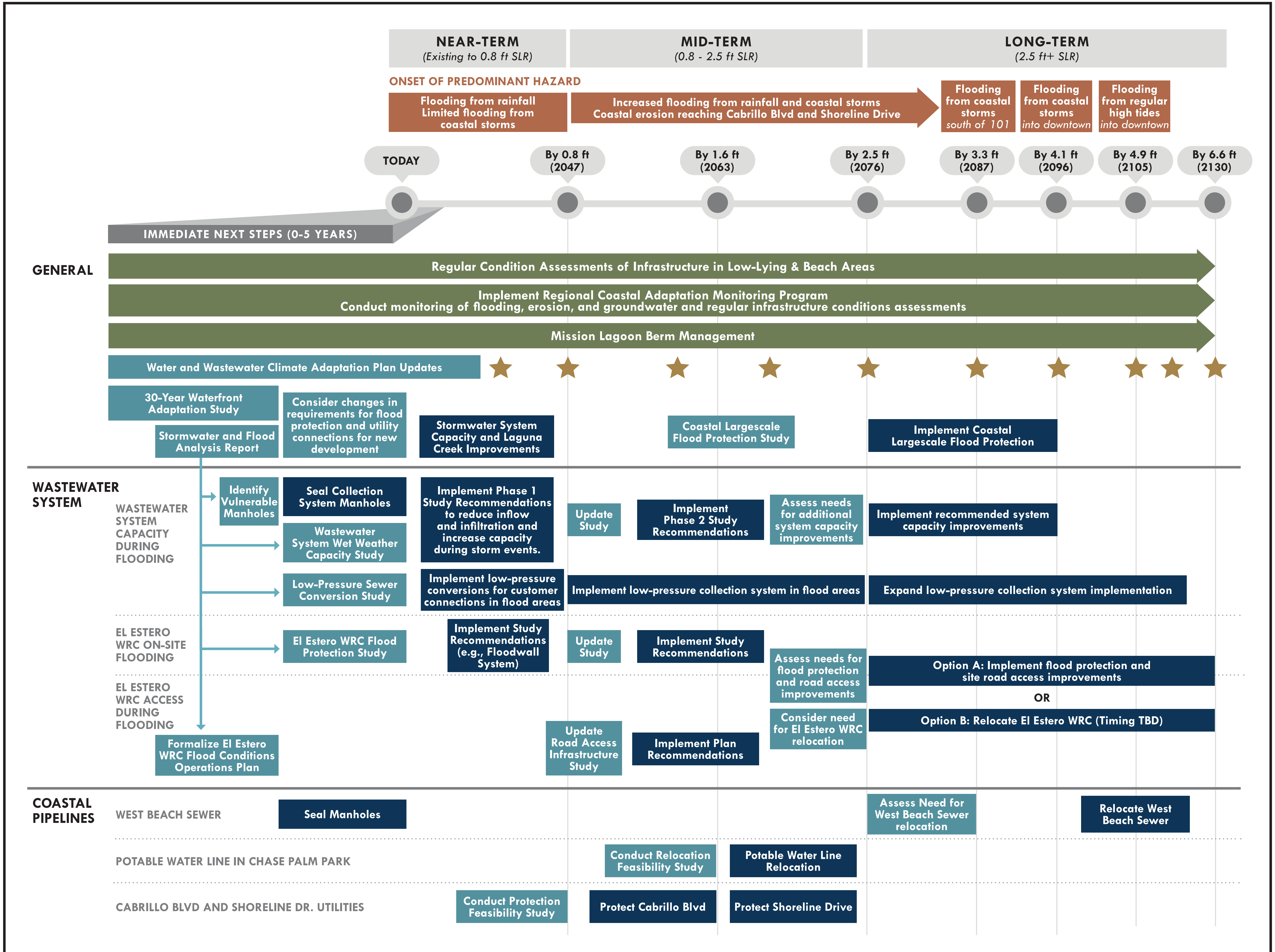
Table ES-5. Summary of High Priority Actions

Action	Adaptation Recommendations
Immediate (0-5 Years)	
Interim Adaptation Measures	• Seal manholes in flood-prone areas (e.g., West Beach sewer). • Continue Mission Lagoon berm management to facilitate. stormwater flows reaching the ocean and reduce ponding time.
Improve Understanding of Flood Hazards	• 30-Year Waterfront Adaptation Plan: Develop a near-term strategy for coastal areas. • Stormwater Model and Flood Analysis: Study flooding around El Estero WRC. • Wastewater System Capacity Study: Characterize sources of infiltration and inflow and potential solutions. • Low-Pressure Sewer Conversion Study: Define potential phasing of sewer conversions based on projected hazards. • El Estero WRC Flood Protection Study: Identify flood protection measures with sea level rise.
Flood Access & Protection for El Estero WRC	• Formalize Flood Conditions Operations Plan.
Near-Term (5-20 Years, 0-0.8 ft SLR)	
Wastewater System Capacity Improvements	• Implement improvements from the Wastewater System Capacity Study (e.g., manhole sealing, sewer rehabilitation, wastewater storage at El Estero WRC). • Facilitate low-pressure customer connection conversions for low-lying properties and plan for pressurization of low-lying collection systems.
Flood Access & Protection for El Estero WRC	• Implement floodwall system protection for El Estero WRC. • Plan stormwater improvements for Laguna Creek.
Mid-Term (20-50 Years, 0.8-2.5 ft SLR)	
Wastewater System Capacity Improvements	• Implement remaining recommendations from Wastewater System Capacity Study. • Implement initial phases of low-pressure collection system in low lying areas and plan for full pressurization of coastal area collection system.
El Estero WRC Flood Protection Measures	• Implement additional flood protection for El Estero WRC. • Conduct long-term El Estero Flood Protection, Flood Access, and Relocation Study.
Potable & Sewer Pipeline Protection	• Protect utilities from shoreline erosion along Cabrillo Blvd and Shoreline Drive. • Relocate potable water pipeline in Chase Palm Park.
Flood Access & Protection for El Estero WRC	• Improve access to El Estero WRC as flooding increases.

Figure ES-7. Adaptation Measures for Highest Near-Term and Mid-Term Infrastructure Risks from Climate Change

Timeframes:

- Immediate Next Steps (0 to 5 Years)
- Near-Term (now through 0.8 ft SLR [~2048]; 5 to 20 years)
- Mid-Term (0.8 ft to 2.5 ft SLR [~2048 to ~2076]; 20 to 50 years)
- Long-Term (2.5+ ft SLR [~2076+]; 50+ years)



Water & Wastewater Climate Adaptation Project

Figure ES-8
Implementation Plan

Legend

- Hazard
- Monitoring and Maintenance
- Study
- Design and Construct

WSC

Water & Wastewater Climate Adaptation Project

Figure ES-9. Coastal Hazards, Existing

Legend

- El Estero WRC
- Desalination Plant
- Pump Station & Chemical Area
- Sewer Manhole
- Sewer Main
- West Beach Sewer
- Water Main
- Desalination Intake
- Recycled Water Main

Hazards

- Tidal Inundation
- Coastal Storm Flooding (100-yr)
- Coastal Storm Flooding (1-yr)

N

0 0.15 0.3 Miles

0 500 1,000 US Feet

WSC

Water & Wastewater Climate Adaptation Project

Figure ES-9. Coastal Hazards, Existing

Legend

- El Estero WRC
- Desalination Plant
- Pump Station & Chemical Area
- Sewer Manhole
- Sewer Main
- West Beach Sewer
- Water Main
- Desalination Intake
- Recycled Water Main

Hazards

- Tidal Inundation
- Coastal Storm Flooding (100-yr)
- Coastal Storm Flooding (1-yr)

N

0 0.15 0.3 Miles

0 500 1,000 US Feet

WSC

Water & Wastewater Climate Adaptation Project

Figure ES-10. Coastal Hazards, 0.8 ft SLR

Legend

- El Estero WRC
- Desal Plant & Annex Yard
- Pump Station & Chemical Area
- Sewer Manhole
- Sewer Main
- West Beach Sewer
- Water Main
- Desalination Intake
- Recycled Water Main

Hazards

- Tidal Inundation
- Shoreline Retreat
- Coastal Storm Flooding (100-yr)
- Coastal Storm Flooding (1-yr)

Notes

1. Erosion at West Beach is analyzed separately and discussed further in the Wastewater and Water Systems Climate Adaptation Plan.

N

0 0.15 0.3 Miles

0 500 1,000 US Feet

WSC

Water & Wastewater Climate Adaptation Project

Figure ES-11. Coastal Hazards, 1.6 ft SLR

Legend

- El Estero WRC
- Desal Plant & Annex Yard
- Pump Station & Chemical Area
- Sewer Manhole
- Sewer Main
- West Beach Sewer
- Water Main
- Desalination Intake
- Recycled Water Main

Hazards

- Tidal Inundation
- Shoreline Retreat
- Coastal Storm Flooding (100-yr)
- Coastal Storm Flooding (1-yr)

Notes

1. Erosion at West Beach is analyzed separately and discussed further in the Wastewater and Water Systems Climate Adaptation Plan.

N

0 0.15 0.3 Miles

0 500 1,000 US Feet

WSC

Water & Wastewater Climate Adaptation Project

Figure ES-12. Coastal Hazards, 2.5 ft SLR

Legend

- El Estero WRC
- Desal Plant & Annex Yard
- Pump Station & Chemical Area
- Sewer Manhole
- Sewer Main
- West Beach Sewer
- Water Main
- Desalination Intake
- Recycled Water Main

Hazards

- Tidal Inundation
- Shoreline Retreat
- Coastal Storm Flooding (100-yr)
- Coastal Storm Flooding (1-yr)

Notes

1. Erosion at West Beach is analyzed separately and discussed further in the Wastewater and Water Systems Climate Adaptation Plan.

N

0 0.15 0.3 Miles

0 500 1,000 US Feet

WSC

Water & Wastewater Climate Adaptation Project

Figure ES-13. Coastal Hazards, 3.3 ft SLR

Legend

- El Estero WRC
- Desal Plant & Annex Yard
- Pump Station & Chemical Area
- Sewer Manhole
- Sewer Main
- West Beach Sewer
- Water Main
- Desalination Intake
- Recycled Water Main

Hazards

- Shoreline Retreat
- Coastal Storm Flooding (100-yr)
- Coastal Storm Flooding (1-yr)
- Tidal Inundation

Notes

1. Erosion at West Beach is analyzed separately and discussed further in the Wastewater and Water Systems Climate Adaptation Plan.

N

0 0.15 0.3 Miles

0 500 1,000 US Feet

Water & Wastewater Climate Adaptation Project

Figure ES-14. Coastal Hazards, 4.1 ft SLR

Legend

- El Estero WRC
- Desal Plant & Annex Yard
- Pump Station & Chemical Area
- Sewer Manhole
- Sewer Main
- West Beach Sewer
- Water Main
- Desalination Intake
- Recycled Water Main

Hazards

- Tidal Inundation
- Shoreline Retreat
- Coastal Storm Flooding (100-yr)
- Coastal Storm Flooding (1-yr)

Notes

1. Erosion at West Beach is analyzed separately and discussed further in the Wastewater and Water Systems Climate Adaptation Plan.

N

0 0.15 0.3 Miles

0 500 1,000 US Feet

WSC

Water & Wastewater Climate Adaptation Project

Figure ES-15. Coastal Hazards, 4.9 ft SLR

Legend

- El Estero WRC
- Desal Plant & Annex Yard
- Pump Station & Chemical Area
- Sewer Manhole
- Sewer Main
- West Beach Sewer
- Water Main
- Desalination Intake
- Recycled Water Main

Hazards

- Tidal Inundation
- Shoreline Retreat
- Coastal Storm Flooding (100-yr)
- Coastal Storm Flooding (1-yr)

Notes

1. Erosion at West Beach is analyzed separately and discussed further in the Wastewater and Water Systems Climate Adaptation Plan.

N

0 0.15 0.3 Miles

0 500 1,000 US Feet

WSC

Water & Wastewater Climate Adaptation Project

Figure ES-16. Shoreline Erosion, East Beach and West Beach

Legend

- El Estero WRC
- Desal Plant & Annex Yard
- Pump Station & Chemical Area
- Sewer Manhole
- Sewer Main
- West Beach Sewer
- Water Main
- Desalination Intake
- Recycled Water Main

Shoreline Retreat

- 0.8 ft SLR
- 1.6 ft SLR
- 2.5 ft SLR
- 3.3 ft SLR
- 4.1 ft SLR
- 4.9 ft SLR

Notes

1. Erosion at West Beach is analyzed separately and discussed further in the Wastewater and Water Systems Climate Adaptation Plan.

N

0 0.1 0.2 Miles

0 420 840 US Feet

WSC

Water & Wastewater Climate Adaptation Project

Figure ES-17. Shoreline Erosion, Leadbetter Beach

Legend

- Sewer Manhole
- Sewer Main
- Water Main
- Desalination Intake
- Recycled Water Main

Shoreline Retreat

- 0.8 ft SLR
- 1.6 ft SLR
- 2.5 ft SLR
- 3.3 ft SLR
- 4.1 ft SLR
- 4.9 ft SLR

Notes

1. Erosion at West Beach is analyzed separately and discussed further in the Wastewater and Water Systems Climate Adaptation Plan.

N

0 0.03 0.07 Miles

0 137.5 275 US Feet

WSC