



City of Palo Alto

City Council Staff Report

(ID # 9576)

Report Type: Action Items

Meeting Date: 3/18/2019

Council Priority: Climate/Sustainability and Climate Action Plan

Summary Title: Proposed Draft Sea Level Rise Policy

Title: Acceptance of Proposed Policy to Plan for Sea Level Rise

From: City Manager

Lead Department: Public Works

RECOMMENDATION

Staff recommends that City Council:

1. Accept the attached Sea Level Rise Adaptation Policy (Attachment A), which will serve as a guide for the development of a subsequent Sea Level Rise Adaptation Plan. This Plan will serve as the Sustainability and Climate Action Plan–Sea Level Rise chapter;
2. Direct Staff to return to Council with a Sea Level Rise Adaptation Plan by December 2020.

EXECUTIVE SUMMARY

This report provides an overview of Palo Alto’s draft Sea Level Rise Adaptation Policy. The purpose of the policy is to provide guidance in planning for rising tides that could impact Palo Alto’s neighborhoods, economy, and the Baylands habitat. The Policy strives to ensure consistency and integration with the City’s [Comprehensive Plan](#) (November 2017), the [Sustainability and Climate Action Plan](#) (S/CAP) (November 2016) and related [Sustainability Implementation Plans](#) (SIPs) (December 2017), the [Local Hazard Mitigation and Adaptation Plan](#) (March 2017), the [Baylands Master Plan](#) (2008), [Parks Master Plan](#) (August 2017) and the [Urban Forest Master Plan](#) (February 2019).

The Policy will serve as guidance in developing the more detailed Sea Level Rise Adaptation Plan (Plan) to protect Palo Alto’s neighborhoods, economy, and Baylands habitat. The Policy and Plan are needed to complete the 2018-2020 SIPs which were accepted by Council in 2017 ([Staff Report 8487](#)). The Plan will be delivered for Council review by December 2020 and will serve as the Sea Level Rise Implementation Plan chapter of the 2020 S/CAP Update. The Plan will include suggested measures to protect infrastructure, determine sea level height triggers for the Plan’s various actions, and initiate adaptation strategies. The adaptation strategies of the Plan will likely include measures such as revising building requirements, staff and public education, and integrating sea level rise policy elements into other City operational procedures and plans.

BACKGROUND

On May 31, 2016, staff presented a Study Session on Sea Level Rise to City Council ([Staff Report 6953](#)). At that study session, Staff identified facility-specific and programmatic issues that involve sea level rise. Facilities that could be impacted by sea level rise include the Regional Water Quality Control Plant, the Palo Alto Golf Course, the Palo Alto Airport, and the Municipal Service Center. Services that could be impacted by sea level rise include critical underground utilities, Highway 101, and emergency response capabilities. Six “Guiding Principles” and three generic “Tools” (Protect, Adapt, and Retreat) were presented as a framework for Council discussion on future sea level rise plans and projects, including the City of Palo Alto Comprehensive Plan Update.

On November 28, 2016, Palo Alto City Council unanimously adopted the draft [Sustainability/Climate Action Plan \(S/CAP\) Framework \(Staff Report 7304\)](#), which included goals and strategies for sea level rise. The S/CAP Framework also included six Guiding Principles and four goals for Sea Level Rise Response:

1. Plan for coming changes in our climate and environment
2. Protect the City from climate change induced hazards
3. Adapt to current and projected environmental conditions
4. Empower the local community and foster regional collaboration

DISCUSSION

Greenhouse gases trap the earth’s heat which warms land and oceans. This causes both thermal expansion of the oceans and Antarctic and Greenland ice melt which together are the primary sources of sea level rise globally and in San Francisco Bay.

Sea level rise threatens the operational integrity of critical services and facilities, e.g., Palo Alto’s electrical, gas, water and wastewater utilities, the Municipal Service Center, the Palo Alto Airport, Highway 101 and surrounding roads. Business districts and residential neighborhoods within the projected sea level rise area are vulnerable to a rising Bay and potential future FEMA insurance zone requirements.

Sea level rise is also likely to affect the elevation and salinity of groundwater close to the Bay. Rising groundwater could have impacts on belowground infrastructure which may be subject to corrosion and buoyancy effects and could contribute to liquefaction. In the case of very low-lying areas, groundwater may result in surface flooding and long-term ponding.

Under the State of California’s *Ocean Protection Council (OPC)* [2018 Probabilistic Sea Level Rise Projections](#), the Palo Alto Baylands may be submerged by mid-century which would eliminate their ability to buffer upstream or Bayside flooding sources, attenuate storm surge, or sequester carbon. The encroachment of Bay water may alter or eliminate habitat for endangered species that reside in Palo Alto Baylands and the millions of birds that use the Palo Alto segment of the Pacific Flyway for seasonal migration. The recreational and inspirational

services of the Palo Alto shoreline could change if Baylands trails, playing fields, and golf course are surrendered to encroachment of San Francisco Bay.

The decisions that Palo Alto makes in future years to adapt to rising tides extend beyond the City's borders. Implications with built features such as levees will impact adjacent communities and thus require close coordination with surrounding local and regional agencies.

The proposed *Sea Level Rise Adaptation Policy*:

1. Recognizes that the best way to avoid long-term impacts from the worst sea level rise predictions and to minimize adaption response costs is to reduce greenhouse gas (GHG) contributions locally and to support regional, state, and national initiatives that reduce GHGs.
2. Guides staff to lead by example and coordinate on sea level rise studies and planning efforts with East Palo Alto, Mountain View, and other cities and public agencies, including counties, as needed as well as utilities and public-private partnerships.
3. Standardizes the use of the *Ocean Protection Council (OPC) 2018 Probabilistic Sea Level Rise Projections* for use in the City's sea-level rise planning efforts for proposed development projects, renovations and possible property acquisitions and other City planning.
4. Provides a framework for the development of a Sea Level Rise Adaptation Plan which would include a vulnerability assessment, short-term and long-term plan components, and roles and responsibilities of staff.

The draft policy reflects extensive input from staff, subject matter experts working on sea level rise and climate adaptation planning, and Palo Alto residents. Reviewers included:

- Staff across City of Palo Alto Departments (Planning, Public Works, Utilities, Community Services, Office of Emergency Services, City Manager's Office, Open Space);
- The San Francisco Estuary Institute–Resilient Landscapes Program. This program develops innovative ecosystem restoration and management strategies to re-establish and sustain key ecological functions and services. These strategies integrate natural and human infrastructure to create systems that are more adaptive to climate change and other stressors;
- The Bay Area Climate Action Network (BayCAN). BayCAN is a collaborative network of local government staff helping the Bay Area respond to the impacts of climate change on human health, infrastructure and natural systems;

- UC Berkeley scientists and professors affiliated with the Climate Readiness Institute (CRI). CRI utilizes experts from the region’s leading research institutions with expertise in climate science, civil engineering, urban planning, ecology, oceanography, and law;
- Staff from the cities of Mountain View, Santa Clara County, San Mateo County Sea Change (oversees sea level rise planning efforts for the County); and,
- Palo Alto residents who attended a public meeting on Wednesday February 27, 2019. Invitees included members from the Parks and Recreation Commission and Baylands Comprehensive Conservation Plan Committee, Save Palo Alto’s Groundwater and other interested public members.

A separate Parks and Recreation Commission meeting is also scheduled for March 26, 2019 to assist in Sea Level Rise Adaptation Plan development.

Current Palo Alto Sea Level Rise Planning Efforts

The development of a sea level rise policy and a proposal for a Sea Level Rise Adaptation Plan are two efforts among several to plan for sea level rise. Additional current City of Palo Alto sea level rise-related planning efforts include:

1. A feasibility study for levee Improvements along the Palo Alto’s San Francisco Bay edge via the Strategy to Advance Flood Control, Environmental Protection and Recreation (SAFER) Project. This project will propose options for new and upgraded levee alignments around Palo Alto Bay edge which also enhance habitat and recreation opportunities. Palo Alto’s levees currently do not meet standards for Federal Emergency Management Agency (FEMA) accreditation and may be vulnerable to overtopping from future rising tides and storm surge. SAFER feasibility study and coordination with East Palo Alto and Menlo Park is supported by the San Francisquito Creek Joint Powers Authority. Staff will bring a feasibility study for proposed levee alignments to City Council in 2019;
2. A conceptual design for a horizontal levee to be integrated into the SAFER alignment. Horizontal levees are wide, engineered planted landscapes that mimic nature to attenuate storm surge and rising tides, and sequester carbon. The preferred location that was identified is at the east end of Embarcadero Road. A 30% design development is in process;
3. The completion of a [Baylands Vulnerability Assessment](#) by the Community Services Department in 2018. This document describes the potential impacts of sea level rise on physical assets and habitats in the Baylands and high-level measures that the City can take to adapt to climate change and sea level rise. This document can be used as a starting point for planning efforts to address potential future impacts caused by sea level rise and climate change.

Public Works–Watershed Protection hopes to build upon this work to prioritize projects that would protect critical infrastructure and to develop “Adaptation Pathways.” “Pathways,” in relation to adaptation, is an approach designed to schedule adaptation decision-making. It identifies the decisions that need to be taken now and those that may be taken in future. The approach supports strategic, flexible and structured decision-making. The pathways approach allows decision makers to plan for, prioritize, and stagger investment in adaptation options. Sea level rise trigger points and thresholds help them identify when to revisit decisions or actions. Examples of pathways approaches can be translated into visual aids that help with stakeholder communication. The adaptation pathway approach has been successfully applied in adaptation planning for infrastructure and water management projects, and broader cross-sector adaptation planning¹;

4. Improved Stormwater Management. Stormwater runoff travels to low-lying areas in Palo Alto which may also be impacted by sea level rise. Two recent stormwater management efforts will reduce stormwater ponding contributions to projected sea level rise inundation areas:
 - a) The [Stormwater Management Fee](#). The Stormwater Management Fee ballot measure passed in April 2017 with 64% of Palo Altans voting for the measure. The Storm Water Management Program funds stormwater system maintenance and provides for stormwater system improvements that prevent street flooding and protect water quality. The program also provides litter reduction, creek pollution prevention programs, commercial and residential rebates, and flooding emergency- response services. Constructing Green Stormwater Infrastructure projects is a new priority which includes infiltrating and cleansing storm water to decrease peak flows to the conveyance system. ;
 - b) [Green Stormwater Infrastructure \(GSI\) Framework](#). The GSI Framework was adopted by Council in June 2017. Its purpose is to describe how the City will gradually integrate GSI features into its urban landscape and stormwater conveyance systems over several decades. GSI uses vegetation, soils, and natural processes to manage stormwater runoff. It can help to avoid additional ponding in areas that may also be flooded in future years by rising tides. GSI is partially funded by the Stormwater Management Fee.
5. Sea level rise integration into City Planning Documents. Planning for Sea Level rise is now referenced in the [Local Hazard Mitigation and Adaptation Plan](#) Revision and the [2030 Comprehensive Plan; and,](#)
6. There are many Bay Area Regional efforts working to coordinate and provide resources to public agencies for sea level rise planning. See Attachment B–Regional Sea Level Rise Planning Efforts for a summary table.

¹ CoastAdapt. (2019). Retrieved from <https://coastadapt.com.au/pathways-approach>

Resource Impacts

Development of the Sea Level Rise Adaptation Policy to date required relatively small amounts of staff time by each department and minimal consultant support. Should the Sea Level Rise Policy be accepted by Council, resource requirements will increase to develop the follow-on Sea Level Rise Adaptation Plan. Staff's preliminary estimate is a one-time cost of \$250,000 for development of the Sea Level Rise Adaptation Plan, with ongoing costs for implementation of the plan that will be evaluated during plan development. These budget needs, as well as a position reclassification to provide coordination of the plan, are being considered through the annual budget process. Once the City's Policy and Plan are complete and the regional efforts are developed, the more difficult issues of locating funding for implementation will commence.

Policy Implications

The Sea Level Rise Adaptation Policy aligns with the 2019 Climate/Sustainability and Climate Action Plan Council Priority.

Environmental Review

Acceptance by Council of and direction to staff regarding next steps concerning the Sea Level Rise Adaptation Rise Policy is not a "project" approval under California Environmental Quality Act (CEQA) because the action constitutes acceptance of a work program to develop a plan, and the work program is subject to change, is non-binding and its acceptance would not result in a direct or indirect physical change to the environment. If the action were considered a project, it would be exempt from review under CEQA Guidelines Section 15061(b)(3) for the same reasons. The plan that will be developed will be evaluated under CEQA prior to its consideration by Council.

Attachments:

- Attachment A - Sea Level Rise Policy
- Attachment B - Summary of Regional Sea Level Rise Planning Efforts



SEA LEVEL RISE ADAPTATION

OVERVIEW

The State of California anticipates that relative sea level rise (SLR) projections stemming from greenhouse gas emissions and related climate change pose significant economic, environmental and social risks to communities along the San Francisco Bay Shoreline, including the City of Palo Alto. Research shows that these projections may worsen if greenhouse gas emission trajectories continue unabated.¹

Sea level rise in San Francisco Bay is anticipated to range between three feet to more than ten feet by 2100 with rising tides likely thereafter.² In Palo Alto, many City services and infrastructure that are essential to the City's public health, safety and economy are located within areas that are predicted to be inundated by Bay water if adaptation measures are not implemented.³

PURPOSE OF POLICY

The purpose of this policy is to plan for rising tides that could impact Palo Alto's neighborhoods, economy and the Baylands habitat, and to ensure consistency and integration with the range of City plans that call for SLR planning such as the City's [2030 Comprehensive Plan](#) (adopted November 2017), the [Sustainability and Climate Action Plan](#) (S/CAP) (November 2016) and related [Sustainability Implementation Plans](#) (SIPs), the [Local Hazard Mitigation and Adaptation Plan](#) (March 2017), the [Baylands Master Plan](#) (2008), Baylands Comprehensive Conservation Plan (in development), and the [Urban Forest Master Plan](#) (February 2019), and other key planning documents that are produced. This policy will serve as a blueprint for the development of a Sea Level Rise Adaptation Plan, and is not intended to establish requirements on new development for implementation prior to Plan adoption; however, projects may be encouraged in advance to consider sea level rise as part of the development process. Definitions and terminology relevant to this policy are listed in Appendix 1– Policy Definitions and Related Terminology.

POLICY SUMMARY

The City recognizes that the best way to avoid long-term impacts from the worst SLR predictions and to minimize adaption response costs is to reduce greenhouse gas (GHG) contributions locally and to support regional, state and national initiatives that reduce GHGs.

Palo Alto will lead by example and coordinate on SLR studies and planning efforts with East Palo Alto, Mountain View, and other cities and public agencies, including counties, as well as utilities, and public-private partnerships, as needed. Palo Alto will establish interdepartmental SLR Planning responsibilities into City

¹ Ocean Protection Council. (2018). *State of California Sea-Level Rise Guidance 2018 Update*. Retrieved from http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf. Page 12.

² Reference ¹, page 18.

³ San Francisco Bay Conservation and Development Commission Adapting to Rising Tides Program (2018). *Adapting to Rising Tides Bay Shoreline Flood Explorer* online tool. Retrieved from <https://explorer.adaptingtorisingtides.org/home>.

procedures and planning (see, e.g., Appendix 2—Departmental Responsibilities for Sea Level Rise Planning).

Palo Alto will use the *Ocean Protection Council (OPC) 2018 Probabilistic SLR Projections* published by the State of California (Appendix 3) for proposed development projects, renovations and possible property acquisitions and other City planning unless a more suitable reference is identified and agreed upon by local agencies tasked with SLR preparedness. City of Palo Alto, business and residential investments in new property, development, and infrastructure should be designed based on OPC SLR projections for the useful life of the asset to avoid flooding or erosion. To that end, the forthcoming Sea Level Rise Adaptation Plan should consider the following best practices:

1. Upgrades to existing property or infrastructure that are considered less-critical (not essential to immediate public health and safety, e.g. trails or playing fields) should consider the impacts of SLR beyond 2050 using the Low Risk Aversion or Medium-high Risk Aversion Projection listed in Table 1;
2. For critical development and infrastructure (e.g., wastewater treatment facility or utilities that are essential to public health and safety), a risk assessment should be completed based on the SLR projections to 2100 and to include the lifetime of the building using the Medium-high or Extreme Risk Aversion Projections;
3. All designs and engineering strategies, where possible and financially feasible, should be adaptable to changing climate predictions. Each new development should be required to develop and maintain an individual “adaptation pathway plan” to prepare for changes in rising sea level, and related groundwater intrusion. In all sea level rise assessments, and where data are available, the City will consider Base Flood Elevations, storm surge, groundwater table changes due to rising sea levels, and wave runup, where appropriate.

BACKGROUND

Greenhouse gases trap the earth’s heat which warms land and oceans. This causes both thermal expansion of the oceans and Antarctic and Greenland ice melt which together are the primary sources of SLR globally and in San Francisco Bay.

SLR threatens the operational integrity of critical services and facilities, e.g., Palo Alto’s electrical, gas, water and wastewater utilities, the Municipal Service Center, the Palo Alto Airport, Highway 101 and surrounding roads. Business districts and residential neighborhoods within the projected SLR area are vulnerable to a rising Bay and potential future FEMA insurance zone requirements.

SLR is also likely to affect the elevation and salinity of groundwater close to the Bay. Rising groundwater could have impacts on belowground infrastructure which may be subject to corrosion and buoyancy effects and could contribute to liquefaction. In the case of very low-lying areas, groundwater may result in surface flooding and long-term ponding.

Under current SLR predictions, the Palo Alto Baylands may be submerged by mid-century which would eliminate their ability to buffer upstream or Bayside flooding sources, attenuate storm surge or sequester carbon. The encroachment of Bay water may alter or eliminate habitat for endangered species that reside in

Palo Alto Baylands and the millions of birds that use the Palo Alto segment of the Pacific Flyway for seasonal migration. The recreational and inspirational services of the Palo Alto shoreline could change if Baylands trails, playing fields and golf course are surrendered to encroachment of San Francisco Bay.

The decisions that Palo Alto makes in future years to adapt to rising tides extend beyond the City's borders. Implications with built features such as levees will impact (help or imperil) adjacent communities and thus require close coordination with surrounding local and regional agencies.

PROCEDURES FOR POLICY IMPLEMENTATION

1. The City will:

- a) **conduct a SLR vulnerability assessment**, which will:
 - i. identify critical and less-critical City infrastructure and ecosystem assets to manage risks given predicted SLR scenarios through 2100 and beyond;
 - ii. Identify hazards and determine tolerable risks of the City and community members (risk = hazard x exposure x vulnerability; risk (\$/year) = frequency (events/year) x consequences (\$/event);
 - iii. include an economic assessment of SLR vulnerability for public and private property and cost estimates for inaction;
 - iv. engage community members in the process.

- b) **develop a multi-year SLR Implementation Plan** to coordinate internal and regional SLR planning, project funding and public outreach. The Plan will include a SLR adaptation plan and timeline which will:
 - i. align with the intent and language of the City's various plans, policies and documents that intersect with SLR Policy and Plan (e.g., the Comprehensive Plan, Sustainability and Climate Action Plan, Local Hazard Mitigation Plan, Baylands Comprehensive Conservation Plan, Baylands Master Plan, Regional Water Quality Control Plant Long Range Facility Plan, Urban Water Management Plan, Recycled Water Strategic Plan, Parks Master Plan, etc.);
 - ii. include a table of prioritized adaptation pathways to manage risks to natural and built assets based on the SLR Vulnerability Assessment. Adaptation pathways provide a menu of recommendations and logically staged phases for adaptation over time based on triggers related to SLR levels. Adaptation pathways factor in cost/benefits, the lengthy time to plan, fund and build response strategies and potential additional benefits of carbon sequestration, GHG reduction, wildlife protection and social equity;

- iii. include a development plan for public and private property anticipated to be impacted by SLR which may include:
 - a. changing the city zoning map and amending requirements, restrictions, or municipal codes to be stricter than state or federal requirements as necessary and when feasible to reduce risks;
 - b. adding conditions of approval for project permits in areas where there is a SLR or groundwater intrusion risk;
 - c. establishing geographic areas and/or triggers for requiring consideration of relocation;
 - d. developing restrictions or additional criteria; and
 - e. funding identification
 - f. educate and engage community members in the process of SLR planning, including creating a SLR Task Force and meeting with stakeholders (e.g., realtors, property owners, etc.) to educate them about SLR and the options, tradeoffs, and costs, for resilience;
- iv. address budget and funding considerations for additional or existing staff to perform SLR planning, adaptation and Capital Improvement Projects (CIPs);
- v. provide guidance on managing and enhancing Baylands, creek and open space ecosystem services to mitigate SLR impacts through carbon sequestration and absorption. Examples of this include the use of horizontal levees, expanding or improving Baylands habitat; this guidance should consider the use of the Baylands Comprehensive Conservation Plan, and the concept of “Operational Landscape Units” developed by San Francisco Estuary Institute which delineate Bay shoreline ecosystem functions and services within the natural and built environment and not by jurisdictional boundaries, and;
- vi. include the development of educational materials and technical assistance for staff and developers, including:
 - a. a checklist and primer on SLR, risk and sharing risk, and planning guidance;
 - b. technical and regulatory guidance to City engineers and public developers so that projects are designed based on accepted OPC SLR assumptions and which prompt design-standard revisions, and protect, adapt, retreat responses for threatened areas;
 - c. a risk assessment process to be used during CIP site selection, planning and property purchases;
 - d. a SLR and groundwater projection zone map which also shows the intersection of the FEMA flood zone and associated insurance requirements;

2. **Recognize policy limits:** This policy does not establish specific requirements for all projects because each site condition is unique, but instead provides expectations for developing guidance and tools to answer key building and infrastructure design and SLR response strategies. This policy also recognizes that not all codes and regulations that govern construction are yet synchronized with OPC SLR predictions, however Palo Alto will incorporate SLR guidance and planning into its own construction

and planning process proactively for both public and private structures until regional standards are adopted for use.

Draft

Appendix 1: Policy Definitions and Related Terminology

Adaptation Pathway: “Pathways” in relation to adaptation is an approach designed to schedule adaptation decision-making. It identifies the decisions that need to be taken now and those that may be taken in future. The approach supports strategic, flexible and structured decision-making. The pathways approach allows decision makers to plan for, prioritize and stagger investment in adaptation options. Trigger points and thresholds help them identify when to revisit decisions or actions. Examples of pathways approaches can be translated into visual aids such as “route maps” that support communication and consultation with stakeholders. The adaptation pathway approach has been successfully applied in adaptation planning for infrastructure and water management projects, and broader cross-sector adaptation planning⁴.

Baylands: Lands which are located between the lines of mean high tide and mean low tide (California Coastal Commission Sea Level Rise Policy Guidance).

Base Flood Elevation (1% annual chance flood): A flood that has a 1% probability of occurring in any given year. The 100-year floodplain is the extent of the area of a flood that has a 1% chance of occurring or being exceeded in any given year. This is indicated by the Special Flood Hazard Area (SFHA) on FEMA flood maps.

Baylands Comprehensive Conservation Plan: A plan currently being prepared by the City of Palo Alto that provides specific programs and projects to achieve the goals and policies of the Baylands Master Plan.

Baylands Master Plan: A plan prepared by the City of Palo Alto to provide a framework and guide for actions in the Baylands that seek to preserve the area’s unique natural, recreational and flood-prevention resources.

Capital Improvement Program (CIP): The Capital Improvement Program (CIP) includes projects that help maintain or improve City assets, often called infrastructure. To be included in the City of Palo Alto Capital Budget, a project must meet the following criteria:

- Must have a minimum cost of \$50,000 for each stand-alone unit or combined project.
- Must have a useful life of at least five to seven years (the purchase or project will still be functioning and not be obsolete at least five to seven years after implementation).
- Must extend the life of an existing asset or provide a new functional use for an existing asset for at least five years. Examples include extensive roof rehabilitations. These improvements are distinguished from ongoing maintenance work that may extend the life of the asset but is done on a routine basis.

Climate change: Any long-term change in climate conditions in a place or region, whether due to natural causes or as a result of human activity.

Comprehensive Plan: The City of Palo Alto Comprehensive Plan (or Comp Plan) is the primary tool for guiding land use and development in Palo Alto. The Plan fulfills the State requirement that the City adopt

⁴ CoastAdapt. (2019). Retrieved from <https://coastadapt.com.au/pathways-approach>

a General Plan. The Plan provides a foundation for the City's development regulations, capital improvements program, and day-to-day decisions.

Critical infrastructure: City built assets with a long-projected life span (greater than 50 years) which if compromised by rising tides could potentially have catastrophic results on public health, safety or well-being, e.g., wastewater treatment facilities, stormwater infrastructure, levees or impoundments, bridges along major evacuation routes, airports, seaports, railroads, and major highways, EOC/Fire/Police/Healthcare, schools, homeless shelters, landfills and contaminated sites.

Less-critical Infrastructure: City assets that have an expected lifetime of 10-20 years or is replaceable and adaptable, or has limited interdependencies and limited consequences should the system fail or be inundated by water. Examples include isolated parks, unpaved trails.

Design life: The life expectancy of a project as determined during design. As opposed to useful life (see below).

Erosion: The wearing away of land by natural forces; on a beach, the carrying away of beach material by wave action, currents, or the wind, the loss of marsh due to the erosion of the marsh edge by waves. Development and other non-natural forces (e.g., water leaking from pipes or scour caused by wave action against a seawall) may create or worsen erosion problems (California Coastal Commission Sea Level Rise Policy Guidance).

Facilities: All buildings, communications facilities, energy systems, industrial facilities, all transportation networks, water and wastewater systems, and parks.

Flood (or Flooding): Refers to normally dry land becoming temporarily covered in water, either periodically (e.g., tidal flooding, king tides) or episodically (e.g., storm surge or tsunami flooding).

Greenhouse gases (GHGs): Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride.

Green Stormwater Infrastructure (GSI): Infrastructure that uses vegetation, soils, and natural processes to manage stormwater runoff and reduce peak flows in flood control channels or creeks. Examples of GSI include landscape-based stormwater "biotreatment" using soil and plants ranging in size from grasses to trees; pervious paving systems (e.g., interlocking concrete pavers, porous asphalt, and pervious concrete); rainwater harvesting systems (e.g., cisterns and rain barrels); and other methods to capture and use stormwater as a resource.

Groundwater: The water found below the surface of the land and contained in the pore spaces of saturated geologic media (sand, gravel). Groundwater is either rain water that has seeped through the soil surface and by means of gravity of soil conditions drained from high to lower elevation areas. Groundwater can also come from the bay transferred via bay mud under the existing levees. Groundwater can be source of water found in wells and springs.

Hazard: A situation involving danger such as coastal flooding, earthquake rainfall and local flooding.

Local Hazard Mitigation Plan: The Federal Disaster Mitigation Act of 2000 (DMA) requires all cities, counties, and special districts to adopt a Local Hazard Mitigation Plan (LHMP) to receive disaster mitigation funding from the Federal Emergency Management Agency (FEMA). Hazard mitigation planning is the process used by state, local and tribal leaders to understand risks from natural hazards and develop long-term strategies to reduce the impacts of disasters on people, property, and the environment. [The Palo Alto Local Hazard Mitigation Plan](#) is updated every three years.

Mean Sea Level: The average relative sea level over a period, such as a month or a year, long enough to average out transients such as waves and tides.

Ocean Protection Council (OPC): The Council was created pursuant to the California Ocean Protection Act (COPA), which was signed into law in 2004 by Governor Arnold Schwarzenegger. The mission of the OPC is to "...ensure that California maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations. The OPC is committed to basing its decisions and actions on the best available science, and to promoting the use of science among all entities involved in the management of ocean resources." The OPC published the [State of California Sea Level Rise Guidance Document](#) and subsequent updates which provides an estimated range of predicted SLR and subsequent updates.

Operational Landscape Units: A delineated area that effectively provides specific ecosystem functions and services within the natural and built environment.

Pacific Flyway: A major north-south flyway for migratory birds in America, extending from Alaska to Patagonia. Every year, migratory birds travel some or all of this distance both in spring and in fall, following food sources, heading to breeding grounds, or travelling to overwintering sites.

Protect, adapt, retreat strategies: Responding to SLR generally involves three general concepts:

- **Protect:** Implementing strategies that reduce the risk of SLR impacts to land e.g., levees, horizontal levies, floodwalls, flood gates, and wetlands;
- **Adapt:** Adjusting to natural or human systems in response to actual or expected climatic stimuli or their effects, which minimizes harm or takes advantage of beneficial opportunities. This includes building any new or substantially-improved structures elevated above future flood levels or as structures that can be submerged without sustaining appreciable damage.
- **Retreat:** Surrendering an area partially, seasonally or completely to rising sea level;

[Regional Water Quality Control Plant \(RWQCP\)](#): Owned and operated by the Palo Alto, the Plant treats wastewater for the communities of Los Altos, Los Altos Hills, Mountain View, Palo Alto, Stanford University and the East Palo Alto Sanitary District. The mission of the RWQCP is to protect San Francisco Bay by

cleaning and treating wastewater before it is discharged.

Relative Sea Level: Sea level measured by a tide gauge with respect to the land upon which it is situated.

Risk: Often expressed as “hazard x exposure x vulnerability;” in terms of costs per year it can be expressed as “frequency (events/year) x consequences (\$/event).

SAFER Bay Project Feasibility Report: SAFER (Strategy to Advance Flood protection, Ecosystem and Recreation along San Francisco Bay) has prepared a feasibility report that is in the review and comment phase. Once City staff comments are made and report revised as needed, the report will be available for public review and comment.

Sea level: The height of the ocean relative to land; tides, wind, atmospheric pressure changes, heating, cooling, and other factors cause sea level changes.

Sea level rise (SLR): Sea level can change, both globally and locally, due to (a) changes in the shape of the ocean basins, (b) changes in the total mass of water and (c) changes in water density. Factors leading to SLR under climate change include both increases in the total mass of water from melting land-based snow and ice, and changes in water density from an increase in ocean water temperatures and salinity changes. Relative SLR occurs where there is a local increase in the level of the ocean relative to the land, which might be due to ocean rise and/or land level subsidence.

Storm Surge: A rise above normal water level due to low atmospheric pressure associated with storms and the action of wind stress on the water surface.

Sustainability and Climate Action Plan (S/CAP): Palo Alto’s plan to reduce the city and community’s greenhouse gas emissions to meet climate protection goals and also consider broader issues of sustainability, such as sea level rise, land use and biological resources.

Sustainability Implementation Plans (SIPS): Specific actions needed to achieve S/CAP goals.

Useful life: The period over which a project is expected to be available for use by an entity. This period of time typically exceeds the design life (see above).

Threat and Hazard Identification and Risk Assessment (THIRA): A THIRA helps communities better understand the hazards from natural, technological, and human-caused threats that pose the greatest risk. [The Palo Alto THIRA report](#) is updated every two years.

Vulnerability: The extent to which a species, habitat, ecosystem, or human system is susceptible to harm from climate change impacts. More specifically, the degree to which a system is exposed to, susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, as well as of non-climatic characteristics of the system, including its sensitivity, and its coping and adaptive capacity.

Vulnerability Assessment: A practice that identifies who and what is exposed and sensitive to change and how able a given system is to cope with extremes and change. It considers the factors that expose and make people or the environment susceptible to harm and access to natural and financial resources available to cope and adapt, including the ability to self-protect, external coping mechanisms, support networks, and so on.

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Appendix 2–Departmental Responsibilities for Sea Level Rise Planning

The following table is a menu of potential actions to be confirmed in the plan for each department.

Lead Department	Responsibility
Administrative Services Department	<ol style="list-style-type: none"> 1. Revise Purchasing Department construction solicitation templates and contract documents to include SLR and sustainability considerations. 2. Prioritize SLR planning and budget equal to other performance indicators for projects within projected SLR areas.
City Manager’s Office	<ol style="list-style-type: none"> 1. Implement the Sustainability and Climate Action Plan to reduce greenhouse gas emission contributions. 2. Include SLR update with annual Earth Day and Sustainability Implementation Plan reporting. 3. Consider development of key performance indicators to track if the City is meeting its SLR planning goals. 4. Provide outreach through City Manager Office communication channels about how the City is preparing for sea level rise in coordination with Public Works and Utilities Department outreach. 5. Prioritize SLR projects equal to other Council priorities.
Community Services/Open Space	<p>Implement the recommendations of the 2019 Palo Alto Baylands Vulnerability Assessment for flood control, access, non-recreational features and facilities, habitats and wildlife where feasible, e.g.:</p> <ol style="list-style-type: none"> 1. Seek funding to expand and enhance Baylands habitat to leverage wave attenuation, water absorption and other ecosystem services that mitigate SLR. 2. Develop climate-smart planting palettes that are projected to survive under changing climate conditions.
Office of Emergency Services	<p>Continue to consider sea level rise in community risk assessments, such as Threat and Hazard Identification Risk Assessment and Local Hazard Mitigation Plan, with appropriate risk considerations and weighting.</p>
Planning & Community Environment	<ol style="list-style-type: none"> 1. Update zoning code and related requirements, such as design standards for public and private development based on OPC predictions.
Public Works–Airport	<ol style="list-style-type: none"> 1. Plan for SLR to reduce risk of impacts to Airport operations. 2. Seek funding opportunities with the Federal Aviation Administration and Caltrans Division of Aeronautics.
Public Works–Interdepartmental	<ol style="list-style-type: none"> 1. Coordinate groundwater management in recognition that SLR will push groundwater levels inland and closer to the surface. 2. Explore the interaction between groundwater, Sea Level Rise and Stormwater.

<p>Public Works– Engineering</p>	<ol style="list-style-type: none"> 1. Plan, design, identify funding, build and maintain resiliency features in City planning and CIP projects per the City’s Comprehensive Plan, e.g.: <ol style="list-style-type: none"> a) Manage the preparation of SAFER feasibility report and potential environmental review, funding, public outreach and construction of SAFER levees and related projects to mitigate SLR. b) Seek grants and other funding for design alternatives and structures that mitigate SLR. c) Build design alternatives and structures that mitigate SLR. 2. Manage the implementation of large-scale stormwater infrastructure rehabilitation projects to minimize flooding from upstream sources, e.g.: <ol style="list-style-type: none"> a) Construct the high priority projects identified through Storm Drain Master Plan and listed with the Stormwater Management Fee and consider integration of GSI Plan elements. b) Address FEMA regulations (flooding risks) and sea level rise associated with at least 100-year storm events for at least the design life of the structure. c) Manage stormwater rebate program and coordinate with development services, inspect project sites once completed and issue rebates to property owners for installed rainwater capture devices. d) Work with Development Services to help developers of private projects comply with SLR policy and plans and FEMA regulations. e) Implement County Hazard Mitigation Plan (FEMA). f) Implement Green Stormwater Infrastructure Plan requirements. g) Design new infrastructure to be flexible so that it may be incrementally enhanced as sea level rise increases
<p>Public Works– Environmental Services</p>	<ol style="list-style-type: none"> 1. Coordinate internal discussions on SLR planning at a frequency that facilitates proactive planning, e.g., quarterly or as needed. 2. Manage SLR risks to allow for ongoing operations of the RWQCP and the sanitary landfill; 3. Seek opportunities and funding to enhance the Baylands ecosystem and build and nature-based features such as horizontal levees. 4. Maintain AB2516 Ocean Protection Council semi-annual report. 5. Conduct Public Outreach on SLR education and planning in

	<p>coordination with the City Manager’s Office and Utilities.</p> <ol style="list-style-type: none"> 6. Prepare Policy updates. 7. Lead Green Stormwater Infrastructure planning and implementation.
Utilities	<ol style="list-style-type: none"> 1. Execute energy portfolio-related actions in the SIPs Plan for Utilities-related asset protection from flooding, SLR and erosion. 2. Increase climate and SLR messages in ongoing water conservation public awareness campaigns in coordination with the City Manager’s Office and Public Works–Watershed Protection.

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Appendix 3—Ocean Protection Council 2018 Probabilistic Sea Level Rise Projections
*Rising Seas Report, State of California Sea Level Rise Guidance**

	Low Risk Aversion Likely Range (ft.) 66% Probability	Medium-high Risk Aversion (ft.) 0.5% probability 1-in-200 chance	Extreme Risk Aversion (ft.) (No probability yet available)**
	<i>Use for less-critical infrastructure and services e.g., trails, playing fields, golf course that could potentially be surrendered to SLR.</i>	<i>Use for critical infrastructure and services e.g., Regional Water Quality Control Plant, Municipal Service Center, Utilities infrastructure</i>	
2030	0.5	0.8	1.0
2040	0.8	1.3	1.8
2050	1.1	1.9	2.7
2060	1.5	2.6	3.9
2070	1.9	3.5	5.2
2080	2.4	4.5	6.6
2090	2.9	5.6	8.3
2100	3.4	6.9	10.2

SLR rates in this table show the upper-range predictions for how SLR may increase in future years and the SLR rate assumptions that should be used for different facilities and development. Probabilistic projections in the first two columns are with respect to a baseline of the year 2000, or more specifically the average relative sea level over 1991 - 2009. These numbers do not include impacts of El Niño, storms or other acute additions to sea-level rise.⁵ The time period referenced should be based on the useful life of the structure. The low and medium-risk projections listed in this table may underestimate the likelihood of extreme sea-level rise, particularly under high greenhouse gas emissions scenarios which as the writing of this policy are projected to continue to increase.

Not all infrastructure and development need to be designed to withstand the most extreme SLR predictions. This table suggests the types of facilities that could be designed to withstand the low, medium or extreme risk scenarios. Buildings for which there is an extreme risk aversion (e.g. wastewater treatment facilities) require more extensive and thus more costly designs and retrofits.

*The relative SLR heights above as it relates to Palo Alto’s shoreline can be viewed at *Adapting to Rising Tides Bay Shoreline Flood Explorer* online tool at <https://explorer.adaptingtorisingtides.org/home>.

** OPC guidance also includes an Extreme Risk Aversion scenario (aka H++ Scenario (Sweet et al 2017 Single scenario)). The probability of this scenario is currently unknown, but its consideration is important, particularly for high stakes, long-term decisions for critical infrastructure and given the uncertainties of projected GHG emissions discussed above.

⁵ Ocean Protection Council. (2018). *State of California Sea-Level Rise Guidance 2018 Update*. Retrieved from http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_ Exhibit-A OPC SLR Guidance-rd3.pdf. Page 18.

Attachment B–Summary of Regional Sea Level Rise Planning Efforts

Organization Name	Organization Description
Adapting to Rising Tides (ART)	ART is a collaborative planning effort led by San Francisco Bay Conservation and Development Commission (BCDC) and the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center to understand how San Francisco Bay Area communities can adapt to sea level rise and storm event flooding. The ART Project has engaged local, regional, state and federal agencies, as well as non-profit and private stakeholders, to explore how the Bay Area can increase resilience to sea level rise and storm events, while protecting critical ecosystem and community services.
Bay Area Climate Adaptation Network (BayCAN)	BayCAN is a collaborative network of local government staff helping the Bay Area respond effectively and equitably to the impacts of climate change on human health, infrastructure and natural systems.
Resilient By Design	A year-long collaborative design challenge bringing together local residents, public officials and local, national and international experts to develop innovative community-based solutions that will strengthen our region’s resilience to sea level rise, severe storms, flooding and earthquakes.
San Francisco Bay Conservation and Development Commission (BCDC)	The BCDC is a 27-member commission authorized to control bay filling and dredging, and bay-related shoreline development.
San Francisco Bay Regional CHARG - Coastal Hazards Adaptation Resiliency Group (CHARG)	CHARG is a forum at which local, regional, state, and federal scientists, engineers, planners, and policy makers can develop a common understanding about regional coastal hazards issues. CHARG’s participants represent many Bay Area cities (including Palo Alto), all nine Bay Area counties, and regional, state, and federal agencies. CHARG shifted its focus in 2017 to supporting technical studies and solutions to inform regional adaption, policy, and funding decisions. In 2018, CHARG became a Strategic Initiative of the Bay Area Flood Protection Agencies Association (BAFPAA). CHARG seeks to engage all local flood control districts and stakeholders from San Francisco Bay through the Sacramento-San Joaquin Delta to advance the scientific foundation needed to direct sea level rise adaptation at

	a regional scale.
San Francisquito Creek JPA (SFCJPA)	The SFCJPA is a regional government agency founded by the cities of East Palo Alto, Menlo Park, and Palo Alto, the San Mateo County Flood Control District and Santa Clara Valley Water District in 1999 following a major flood the preceding year. The SFCJPA plans, designs and implements capital projects which are comprehensive in terms of geography and function because they cross jurisdictional boundaries and serve to reduce a proven flood threat, enhance ecosystems and recreational opportunities, and connect our communities.
San Mateo County Sea Change	Sea Change SMC addresses the challenge of sea level rise by working together with and providing resources to local governments, stakeholder agencies and communities groups to create a prepared and stronger County.
South Bay Shoreline Study	The South San Francisco Bay Shoreline Project is a Congressionally authorized study by the US Army Corps of Engineers together with the Santa Clara Valley Water District and the State Coastal Conservancy to identify and recommend flood risk management projects for Federal funding. The Corps is looking at projects that will reduce flood risk, restore some of the region's lost wetlands, and provide related benefits such as recreation and public access.
Strategy to Advance Flood protection, Ecosystems, and Recreation (SAFER)	The SFCJPA's SAFER Bay project will evaluate infrastructure alternatives to protect Menlo Park, East Palo Alto, and Palo Alto against extreme tides with sea level rise and enhance shoreline habitat and trails.