



City of Palo Alto

City Council Staff Report

(ID # 6953)

Report Type: Study Session

Meeting Date: 5/31/2016

Summary Title: Study Session on Sea Level Rise

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From: City Manager

Lead Department: Public Works

Recommendation

This is a Study Session report and requires no Council action.

Executive Summary

This study session is being presented to identify facility-specific and programmatic issues that involve sea level rise. Six “Guiding Principles” and three generic “Tools” are being presented as a framework for Council discussion both now and as plans and projects are brought to Council in the future. Specific concerns discussed in this report as examples include the Regional Water Quality Control Plant, the Palo Alto Golf Course and Palo Alto Airport, the Municipal Service Center/Emergency Response capabilities, and the City of Palo Alto Comprehensive Plan Update to show how the Guiding Principles and Tools could be used to assist in decision-making. Council input on the Guiding Principles and Tools is being sought in preparation for specific program and project recommendations, which will follow in the coming months.

Background

Scientists agree that climate change has led to global increases in temperature and sea level rise. In the past century, global mean sea level has increased by seven to eight inches¹. In the last 10 to 15 years, the rate of global sea level rise has increased by about 50 percent. According to experts, climate change will fundamentally change the way we live. No longer will the environment be a static condition, a certainty upon which other variables depend. Rather, it will be a

¹ Intergovernmental Panel on Climate Change (IPCC), 2013

variable itself, and it will make us plan for the future like never before.²

In addition to the non-static nature of climate change and its effects, the sheer complexity of the multiple factors that affect climate change makes modeling difficult at best. There are many elements at risk of variation because of climate change, and it is not known how each of these elements will affect each other. As a result, the general public's assumption of a steady and predictable change is likely not accurate.

The San Francisco Bay, home to one of the oldest tide gauges in the country, has seen 0.63 feet of sea level rise over the last century. In the coming century, the rate of sea level rise is expected to accelerate, as higher average atmospheric temperatures cause glaciers and the polar ice caps to melt. Opinions vary on the forecasted amount of sea level rise, but there is little argument that the accelerating trend will continue. As a result, there is a very high level of uncertainty for which it is difficult to plan.

In the year 2000, the State of California adopted guidance and sea level rise projections for planning purposes ranging from 10 to 17 inches by 2050, 17 to 32 inches by 2070, and 31 to 69 inches by 2100³. The San Francisco Bay Conservation and Development Commission (BCDC) in its latest Bay Plan amendment (October 2011) revised its estimate of the year 2100 sea level rise from 55 inches to up to 69 inches. However, data on sea level rise is evolving, and BCDC uses the 55-inch sea level rise scenario in the Bay Plan when assessing long-term impacts. Recent projections by the United States Geological Survey (USGS) for the South Bay range from 0.5 to 5 meters (19.7 to 196.8 inches), showing the considerable uncertainty as to what level of rising waters to expect and the high variability in projections.⁴

The Pacific Institute estimates that a 3.28 foot rise in sea level would put 220,000 people at risk of a 1% (100-year) flood event, given today's population in the Bay Area. Critical infrastructure, such as roads, hospitals, schools, emergency facilities, wastewater treatment plants, power plants, and more will be at increased risk of inundation, as will vast areas of wetlands and other natural

² Columbia Law School, Center for Climate Change Law, *Managed Coastal Retreat*, 2013

³ http://www.opc.ca.gov/webmaster/ftp/pdf/docs/2013_SLR_Guidance_Update_FINAL1.pdf

⁴ <http://www.spur.org/publications/article/2009-11-01/sea-level-rise-and-future-bay-area>

ecosystems. In addition, it is estimated that the cost of replacing property that will likely be at risk of coastal flooding with this level of sea level rise is \$49 billion (in year 2000 dollars)⁵.

The overall result of both sea level rise and possible changes in precipitation patterns is that low-lying areas surrounding the San Francisco Bay will experience more frequent and severe flooding. Areas that are typically flood-prone will be inundated, and some areas that are currently not at risk will be periodically flooded. The National Oceanic and Atmospheric Administration (NOAA) predicts that by 2050, a majority of U.S. coastal areas are likely to be threatened by 30 or more days of flooding each year due to dramatically accelerating impacts from sea level rise.⁶

The purpose of this study session is to: 1) inform the Council on sea level rise protection, mitigation, and adaptation efforts occurring in California, regionally, and in Palo Alto; 2) prepare Council for future actions; 3) present conceptual draft guiding principles for addressing sea level rise; and 4) obtain input from Council members on their questions, priorities, and vision for Palo Alto regarding sea level rise.

Discussion

Palo Alto's existing Bayfront flood protection system is comprised of a levee network between San Francisquito Creek and the Mountain View border. These levees do not meet current Federal Emergency Management Agency (FEMA) standards for height or construction quality. As a result, there are approximately 2,700 Palo Alto properties in a FEMA-designated Special Flood Hazard Area that are currently potentially subject to tidal flooding from a 1% (100-year) high tide event in San Francisco Bay, assuming no sea level rise. In addition there are critical City facilities and infrastructure as well as a regional facility located within the designated tidal floodplain, including:

- Regional Water Quality Control Plant
- Palo Alto Airport
- City of Palo Alto Municipal Service Center
- Palo Alto Utility Control and Engineering Center

⁵ http://www.pacinst.org/wp-content/uploads/sites/21/2013/02/sea_level_rise_sf_bay_cec3.pdf

⁶ Coastal Hazards Resiliency Group (CHARG), Strategic Brief, 2015

- City of Palo Alto Animal Services
- City of Palo Alto offices at Elwell Court
- Palo Alto Municipal Golf Course
- Palo Alto Baylands and Byxbee Park
- Palo Alto's closed landfill
- Commercial properties, including the U.S. Post Office and International School
- Regional utility corridors (e.g. PG&E gas mains and electric transmission lines)
- Palo Alto Utility Substations
- Stormwater Pump Stations
- U.S. Highway 101

Sea level rise will result in an increase in the number of properties designated as being in the floodplain unless measures are taken to adapt and protect the shoreline and/or specific properties. Such measures may lead to possible changes in the shoreline as decisions must be made regarding which assets to protect and whether to retreat or adapt. It will require the expenditure of significant resources to address sea level rise. Sea level rise also poses emergency response and safety challenges, which are addressed in the *City's Threat and Hazard Identification and Risk Assessment* as well as the *Local Hazard Mitigation Plan*. This study session provides the Council with information on efforts being taken at the state, regional and local level related to sea level rise.

State of California Initiatives

In 2014, the State legislature passed AB 2516, which imposes new requirements for sea level rise planning. The law directed the California Natural Resources Agency (CNRA) to create a database consisting of various entities, departments, and boards to share information about sea level rise planning projects. Participating agencies include the Department of Water Resources, California Coastal Commission, State Energy Resources Conservation and Development Commission, State Lands Commission, San Francisco Bay Conservation and Development Commission, and State Coastal Conservancy. AB2516 requires, on or before January 1, 2016, the CNRA, in collaboration with the Ocean Protection Council (OPC), to create, update biannually, and post on an internet website a Planning for Sea Level Rise Database describing steps being taken throughout the state to prepare for and adapt to sea level rise. As a result of AB 2516, the Palo

Alto Utilities Department and Palo Alto Airport were required to provide information on July 1, 2015 regarding their planning efforts with respect to sea level rise.

The State Assembly has a Select Committee on Sea Level Rise and the California Economy chaired by Assemblyman Rich Gordon.

The California Coastal Commission unanimously adopted a Sea Level Rise Policy Guidance document on August 12, 2015. It provides an overview of the best available science on sea level rise for California and a recommended methodology for addressing sea level rise in Coastal Commission planning and regulatory actions. The potential impacts of sea level rise fall within the California Coastal Commission's (and local governments') planning and regulatory responsibilities under the Coastal Act. Sea level rise increases the risk of flooding, coastal erosion, and saltwater intrusion into freshwater supplies. The Coastal Act mandates the protection of public access and recreation along the coast, coastal habitats, and other sensitive resources, as well as providing priority visitor-serving and coastal-dependent or coastal-related development while simultaneously minimizing risks from coastal hazards.

The California Ocean Protection Council provided an updated Sea Level Rise Guidance Document "to help state agencies incorporate future sea-level rise impacts into planning decisions." This document includes a table summarizing sea level rise models for the years 2030-2100 north and south of Cape Mendocino, which were adopted by the State for planning projections.

The State of California Natural Resources Agency has a California Climate Adaptation Strategy, which is a comprehensive plan to guide adaptation to climate change, becoming the first state to develop such a strategy in 2009.

Bay Area Initiatives

The Coastal Hazards Adaptation Resiliency Group (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. Each member organization is responsible for protecting public safety, health, and

welfare through planning, building, and maintaining infrastructure and enhancing and maintaining the natural environment. CHARG has developed a Strategic Brief and is working on technical, funding, and policy issues related to sea level rise. The Santa Clara Valley Water District (Water District) and Joint Venture Silicon Valley are hosting sub-regional meetings for agencies in Santa Clara County.

The San Francisco Bay Conservation and Development Commission (BCDC) consists of 27 members who represent various interests in the Bay, including federal, state, regional, and local governments and the public of the San Francisco Bay region. The Commission is authorized to control: 1) Bay filling and dredging, and 2) bay-related shoreline development. BCDC updated the San Francisco Bay Plan in October 2011 to deal with the expected impacts of climate change in San Francisco Bay.⁷ The previous policy language recommended that new development not be approved in low-lying areas that are in danger of flooding now or in the future unless the development was elevated above possible flood levels. The new BCDC policies require sea level rise risk assessments to be conducted when planning shoreline development or designing large shoreline projects within BCDC jurisdiction. The risk assessment should be prepared by a qualified engineer and should be based on the estimated 100-year flood elevation that takes into account a range of sea level projections for mid-century and end of century. All projects should be designed to be resilient to a mid-century sea level rise projection. If it is likely that the project will remain in place longer than mid-century, an adaptive management plan should be developed to address the long-term impacts. Shoreline protection projects, such as levees and seawalls, must be designed to withstand the effects of projected sea level rise and to be integrated with adjacent shoreline protection. Whenever feasible, projects must integrate hard shoreline protection structures with natural features, such as marsh or upland vegetation, that enhance the Bay ecosystem.^[2]

Adapting to Rising Tides (ART) is a collaborative planning effort led by 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.

⁷ http://www.bcdc.ca.gov/planning/climate_change/SLRfactSheet.shtml

The Association of Bay Area Governments (ABAG) provides resources via its Resilience Program (http://resilience.abag.ca.gov/climate_change/) as well as sea level rise vulnerability maps (<http://resilience.abag.ca.gov/news/new-sea-level-rise-map-interface/>)

The South Bay Salt Pond Restoration Project is the largest tidal wetland restoration project on the West Coast. When complete, the project will restore 15,100 acres of industrial salt ponds to a rich mosaic of tidal wetlands and other habitats. Its goals are to restore wetland habitat, provide public access and recreation, and provide for flood management in the South Bay that enables restoration. Once established, tidal marshes on the outboard side of levees will be the first line of flood defense and will help protect the levees from storm wave action and tidal surge. Restored tidal wetlands also increase the flood carrying capacity of local creeks, flood control channels, and rivers. In addition, the San Francisco Estuary Institute has updated its Baylands Goals Report to include sea level rise. The Baylands Goals Report provides a roadmap for wetland restoration and describes how such restoration can assist with sea level rise protection. In order for wetlands to assist with sea level rise adaptation, they must be restored quickly, reconnected to natural processes, such as creeks, and have open land to be able to migrate landward as sea levels rise.⁸

The San Francisco Bay Restoration Authority⁹ is a regional government agency charged with raising and allocating resources for the restoration, enhancement, protection, and enjoyment of wetlands and wildlife habitat in the San Francisco Bay and along its shoreline. The Authority was created by the California legislature in 2008 with the enactment of AB 2954 (Lieber). The restoration authority has placed a regional parcel tax measure on the June 2016 ballot. The \$12 tax would raise \$500 million over 20 years to fund flood protection infrastructure and wetland restoration projects across the San Francisco Bay.

The South San Francisco Bay Shoreline Study is a study by the US Army Corps of Engineers funded through a congressional appropriation together with local funding from the Water District and the State Coastal Conservancy to identify and recommend tidal flood risk management projects for federal funding. The

⁸ www.baylandsgoals.org

⁹ <http://sfbayrestore.org/>

shoreline study team is currently working on the planning and design of flood protection projects in the Alviso area of San Jose and a pre-feasibility study for the remaining shoreline area in Santa Clara County. The Water District is also working with the San Francisquito Creek Joint Powers Authority (JPA) on flood protection, has performed coastal floodplain modeling, and maintains a resource website on sea level rise¹⁰.

The Bay Area Climate Change Consortium (BAECCC) facilitates collaboration between resource managers, scientists, and interested parties. BAECCC is working on implementing a Natural Infrastructure Initiative to recognize the value the ecosystems in the Bay Area add to human well-being and resiliency.

The Silicon Valley 2.0 Project was developed by the County of Santa Clara Office of Sustainability to respond to a gap in regional climate adaptation planning and the need for an implementation tool rather than simply a plan.¹¹ This interactive risk management tool includes geo-economic information about various assets and allows planners to assess the value of vulnerable assets.

The Bay Area Integrated Regional Water Management Plan (IRWMP) presents a thorough summary of climate change projections and expected impacts to four water-related Functional Areas in the Bay Area, including water supply/water quality, flood control wastewater/stormwater, and watershed and habitat protection. The Bay Area IRWMP reviewed climate change adaptation strategies from a wide range of regional and local initiatives and planning documents such as urban water management plans, habitat restoration plans, wastewater treatment master plans, watershed stewardship plans and water supply strategies. The Bay Area IRWMP identifies the following general strategies for adapting to climate change:

- Incorporate climate change adaptation into relevant local and regional plans and projects;
- “No Regrets” approach to address immediate or ongoing concerns while reducing future risks;

¹⁰http://cf.valleywater.org/Water/Where_Your_Water_Comes_From/Water%20Supply%20and%20Infrastructure%20Planning/Climate%20Change/SeaLevel.cfm

¹¹<https://www.sccgov.org/sites/osp/SV2/Pages/SV2.aspx>

- Establish a climate change adaptation public outreach and education program;
- Build collaborative relationships between regional entities and neighboring communities to promote complementary adaptation strategy development and regional approaches;
- Establish an ongoing monitoring program to track local and regional climate impacts and adaptation strategy effectiveness; and
- Update building codes and zoning.

For Sea Level Rise, the specific strategies identified by the Bay Area IRWMP are:

- Multifunctional ecosystem-based adaptation along the bay shore and rivers
- Remove critical infrastructure from hazard zone
- Raise, armor and maintain flood control structures that protect critical infrastructure that cannot be moved.
- Prevent placement of new infrastructure in areas likely to be inundated.
- Improve emergency preparedness, response, evacuation and recovery plans.

Local Projects

The City of Mountain View conducted a comprehensive sea level rise vulnerability and adaptation assessment for its Shoreline Community adjacent to San Francisco Bay. The study addresses the potential for increased flooding directly from coastal sources as well as upstream sea level rise impacts to creek flooding and stormwater drainage. Supporting assessments include geotechnical levee evaluations, pump intake siltation, and landfill management concerns. As a result of the study, the City has developed a Capital Improvement Program to meet the flood protection needs of the area.

Across the Bay in San Leandro, a multi-agency partnership is piloting the construction of a wide horizontal “ecotone” levee at the Oro Loma Sanitary District wastewater treatment plant. The ecotone slope (essentially a wide, gently-sloped levee with wetland vegetation) serves to provide protection from rising sea levels as well as increase the removal of nutrients from secondary wastewater effluent. Wastewater treatment plants of the future will be moving away from the goal of “wastewater treatment” and towards a framework of “resource recovery.” Wastewater contains two major resources that are important to the ecology of coastal ecosystems: fresh water and nutrients. The

movement of fresh water across the ecotone slope is crucial in replenishing a coastal habitat type that has been removed from the Bay as streams have been channelized. In addition, wastewater contains nutrients that can stimulate the growth of the plants on the ecotone levee.¹²

In terms of tidal flood protection, the San Francisquito Creek JPA is conducting a levee improvement feasibility study and design project for the Bayfront levees between San Francisquito Creek and Redwood City. This project, which the JPA has designated as the “Strategy to Advance Flood protection, Ecosystems and Recreation” or “SAFER Bay” project, is being jointly funded through a grant from the State of California Department of Water Resources (DWR) and financial contributions from the cities of Menlo Park, East Palo Alto and Palo Alto. This is a separate, but related project from the JPA’s San Francisquito Creek Flood Protection Project. The scope of the SAFER Bay project includes a feasibility study to identify the preferred alternative for improving the existing Bayfront levee system to provide 1% (100-year) protection from tidal flooding (including consideration of future sea level rise), followed by preparation of an environmental impact report and final construction bid documents. While FEMA does not currently address sea level rise in its flood mapping, the SAFER Bay feasibility study incorporates three feet of sea level rise into its design assumptions in order to be consistent with the project time frame (at least five decades) and the range of sea level rise projections over this time¹³.

The JPA has a long-term goal of placing a ballot measure before local voters seeking approval of a special tax or assessment to fund construction of the recommended tidal levee improvements. The feasibility study consultant team is currently finalizing a report with potential levee alignments for the Palo Alto area.

Restoration of tidal marshes, including the idea of constructing wide ecotone levees, is one of the strategies being considered regionally as the first line of defense from rising seas and storm surges, which also allows for levees to be lower than they would need to be without the marsh protection (see discussion above of Baylands Goals Report).

¹² http://www.acfloodcontrol.org/SFBayCHARG/pdf/oro_loma_ecotone.pdf

¹³ Based on OPC 2013 and USACE 2011

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Responding to sea level rise generally involves three generic tools:

- Protect (e.g. levees, floodwalls, wetlands)
- Adapt (e.g. build any new or substantially-improved structures elevated above future flood levels or as structures that can be submerged without sustaining appreciable damage)
- Retreat (e.g. either partially/seasonably or completely surrender an area to rising sea level)

While our primary and most cost-effective option may be to protect as much of the existing floodplain as possible from tidal flooding, if sea level rise meets or exceeds the currently accepted projections, managed retreat may be needed over the long-term due to the limitations of the protective structures as well as the costs of continuing to armor the coastline. The City of Palo Alto already has limited protection and adaptation measures in place, and related zoning policies in areas of flood risk.

Staff has developed the following six guiding principles regarding sea level rise for discussion purposes:

1. For City of Palo Alto capital projects, use sea level rise assumptions that accommodate the range of California and regional sea level rise estimates and are consistent with other planning efforts. At this time, the sea level rise estimate should be a minimum of 55 inches by year 2100 based on BCDC projections.
2. Staff should continue to monitor the latest climate change and sea level rise science and adapt as needed if sea level rise occurs at a more rapid pace and/or higher levels than currently projected.
3. Any engineered solutions should be adaptable to changing predictions.
4. All three categories of tools (protect, adapt, retreat) should be considered when appropriate and cost effective.
5. For areas where a protection strategy, i.e. levees, is being pursued, additional tools should still be used in case the severity and speed of sea level rise increases and other measures, such as designing structures that can get wet and locating sensitive equipment higher in a building, become necessary.

6. Staff should continue to collaborate with regional planning efforts on studies of impacts and strategies for response to sea level rise.

The following three examples serve to illustrate how the guiding principles and tools may be used:

1. The Regional Water Quality Control Plant (RWQCP) serves an essential function to protect public health and the environment. Using guiding principle 4, preliminary analysis indicates that relocating the treatment plant would not be cost-effective and that it must be located near the Bay to facilitate discharge of treated effluent. As a result, the RWQCP likely must be protected by levees in the long-term. However, using guiding principle 5, the RWQCP will also need to adapt, including the possible need for new pumps to allow the effluent to discharge to the Bay and the need to construct new facilities with rising groundwater in mind. The RWQCP may also consider use of its effluent to benefit marshes and reduce nutrients, similar to the Oro Loma Ecotone project described above. New buildings at the RWQCP are being built to meet the current flood hazard regulations minimum elevation requirement (Elevation 10.5 feet, NAVD88). In light of guiding principle 1, the City should consider increasing that elevation requirement. When that requirement is changed, new structures at the RWQCP will be constructed in compliance with the modified regulations.
2. The SAFER project described above is designed to protect facilities in the Palo Alto Baylands such as the golf course and airport for at least the next five decades. Should sea level rise be more extreme or occur faster than anticipated over the long term, an analysis would need to be done to determine whether increased protection is cost effective (per guiding principle 4).
3. With the Municipal Service Center (MSC) located in a potential future tidal inundation zone, emergency response capabilities may be affected. Potential future impacts include closure of Highway 101 due to flooding and the inability to get service vehicles from the east side of Highway 101 to the west side and areas within the City needing assistance during flood emergencies. Some of these access problems surfaced during the 70-year

flood event in February 1998. Using all guiding principles, an analysis is needed to determine the best approach to protect the emergency response capabilities and other services that the MSC provides.

The ongoing Comprehensive Plan update is an opportunity to further explore the applicability of the listed guiding principles. It is anticipated that the new Comprehensive Plan will include discussion and references related to sustainability, climate change and sea level rise, and their effects. New policies and programs may be drafted to, for example, increase the resilience of areas in the current or future floodplain through zoning changes. As an example, the Alviso Master Plan prepared by the City of San Jose has design guidelines for the “ground floor “flood story” [which] can be used only for parking and incidental storage.”¹⁴ Other considerations could relate to restricting new housing or other sensitive uses east of Highway 101 and other vulnerable areas, a form of managed retreat. The Comprehensive Plan update could be used to trigger consideration of such new requirements.

Palo Alto’s proposed actions to address sea level rise vulnerabilities will be further discussed in the future. While Palo Alto should plan and implement its own actions, they must be coordinated with other jurisdictions, as rising waters do not respect political boundaries. A regional response will be critical to a successful outcome.

Timeline

The following items related to sea level rise will be submitted to the Council for discussion in 2016 unless otherwise noted:

- The Sustainability and Climate Action Plan (S/CAP) - development will include adaptation strategies to address climate risks and create a resilient community. In addition, this will include an assessment of Palo Alto’s specific sea level rise and climate risks (S/CAP Appendix F “Climate Adaptation and Vulnerability Analysis”).
- The Comprehensive Plan Update - will incorporate sea level rise issues.
- The SAFER Bay feasibility study results and recommended levee alignments - will be brought forward in mid-2016; a funding request will be made in

¹⁴ <https://www.sanjoseca.gov/DocumentCenter/View/9341>

the proposed FY2017 Capital Improvement Program budget for design and environmental analysis of tidal levee improvements in Palo Alto.

- The revised Local Hazard Mitigation and Adaptation Plan - will incorporate plans to mitigate sea level rise such as the SAFER Bay project, and appropriate adapt and retreat strategies.
- FEMA's new Flood Insurance Rate Maps – will expand the footprint of the tidal floodplain in Palo Alto and surrounding communities based on an updated analysis of the existing flood risk.
- Modifications to the zoning and floodplain ordinances as needed.