

**FLOOD RISK & SEA LEVEL RISE  
ADAPTATION REPORT  
FOR SAN RAFAEL GENERAL PLAN 2040**

**Prepared by City of San Rafael**



**July 2020**

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## A. INTRODUCTION

Sea levels have risen an average of eight (8) inches globally in the last century and are projected to rise and additional 40-55 inches by 2100. Sea level rise combined with tidal surges from storm events (e.g., King Tides) has the potential to impact shorelines, coastal communities, and coast side habitats. San Rafael, which is along the San Francisco Bay and San Pablo Bay fronts, contains many areas that are vulnerable to significant impacts from continued flooding, increased storm surges and sea level rise. In San Rafael, assets that are at-risk include numerous residential neighborhoods (including the Canal area, a large, densely-populated neighborhood of low-income residents), the highest concentration of businesses serving Marin County, major utilities and public services, and a major transportation network (including US 101 and I-580).

While there is still a lot to learn about sea level rise and information on this topic is ever-changing, there is an abundance of resources and studies that are available to start planning for adaptation and resilience in San Rafael. The San Rafael General Plan 2040 includes policies and programs to address and plan ahead for increased flooding and sea level rise. The Plan policies and programs include: a) adopting and maintaining a sea level rise prediction map and establishing a sea level rise “overlay” zone; b) a commitment to maintain current and consistent information and data in coordination with the County of Marin; c) maximizing public awareness and disclosure; d) considering and assessing increased flooding and sea level rise impacts in making local decisions on development and public capital projects; e) establishing a minimum construction elevation in areas vulnerable to sea level rise; and f) a commitment to prepare a detailed sea level rise adaptation plan.

This adaptation report is intended to ‘set-the-stage’ for coordinating and preparing a detailed adaptation plan for the San Rafael planning area. The development of a detailed adaptation plan is called out as new Program S-6.3A (Sea Level Rise Adaptation Plan) in the General Plan 2040. Further, given that many property owners, residents, businesses, and public/quasi-public services will be impacted by increased flooding and sea level rise, it is critical that the preparation of a detailed adaptation plan be a community-driven effort. As foundation for preparing a detailed plan, this adaptation report: a) provides a summary of the abundant resources; and b) pulls from these resources the most appropriate adaptation tools and strategies to address San Rafael’s unique conditions. Given the variety of bay front conditions and development pattern, a broad range of adaptation strategies appropriate and should be seriously considered in the preparation of a detailed adaptation plan. These strategies include: retreat (coastal realignment, managed retreat or planned retreat); armoring (hard structures such as levees, breakwaters and seawalls); elevating (elevating buildings and infrastructure); and outboard nature-based improvements (horizontal levees, ecotone levees, reefs). Lastly, as the magnitude of adaptation and the funding that is needed, implementation will be accomplished in phases.

## **B. BACKGROUND**

### **1. Setting**

The City of San Rafael is located approximately 20 miles north of San Francisco. Located along the San Francisco Bay and San Pablo Bay shorelines, San Rafael covers approximately 22 miles consistent of 17 square miles of upland (land) and five square miles of water and tidelands. San Rafael is largely comprised of two watersheds, the San Rafael Creek Watershed, and the Gallinas Creek Watershed. Elevations in the San Rafael range from sea level to 900 feet above sea level.

### **2. Flooding History**

Flooding and inundation along the San Francisco Bay and San Pablo Bay shorelines are considered a major hazard throughout the county of Marin, and flooding occurs in these areas due to the high tides and heavy rainfall. There are many low-lying shoreline areas in San Rafael that were historically marshlands and tidal flats which were filled in for development. These areas include the Canal neighborhood and Downtown, located along the banks of San Rafael Creek; Santa Venetia, located along the banks of Gallinas Creek; and Peacock Gap, located along the Peacock Gap Lagoon. These areas are also subject to mandatory flood insurance required by the Federal Emergency Management Agency.

Marin County experienced 19 flood events between 1950 and 2016 that have been declared federal and/or state disasters (San Rafael Local Hazard Mitigation Plan, 2017). Severe weather events often cause flooding in low-lying areas of San Rafael and surrounding unincorporated areas. The community of Santa Venetia has experienced multiple flooding events, most notably during the El Niño winter of 1982-1983, where three flooding events caused damage to over 150 homes due to storm related flooding (U.S. Army Corps of Engineers 2014). The storm that occurred during January 27-28, 1983 had a still water depth of approximately six feet (U.S. Army Corps of Engineers 2013).

### **3. Areas of Sea Level Rise Vulnerability**

The community of San Rafael is very vulnerable to sea level rise. Direct and indirect impacts to the community will be widespread and will happen with the next 30 years, when sea levels are projected to rise 7 to 13 inches, and possibly as much as 2 feet or even more. The first areas to experience these impacts will be the Canal, Santa Venetia, and Peacock Gap neighborhoods and the Kerner and Francisco Boulevard West business districts (see Figures 1 and 2). Most of the vulnerable residential parcels contain multi-family housing and are densely populated. Canal residents, who are predominately lower-income and Latino, are disproportionately vulnerable to climate change impacts, and they will be some

of the first people to have to deal with a rising sea at their front doors. Critical facilities<sup>1</sup> including the Boro Community Center, the County Health & Wellness Center, and Fire Station 54 on Castro Avenue will experience high tide flooding as well.

In time, the impacts move into downtown San Rafael, ultimately exposing one-third of its population and two-thirds of its economic base by the end of the century. In general, the following geographic areas are vulnerable to sea levels rise:

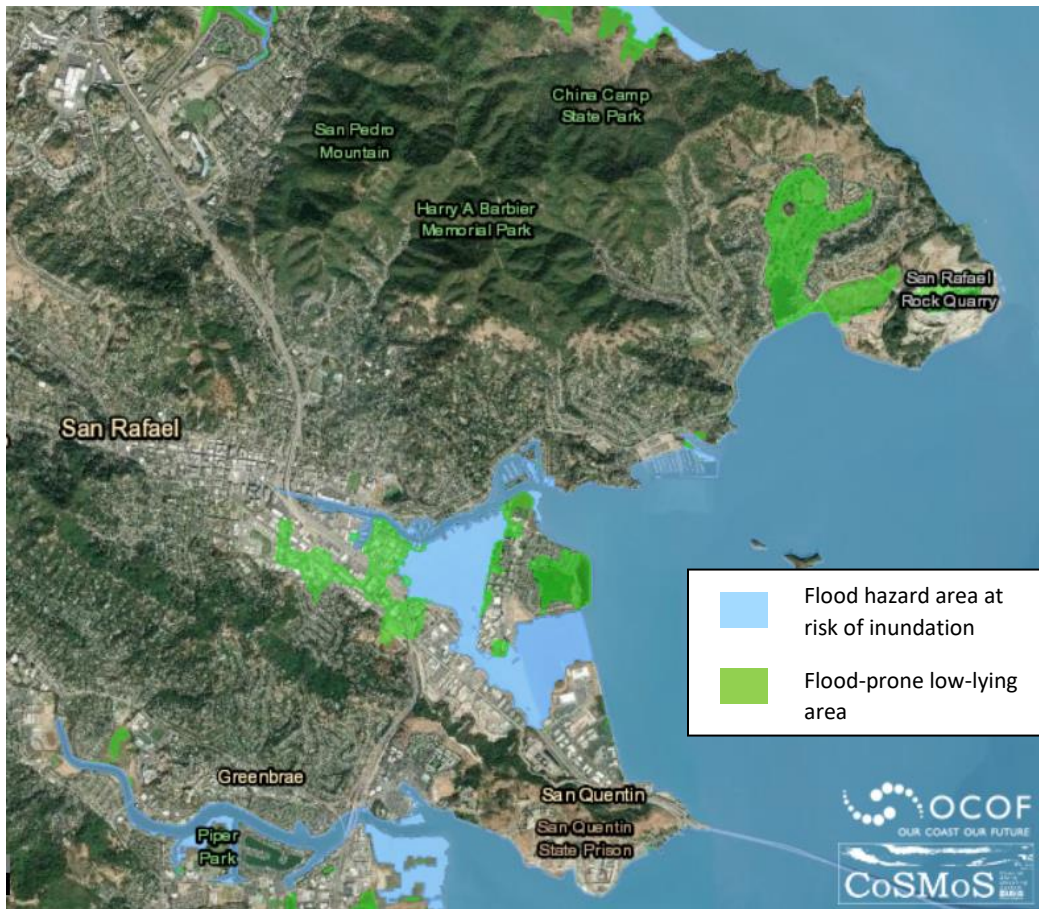
- Central San Rafael Basin – includes San Rafael Canal/Creek and neighborhoods bordering the creek, and major portions of Downtown
- Southeast San Rafael – includes Canal/Spinnaker Point/Baypoint residential areas and the greater commercial and light industrial areas around the I-580 corridor
- San Pedro Peninsula – low-lying areas of Peacock Gap and Glenwood neighborhoods and portions of residential neighborhoods bordering the Bay
- North San Rafael – greater Gallinas Creek Basin from the Bay west to US 101

Sea level rise will pose problems for homeowners at higher elevations, too, as the rising tidewaters cover access roads and major transportation routes, including US 101 and I-580, and flood the SMART station and the transit center. Utilities will be impacted, and coastal recreational areas may become permanently inundated.

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<sup>1</sup> A critical facility is one that is vital to the City's ability to provide essential services and protect life and property. Loss of a critical facility would result in a severe economic or catastrophic impact.

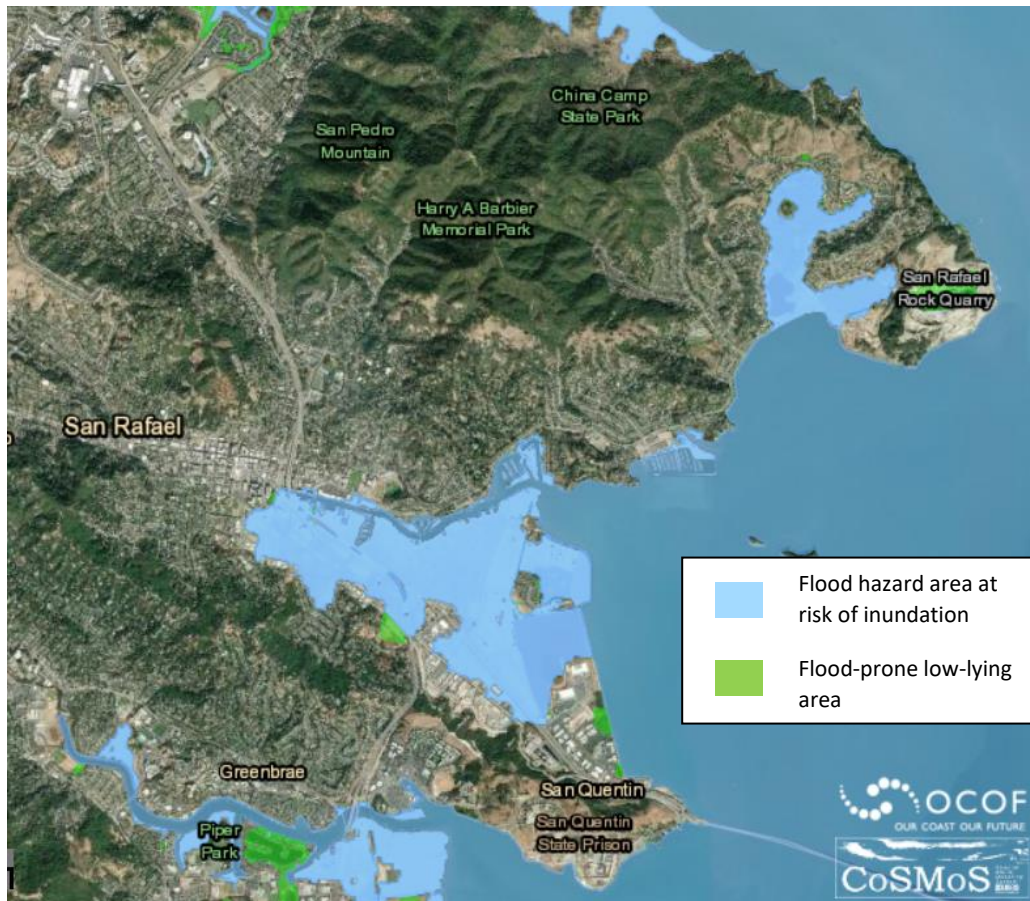
FIGURE 1: FLOODING EFFECT OF 25-CENTIMETER (10-INCH) SEA LEVEL RISE



*Our Coast Our Future, accessed 12-20-19*



FIGURE 2: FLOODING EFFECT OF 75-CENTIMETER (2.5 FEET) SEA LEVEL RISE



*Our Coast Our Future, accessed 12-20-19*

#### 4. BayWAVE Sea Level Rise Vulnerability Assessment (2017)

In 2017, the County of Marin, in partnership with local jurisdictions, developed a sea level rise vulnerability assessment for the eastern Marin shoreline from the Golden Gate Bridge to the county line north of Novato. The goal of the BayWAVE project was to increase awareness and preparation for future sea level rise impacts. The assessment is an informational document that catalogs impacts with six different scenarios across the entire bay shoreline. The best available science was used to complete the report with a range of projections. The sea level rise scenarios evaluated in the project are as follows:

- Scenario 1: 10 inches
- Scenario 2: 10 inches plus 100-year storm surge
- Scenario 3: 20 inches
- Scenario 4: 20 inches plus 100-year storm surge
- Scenario 5: 60 inches
- Scenario 6: 60 inches plus 100-year storm surge

Scenarios 1 and 2 represent near-term sea level rise projections and correspond to the upper range of likely sea level rise by year 2030. Scenarios 3 and 4 represent medium-term sea level rise, and Scenarios 5 and 6 represent the long-term. The model used to project sea level rise scenarios is available at the [Our Coast Our Future](#) website.

The report presents asset profiles describing parcels and buildings, transportation networks, utilities, working lands, natural resources, recreational assets, emergency services, and cultural resources. It also includes municipality profiles that detail all asset vulnerabilities for each exposed municipality in the study area.

San Rafael's vulnerable assets include the entire Canal neighborhood and Kerner Business District, and shoreline development and boating facilities off Point San Pedro Road. In time, the impacts move into downtown San Rafael, Peacock Gap, and Marin Lagoon. In addition to sea level rise, subsidence is already a significant issue south of Interstate 580 and US Highway 101, and in Marin Lagoon, where development is built largely on fill atop bay mud. With sea level rise, subsidence rates could increase.

For San Rafael, in the near-term, 449 acres could be exposed to tidal flooding. By the long-term, 1,856 acres could be exposed to sea level rise, and 2,121 acres could be exposed during a 100-year storm surge. Compared to the other communities in the study area and the County, San Rafael could experience the most significant impacts, including:

- Flooding in the Canal area and Kerner Business District could compromise extensive multi-family housing, commercial, industrial, and recreational uses.
- US Highway 101 on and off-ramps could anticipate 100-year storm surge flooding in near-term and tidal flooding in the medium-term.
- The San Rafael Transit Center could be vulnerable in the long-term. This could compromise local and regional bus lines, and the new SMART train.
- A significant portion of downtown could face storm surges in the near- and medium-terms and sea level rise in the long-term.
- Golden Gate Bridge and Highway Transportation District facilities on Andersen Drive could be vulnerable in the medium-term.
- Several schools including Bahia Vista and Glenwood Elementary, Davidson Middle, and San Rafael High schools could be vulnerable across the BayWAVE scenarios.
- Five historic landfills along the shoreline and one closed brownfield site further inland could be subject to inundation.
- Miles of electrical transmission and natural gas pipelines are in the near-term.
- Marinas and other boating facilities could be vulnerable to sea level rise in the medium- to long-term.
- Peacock Gap homes and golf course could be vulnerable to storms in the near-term and sea level rise in the long-term.
- Marin Lagoon and streets in the Las Gallinas area could begin to see peripheral tidal flooding and storm surge flooding in the near-term, and neighborhood scale flooding by the long-term.
- Fire Station 54 is vulnerable in scenario 1 and two others could have access issues.



The City is and will continue to use BayWAVE as a foundation for sea level rise planning and adaptation, utilizing the same sea level rise model and scenarios for continuity, consistency and partnering. General Plan Safety Element Policy S-3.2 recommends that the City use sea level rise information and data that is consistent with that use by the County of Marin, Program S-3.2A directs the City to utilize BayWAVE as the basis for all City-prepared documents related to flooding and sea level rise.

*Link*

Marin Shoreline Sea Level Rise Vulnerability Assessment: Bay Waterfront Adaptation & Vulnerability Evaluation

<https://www.marincounty.org/main/marin-sea-level-rise/baywave/vulnerability-assessment>

## 5. Local Focus on Addressing Sea Level Rise & Adaptation Planning

### a. San Rafael General Plan 2020

San Rafael's General Plan 2020 was adopted in 2004. In 2011, the General Plan was amended to incorporate the City's 2009 Climate Change Action Plan into a new sustainability element. The General Plan contains the following policy and programs related to adaptation to climate change and sea level rise:

**SU-15. Adapting to Climate Change.** Increase understanding and preparation to adapt to the effects of climate change, including sea level rise.

**SU-15a. Vulnerability Assessment.** Participate in Marin County's regional vulnerability assessment and prepare a local vulnerability assessment for San Rafael.

**SU-15b. Emergency Planning.** Continue to provide emergency planning and community awareness.

**SU-15c. Levee Analysis.** Develop a program of levee analysis, including inventorying heights, testing and maintaining public and private levees.

**SU-15d. Sea Level Monitoring and Planning.** Work with the Bay Conservation and Development Commission (BCDC), and other regional agencies, to monitor sea level rise and plan for shoreline defense.

### b. "Climate Adaptation – Sea Level Rise" San Rafael, California White Paper, January 2014.

This 'white paper' was developed by Paul Jensen, City of San Rafael Community Development Director with assistance by a Sustainability Intern and the Department of Public Works and was presented to the San Rafael City Council on February 3, 2014. The intent of the white paper was to catalogue the studies and resources conducted to date that could serve as a resource for future adaptation planning efforts

related to sea level rise and flood impacts. It included information about agencies and organizations involved in and supporting these efforts, as well as funding opportunities, resources, and tools available to draw from. It concludes with a list of potential next steps for the City to take, including preparing a sea level vulnerability assessment. It also included two appendices: A) San Rafael Levees and Shorelines, and B) San Rafael Possible Opportunity Areas for Adaptation.

Links:

<https://www.cityofsanrafael.org/documents/sea-level-rise-white-paper/>

### c. San Rafael Climate Change Action Plan 2030

In 2019, the San Rafael City Council adopted the San Rafael Climate Action Plan 2030 (CCAP 2030). CCAP 2030 acknowledges the need to address and adapt to rising sea level in the following two programs:

#### **Program SA-C4: Sea Level Rise**

*Prepare and adapt to a rising sea level.*

- a. *Consider the potential for sea level rise when processing development applications that might be affected by such a rise. Use current Flood Insurance Rate Maps and National Oceanic and Atmospheric Administration (NOAA) recommendations associated with base flood elevation adjustments for sea level rise in the review of development proposals. Adopt requirements to assess sea level rise risks on new development, infrastructure, and transit corridors.*
- b. *Prepare a guidance document for incorporating sea level rise into the City's capital planning process.*
- c. *Work with local, county, state, regional and federal agencies with Bay and shoreline oversight and with owners of critical infrastructure and facilities in the preparation of a plan for responding to rising sea levels. Make sure all local stakeholders are kept informed of such planning efforts.*
- d. *Investigate developing flood control projects and modifying the City's land use regulations for areas subject to increased flooding from sea level rise.*
- e. *Update GIS (Geographic Information System) maps to include new data as it becomes available; utilize GIS as a tool for tracking sea level rise and flooding and make available to the public.*
- f. *Study the creation of a Bay front overlay zone or similar that would establish standards for developing in areas subject to flooding from sea level rise.*

#### **Program SA-C5: Climate Change Adaptation**

*Prepare for and respond to the expected impacts of climate change.*

- a. *Continue to incorporate the likelihood of sea level rise and increased risk of wildfire and extreme heat and storm events in the City's Local Hazard Mitigation Plan.*
- b. *Incorporate the likelihood of climate change impacts into City emergency planning and training.*
- c. *Coordinate with water districts, wildlife agencies, flood control and fire districts, Marin County, and other relevant organizations to develop a comprehensive plan addressing climate change impacts and adaptation strategies. Address human health and the health and adaptability of natural systems, including the following:*

- *Water resources, including expanded rainwater harvesting, water storage and conservation techniques, water re-use, water use and irrigation efficiency, and reduction of impervious surfaces.*
  - *Biological resources, including land acquisition, creation of marshlands/wetlands as a buffer against sea level rise and flooding, and protection of existing natural barriers.*
  - *Public health, including heat-related health plans, vector control, air quality, safe water, and improved sanitation.*
  - *Environmental hazard defenses, including sea walls, storm surge barriers, pumping stations and fire prevention and suppression.*
- d. *Ensure fair and robust inclusion of lower-income households and our diverse communities in the planning and response to climate change impacts, including sea level rise, wildfire, public health, and emergency preparedness.*

The above programs are addressed in the San Rafael General Plan 2040 with newly added policies and programs in the Safety Element that are specific to increased flooding hazard and sea level rise, as described in Section C.

*Link*

Climate Change Action Plan 2030

<https://storage.googleapis.com/proudcity/sanrafaelca/uploads/2019/06/Att-D-CCAP-2030-Final-Draft-4-23-19.pdf>

## d. San Rafael Local Hazard Mitigation Plan

Local governments are required to prepare and adopt a Local Hazard Mitigation Plan (LHMP) pursuant to the federal Disaster Mitigation Act of 2000 (42 U.S.C. § 5121 et seq.). The Act outlines how an LHMP can be developed individually or through a multi-jurisdictional LHMP. The successful completion of an LHMP makes the jurisdiction eligible to apply for federal Hazard Mitigation Grant Program post-disaster funding, Pre-Disaster Mitigation funding or Flood Management Assistance funding. The LHMP must be updated every five years. The San Rafael Local Hazard Mitigation Plan was adopted in June 2017 and approved by the Federal Emergency Management Agency in January 2018.

The LHMP is an appropriate document for codifying adaptation strategies related to the mitigation of natural or human-caused hazards such as wildfire, flooding, storms and erosion, drought, and heat emergencies. The San Rafael LHMP analyzes these risks and identifies mitigation strategies to reduce the City’s vulnerability to hazards. Potential climate change impacts, including sea level rise, were assessed using Cal-Adapt and other data sources. The LHMP also reviews that findings from the BayWAVE vulnerability assessment for San Rafael.

Strategies to reduce risks from climate change, flooding, coastal flooding, and sea level rise include the following:

Action 15: Elevate/raise low lying roadways

Action 16: Elevate critical infrastructure

Action 17: Improvements to existing berms, levees, and flood control systems

Action 18: Continued involvement in the BayWAVE county-wide vulnerability assessment (Phase 1 and 2); Implement resulting strategies from Phase 2 of the program.

Action 19: Develop a climate adaptation plan, implement resulting strategies

Action 20: Freitas Ditch riparian and flood improvement project

Action 21: Spinnaker Point levee assessment study

For each of these actions, the plan provides background information, a project description, alternatives, implementation actions, the responsible City department, the project priority, a cost estimate, benefits, potential funding sources, and a timeline.

*Link*

San Rafael Local Hazard Mitigation Plan (June 2017)

<https://storage.googleapis.com/proudcity/sanrafaelca/uploads/2018/01/City-of-San-Rafael-LHMP-Complete.pdf>

## 6. Available Resources on Sea Level Rise & Adaptation

There are many resources available to local communities to evaluate sea level rise impacts and create plans to mitigate and adapt to sea level rise. In addition to the resources summarized in this report, the following resources were reviewed and, as appropriate, incorporated into this document. These resources are also listed in the Bibliography.

### **Sea Level Rise Forecasting**

- [Rising Seas in California: An Update on Sea-Level Science](#) (2017) provides the scientific foundation for sea level rise projections.
- [State of California Sea Level Rise Guidance](#) (2018) provides the most up-to-date sea level rise projections, which associate a likelihood of occurrence (or probability) with sea-level rise heights and rates and are directly tied to a range of emissions scenarios, consistent with ones used in the Intergovernmental Panel on Climate Change's Fifth Assessment Report.

### **Regional Sea Level Rise Vulnerability Assessment**

- [Adapting to Rising Tides Bay Area: Regional Sea Level Rise Vulnerability and Adaptation Study](#) (2020) is a regional study that assesses the impact of rising sea level to four critical regional systems – transportation networks, vulnerable communities, future growth areas, and natural lands – for ten different flooding scenarios.

### **Sea Level Rise Modeling**

There are several sea level rise inundation models available to estimate the extent of coast flood inundation in the Bay Area, each with advantages and disadvantages. In 2015, the BayWAVE Technical Group evaluated models available at the time and chose CoSMos for sea level rise modeling for the Marin Bay Waterfront Adaptation and Vulnerability Evaluation, as described in Section B.4 of this report.

- The Coastal Storm Modeling System (CoSMos), developed by the United States Geological Survey, allows detailed predictions of coastal flooding due to both future sea level rise and storms. CoSMos can be viewed through the [Our Coast Our Future](#) website.
- The [Adapting to Rising Tides Bay Shoreline Flood Explorer](#) provides an interactive visualization tool that allows the user to explore combinations of sea level rise, storm surge, and king tide events for ten total water level scenarios ranging from 12 to 108 inches.
- [Cal-Adapt](#), developed by the California Natural Resources Agency and the California Energy Commission, provides a sea level rise visualization tool that shows inundation location and depth resulting from different increments of sea level rise coupled with extreme storm events.
- The [NOAA Sea Level Rise Viewer](#) visualizes flooding impacts from sea level rise in one-foot increments, up to 10 feet.

Although the information provided by these tools is appropriate for conducting vulnerability and risk assessments, finer-grained information is needed for detailed engineering design and implementation.

### **Regulations and Policy Guidance**

- The [Marin County Climate Action Plan](#) (2015) provides a high-level list of potential adaptation actions.
- The [Marin Countywide Plan](#) (2007) was one of the first general plans to recognize climate change impacts and to prioritize sustainability.
- California state legislation related to sea level rise adaptation. In particular, [Senate Bill 379](#) requires local jurisdictions to include climate adaptation and resiliency strategies in the safety elements of their general plans.
- The San Francisco Bay Conservation & Development Commission’s [San Francisco Bay Plan](#) (2011) requires sea level rise risk assessments when planning shoreline areas or designing larger shoreline projects in areas within BCDC’s jurisdiction. If sea level rise and storms that are expected to occur during the life of the project would result in public safety risks, the project must be designed to cope with flood levels expected by mid-century. If it is likely that the project will remain in place longer than mid-century, the project must include a plan to address the flood risks expected at the end of the century.
- [Federal Emergency Management Agency](#) (FEMA) maps and floodplain development standards. FEMA maps coastal flood hazards based on existing shoreline characteristics, and wave and storm climatology at the time of the flood study. FEMA does not currently map flood hazards based on anticipated future sea levels or climate change. The Flood Disaster Protection Act of 1973 establishes standards for new construction and improvements in Special Flood Hazard Areas as mapped by FEMA, including requirements for buildings to be elevated to or above the base flood elevation.

### **State and Regional Resources for Adaptation Planning**

- The California Adaptation Planning Guide (2012) provides guidance and support for local governments to address the consequences of climate change. An [update](#) to the Guide is currently in progress. The Guide provides a step-by-step process for local governments to assess climate change vulnerabilities, including sea level rise, and define and implement adaption strategies.
- [Safeguarding California Plan: 2018 Update](#) is the State’s climate adaptation strategy. It does not provide policy recommendation or guidelines for local governments.

- [Planning and Investing for a Resilient California: A Guidebook for State Agencies](#) provides guidance to state agencies on how to integrate climate change into planning and investment. While geared to state agencies, *Resilient California* can be used to develop guidelines for how the City of San Rafael should integrate climate change into its own planning and capital improvement projects.
- The [San Francisco Bay Shoreline Adaptation Atlas: Working with Nature to Plan for Sea Level Rise Using Operational Landscape Units](#) (2019) classifies the Bay’s shorelines into 30 practical Operational Landscape Units (OLUs) based on the natural and developed characteristics of the shoreline and pairs each unit with a suite of appropriate nature-based and non-structural sea level rise adaptation strategies that support the resilience of the built and natural environment. The report identifies nature-based adaptation measures that are suitable for the San Rafael OLU, including marsh enhancement and creation and construction of ecotone levees.
- The [San Francisco Bay Regional Coastal Hazards Adaptation Resiliency Group](#) (CHARG), an organization of flood managers and scientists responsible for reducing flood risk in the San Francisco Bay Area. CHARG produces a [sea level rise resiliency map](#) that shows adaptation projects in all stages of development, from assessment and planning studies to final design and construction. The website also provides a well-curated [Resources](#) page with links to guidance, policy, scientific, and planning documents for local and regional sea level rise vulnerability and adaptation planning.

#### **Local Resources for Adaptation Planning**

- *Understanding Impacts of Sea Level Rise and Storm Surge on Transportation Network Vulnerability in San Rafael, California* (2016) assesses sea level rise and storm surge impacts to the road transportation network in San Rafael, including US 101 and Interstate 580, and connectivity to essential services. The study explores adaptation scenarios for the Canal neighborhood, which is particularly vulnerable as it is the most densely populated area with the greatest number of low-income and disadvantaged households.
- [Elevate San Rafael: Resilient by Design Challenge, Bionic Team](#) (2018) envisions a new future for the San Rafael waterfront that not only physically elevates development but also raises the quality of life and social connection for everyone.
- [Resilient Shore](#) (2017) is a fiscally sponsored, non-profit project that focuses on: 1) shoreline resilience and flood risk reduction; 2) transportation alternatives; and 3) risk management and insurance. Its mission is to deliver shoreline protection emphasizing natural resource strategies.
- [Sea Level Rise Adaptation Framework: A user guide to planning with nature, as demonstrated in Marin County](#) (2019) builds on the framework of the San Francisco Bay Shoreline Adaptation Atlas and provides case study examples for Novato and Corte Madera operational landscape units.
- The [Bay Area Climate Adaptation Network](#) (BayCAN), a collaborative membership-based network of local government staff.

#### **Financing Resources**

- [Climate Adaptation Finance and Investment in California](#) (2019) provides a summary of sources that jurisdictions can use to develop revenues and finance resilience and adaptation investments, including bonds (general obligation bonds, catastrophe bonds, resilience bonds,



green bonds, and capital appreciation bonds), taxes (special assessment districts, business improvement districts, special taxes, *ad valorem* property taxes, property tax increment, general taxes, and gas taxes), impact fees, and linkage fees. The book also provides a list of State and federal agencies and programs that provide grants, low-cost financing, and tax credits, as well as a discussion of civic and private sector financing.

- [Paying for Climate Adaptation in California: A Primer for Practitioners](#) (2018) is a guide for leaders aiming to navigate California’s complex funding and financing processes. The report includes a discussion of key laws that affect revenue generation in California and funding and financing strategies.
- [Finance Guide for Resilient by Design \(RbD\) Bay Area Challenge Design Teams](#) includes funding and financing strategies for the Bionic Team project developed for the Resilient by Design Bay Area Challenge.

## C. SAN RAFAEL GENERAL PLAN 2040 – PLANNING AHEAD

The San Rafael General Plan 2040 contains Goal S-3 in the Safety Element to address sea level rise impacts and several policies and programs to guide decision making and adaptation planning. These are shown below.

### **Goal S-3: Flooding and Sea Level Rise Resilience**

**Recognize, plan for, and successfully adapt to the anticipated effects of increased flooding and sea level rise.** *San Rafael’s land use patterns, transportation system, and infrastructure should be planned to anticipate the impacts of extreme weather events and global climate change, including sea level rise and potential flooding. A range of measures will be used to mitigate flood hazards along drainageways and creeks and improve resilience and flood protection in low-lying areas.*

*Policies to reduce the greenhouse gas emissions that contribute to global climate change are included in other parts of the General Plan, especially the Conservation Element and the Mobility Element.*

### **Policy S-3.1: Sea Level Rise Projection Map**

Utilize Figure S-2 (Sea Level Rise Projection Map) to address flooding and sea level rise hazards. The figure should be used to:

- a) maximize public awareness and disclosure to property owners and the public
- b) assess and address impacts to future development
- c) establish a zoning “overlay zone” and building code requirements for future planning and adaptation
- d) plan opportunity areas for adaptation
- e) inform funding and financing decisions about short-term and long-term adaptation projects.

***Program S-3.1A: Incorporate into City GIS.*** *Incorporate the Sea Level Rise Projection Map into the City’s Geographic Information System (GIS) map and utilize GIS as a publicly accessible tool for tracking flooding and sea level rise hazards.*

**Program S-3.1B: Periodic Update of Sea Level Rise Projection Map.** Review sea level rise data at least once every five (5) years to determine the need for Map updates.

**Program S-3.1C: Sea Level Rise Overlay Zone.** Adopt an “overlay zone” on the City Zoning Map incorporating the Sea Level Rise Projection Map. The “overlay zone” shall include land use regulations for site planning and a minimum construction elevation that reflects flooding and sea level rise data.

**Policy S-3.2: Data Consistency**

Ensure that the information and data related to increased flooding and sea level rise is current and consistent with the information and data utilized by the County of Marin.

**Program S-3.2A: Coordination with County of Marin.** Coordinate with the County of Marin on updating data related to increased flooding and sea level rise. Utilize the County of Marin Bay Waterfront Adaptation & Vulnerability Evaluation (BayWAVE) as the basis for all City-prepared documents and plans addressing and adapting to increased flooding and sea level rise.

**Policy S-3.3: Awareness and Disclosure**

Maximize awareness and disclosure by providing information to property owners and the public on areas subject to increased flooding and sea level rise vulnerability.

**Program S-3.3A. Residential Building Resale (RBR) Reports.** Revise the RBR Report template to include a disclosure of potential property risk to increased flooding and sea level rise. Utilize the sea level rise prediction map for confirming property vulnerability.

**Policy S-3.4: Mitigating Flooding and Sea Level Rise Impacts**

Consider and address increased flooding and sea level rise impacts in vulnerable areas (see Figure S-2) in development and capital projects, including resiliency planning for transportation and infrastructure systems.

**Program S-3.4A: Development Projects.** Where appropriate, require new development, redevelopment projects, and substantial additions to existing development to consider and address increased flooding and sea level rise impact, and to integrate resilience and adaptation measures into project design.

**Program S-3.4B: Capital Projects.** Prepare a guidance document for addressing increased flooding, sea level rise impacts, and adaptation measures into the City’s capital projects and planning process. This should include strategies for identifying and evaluating the costs, benefits and potential revenue sources for elevating or redesigning low-lying roadways and critical infrastructure. If the life of a public improvement in a vulnerable area extends beyond 2050, adaptation measures should be incorporated.

**Program S-3.4C. Coordination with Utilities and Services.** Coordinate with the utilities and services that have infrastructure and facilities in vulnerable areas (for example: wastewater treatment plants) to ensure that sea level rise information and goals are consistent with the

*City's goals, and that infrastructure/utilities projects address and plan for increased flooding and sea level rise.*

**Policy S-3.5: Minimum Elevations.** For properties in vulnerable areas, ensure that new development, redevelopment, and substantial additions to existing development meets a minimum required construction elevation. Minimum elevations should provide protection from the potential impacts of a 100-year flood (a flood with a one percent chance of occurring in any given year), the potential for increased flooding due to sea level rise, and the ultimate settlement of the site due to consolidation of bay mud from existing and new loads and other causes.

**Program S-3.5A: Code Amendments for Floor Elevation.** *Update and adopt zoning, building and public works code requirements to establish and mandate a minimum finished floor elevation for new development, redevelopment, and substantial additions to existing development. Consider adopting a minimum, finished floor elevation requirement of +3 feet above the FEMA 100-year flood elevation requirement.<sup>2</sup>*

**Program S-3.5B: Ground Elevation Surveys.** *Perform periodic ground elevation surveys in the Sea Level Rise vulnerability zone. The result of the surveys should be considered when developing projects to reduce coastal flooding potential.*

**Program S-3.5B: Title 18 Flood Protection Standards.** *Evaluate and revise Title 18 of the Municipal Code (Protection of Flood Hazard Areas) to address anticipated sea level rise, increases in rainfall intensities, and any changes related to Federal or regional flood reduction criteria.*

**Program S-3.5C: National Flood Insurance Program (NFIP).** *Continue to comply with the federal NFIP by maintaining a flood management program and flood plain management regulations. In addition, develop and periodically update a Community Rating System (CRS) to notify residents of the hazards of living in a flood area, thereby reducing local flood insurance rates.*

### **Policy S-3.6: Resilience to Tidal Flooding**

Improve San Rafael's resilience to coastal flooding and sea level rise through a combination of structural measures and adaptation strategies.

**Program S-3.6A: Sea Level Rise Adaptation Plan.** *Prepare and adopt an adaptation plan addressing increased flooding and sea level rise. The adaptation plan shall include the following components:*

- a) Sea level rise projection map, to be used as the basis for adaptation planning.*
- b) Coordination with local, county, state, regional and federal agencies with bay and shoreline oversight, major property owners, and owners of critical infrastructure and facilities in the preparation of the adaptation plan.*
- c) An outreach plan to major stakeholders and property owners within the vulnerable areas.*
- d) An inventory of potential areas and sites suitable for mid- to large-scale adaptation projects (see Appendix #: Sea Level Rise Adaptation Report for more information)*

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<sup>2</sup> The + 3 feet requirement has been used in several other bayfront communities.

- e) *A menu of adaptation measures and approaches that would include but not be limited to:*
  - *Managed retreat, especially on low-lying, undeveloped, and underdeveloped sites; in areas that are permanent open space; and in areas that are environmentally constrained. Transfer of development rights from such areas should be encouraged.*
  - *Innovative green shoreline protection and nature-based adaptation measures such as wetlands and habitat restoration, and horizontal levees where most practical and feasible.*
  - *Hard line armoring measures (sea walls, levees, breakwater, locks, etc.) in densely developed areas to minimize the potential for displacement of permanent residents and businesses.*
  - *Elevating areas, structures, and infrastructure to reduce risks.*
- f) *The appropriate timing and “phasing” of adaptation planning and implementation.*
- g) *Potential financing tools and opportunities.*
- h) *Coordination or incorporation into the San Rafael Local Hazard Mitigation Plan.*

**Program S-6.6B: Partnerships.** *Foster, facilitate and coordinate partnerships with the County of Marin, other effected agencies and utilities, property owners, and neighborhood groups/organizations on planning for and implementing adaptation projects. This could include a centralized countywide agency or joint powers authority to oversee adaptation planning, financing, and implementation.*

### **Policy S-3.7: Shoreline Levees**

Improve and expand San Rafael’s shoreline levee system. When private properties are developed or redeveloped, require levee upgrading as appropriate, based on anticipated high tide and flood conditions.

**Program S-2.2A: Levee Improvement Plans.** *Assess existing levees, berms, and flood control systems to identify reaches with the greatest vulnerability. Develop improvement plans based on existing conditions and projected needs, as documented in adaptation plans. This should include improvement studies for the Spinnaker Point levee, as recommended by the LHMP, and the Canalways levee along San Pablo Bay.*

**Program S-2.2B: Financing Levee Improvements.** *Coordinate with property owners; residents and businesses; federal, state, and regional agencies; utilities; and other stakeholders to evaluate potential methods of improving levees and funding ongoing levee maintenance, including assessment or maintenance districts. The cost and fiscal impacts of levee improvements should be evaluated against potential benefits, as well as the potential costs and consequences of inaction.*

## D. APPROACH TO ADAPTATION PLANNING

### 1. Objectives for Adaptation Planning

Adaptation planning is a multi-hazard exercise that considers a variety of factors, including vulnerability and feasibility assessments, community engagement, stakeholder input and decision-making, and coordination amongst agencies and regional partners, among others. Climate change is projected to cause many types of disruption; an all-hazard approach is necessary to ensure community-wide resilience to a variety of threats. For example, planning for future flooding without considering an increase in extreme heat days may miss opportunities to protect a vulnerable community when considering adaptation projects. This report focuses on sea level rise and flooding. However, these objectives are intended to provide broad-level guidance for overall adaptation planning for multiple hazards. Identification of shared values and priorities should be the first objective of any community-based adaptation planning exercise.

Adaptation planning is much like disaster response planning. The effort is intended to protect people, property, and environment to the extent possible through a variety of means, on a continuum from hard protection on one end, to retreat on the other. Some best practices and objectives include the following “buckets”, which coincide with and otherwise complement the Principles in the California Adaptation Planning Guide.

**Equity** – Make sure those most affected and with least voices are engaged at the start and processes are put in place to ensure robust engagement in an ongoing and iterative fashion. Prioritize actions that promote equity, foster community resilience, and protect the most vulnerable. Explicitly include communities that are disproportionately vulnerable to climate impacts.

**Engagement & Education** – Work to provide a shared perspective and level of understanding to all members of the public. Identify key stakeholders to be part of the process, while ensuring that the public is provided plenty of opportunities to engage and learn and provide input.

**Multiple benefits** – Prioritize integrated climate actions, those that both reduce greenhouse gas emissions and build resilience to climate impacts, as well as actions that provide multiple benefits.

**Short-term & long-term planning** - Take immediate actions to reduce present and near future (within 20 years) climate change risks for all Californians; do so while also thinking in the long term and responding to continual changes in climate, ecology, and economics using adaptive management that incorporates regular monitoring.

**Best, most up-to-date science** – Base all planning, policy, and investment decisions on the best-available science, including local and traditional knowledge, and consideration of future climate conditions.

**Coordinate regionally and with State and Federal agencies** – Build collaborative relationships between regional entities and neighboring communities to promote complementary development and regional approaches.

**Balance protection of people and property with protection of environment and ecological systems –** Prioritize natural and green infrastructure solutions to enhance and protect natural resources, as well as urban environments. Preserve and restore ecological systems (or engineered systems that use ecological processes) that enhance natural system functions, services, and quality and that reduce risk, including but not limited to actions that improve water and food security, habitat for fish and wildlife, coastal resources, human health, recreation, and jobs.

**Prevent maladaptation –** Shorter term measures should not preclude or hinder longer-term measures and should ideally help pave the way for longer-term measures and alternatives.

**A living plan –** Learn and adapt as time goes on and as new challenges and opportunities arise. Consciously embed a feedback loop of monitoring, evaluating, adjusting, as much as possible during implementation.

## 2. Utilization of Adaptation Land Use Planning Guidance (County of Marin)

[Adaptation Land Use Planning: Guidance for Marin County Local Governments](#) (2020) explores appropriate adaptation land use planning for Marin county’s bay shoreline based on the BayWAVE Sea Level Rise Vulnerability Assessment (2017) and other research. The guidance identifies a range of land use planning tools, given local conditions and environment, that are appropriate to address sea level rise in Marin County. Guidance includes adaptation tools, regulatory/zoning tools, tax, and market-based tools.

*Link*

Adaptation Land Use Planning: Guidance for Marin County Local Governments  
<https://www.marincounty.org/-/media/files/departments/cd/slr/alup0228.pdf?la=en>

## 3. Adaptation Tools and Strategies

Adaptation measures are engineering, and planning solutions designed to manage, mitigate, and avoid impacts from sea level rise and flooding. Depending on the location, single or hybrid adaptation measures may be most effective solution.

### Nature-based Measures

Living shorelines with wetlands absorb floods, slow erosion, and provide habitat. They are a shoreline protection alternative that rely on the strategic placement of plants, stone, sand fill, and other structural and organic materials to protect the shoreline. As an alternative to ‘hard’ shoreline stabilization methods like rip rap or seawalls, living shorelines can provide numerous benefits such as water quality improvement, habitat, and biodiversity, and buffering of shorelines from storm erosion and sea level rise. They can include any shoreline management system that is designed to protect or restore natural shoreline ecosystems through the use of natural elements and, if appropriate, man-made elements.



Nature-based measures include the following:

- **Nearshore reefs** made of materials such as oyster shell and baycrete (a cement mixture composed mostly of Bay sand and shells). Nearshore reefs can reduce wave transmission at lower tidal elevations and stabilize areas in their lee.
- **Submerged aquatic vegetation** are underwater flowering plants, such as eelgrass, that can contribute to reducing currents, trapping sediment, and slowing shoreline erosion. The vegetation provides food for a variety of organisms and supports biodiversity.
- **Mudflat augmentation** involves the direct or indirect placement of fine sediment to increase mudflat elevation relative to the tides, which can help protect adjacent marshes and shorelines from storm surge and erosion.
- **Beaches** can be created or enhanced with coarser gravel and cobble to dissipate wave energy, reduce storm surge and erosion, and protect against short-term sea level rise.
- **Tidal marshes**, in conjunction with tidal flats, can mitigate flood risk due to storm surges, waves, and tidal currents. Specific actions include restoring diked baylands to marsh, planting native species to accelerate colonization, placing sediment to raise subsided areas, and creating higher areas within marshes to provide high-tide refuge.
- **Polder management** of low-lying areas of land that would normally be inundated by regular tides if they were not protected by dikes. Land uses of polders include residential neighborhoods, salt ponds, hay fields, and flood retention basins. Polders are also commonly used for infrastructure, including roads, rail line, wastewater lines, and transmission lines. Polders often accumulate runoff that needs to be detained and pumped into the bay.
- **Ecotone levees** are gentle slopes bayward of flood risk management levees and landward of a tidal marsh. They can attenuate waves, provide upland transition zone habitat and high-tide refuge for marsh wildlife, and allow room for marshes to migrate upslope with sea level rise.
- **Migration space preparation** are wetland-upland transition zones that could be protected, enhanced, or restored to allow marshes to migrate landward as sea level rises.
- **Creek-to-baylands restoration** involves reconnecting creeks to their adjacent baylands through levee breaching or removal as a way to improve habitat while managing flood risk.
- **Green stormwater infrastructure** includes rain gardens, bioswales, cisterns, permeable pavement, creek daylighting, green roofs, urban forestry, and more. These tools help to retain storm water and slow it down to reduce flooding.

Nature-based solutions are often cost-effective, have environmental benefits, and are generally supported by Marin County residents. However, these solutions typically address near-to-medium range sea level rise impacts only and require robust monitoring.

### Grey Infrastructure

Grey infrastructure refers to conventional, physical structures to protect the coastline from rising seas. These traditional engineering approaches can sometimes incorporate nature-based measures in a hybrid approach.

Grey infrastructure includes the following:

- **Barriers** or tidal barrage(s) to manage tidal flows in and out of San Francisco Bay, at the Golden Gate or in smaller, strategic parts of the bay.
- **Coastal armoring** with linear protection, such as levees and seawalls, to fix the shoreline in its current place.
- **Flood walls** to protect development from occasional flooding and overtopping in low-lying areas.
- **Bulkheads, revetments and riprap** to stabilize the existing shoreline and limit shoreline erosion.
- **Elevate land** to lift development out of the flood zone.
- **Elevate or realign transportation** to move roads and railway out of the sea level rise hazard zone by raising them on a levee, causeway, or bridge, or moving them to a new upland location, or rerouting service to other existing transportation routes.

## ADAPTATION MEASURES

Adaptation Measures are engineering and planning solutions designed to manage, mitigate, and avoid impacts from sea level rise and flooding. Depending on the location, single or hybrid adaptation measures can effectively address flooding.

	<p><b>Accommodate</b></p> <ol style="list-style-type: none"> <li>1. Floating structures or floodable developments are designed to accommodate flooding.</li> <li>2. Elevating buildings, roads, utilities, and grades provides near to medium-term flood protection.</li> </ol>
	<p><b>Protect: Engineered</b></p> <ol style="list-style-type: none"> <li>3. Seawalls, revetments, and bulkheads are vertical features that protect from wave action and erosion.</li> <li>4. Pump stations move water to nearby retention basins or to outer water ways.</li> <li>5. Tide gates span waterways to provide protection from high tides or storm surge.</li> <li>6. Levees are vertical earthen structures that protect shorelines from flooding and wave action.</li> <li>7. Breakwaters and artificial reefs are structures engineered for erosion control and wave energy reduction.</li> </ol>
	<p><b>Protect: Natural</b></p> <ol style="list-style-type: none"> <li>8. Bio-beds or near-shore habitat enhancements reduce small wave action and erosion.</li> <li>9. Bay and beach nourishment protect inland structures and reduce erosion from flooding and wave action.</li> <li>10. "Horizontal levees" combine marsh and transition zone habitat backed by a levee for dual protection benefits.</li> </ol>
	<p><b>Retreat</b></p> <ol style="list-style-type: none"> <li>11. Managed retreat accommodates flooding and shoreline migration by moving development out of harms way.</li> </ol>

Source: *Adaptation Land Use Planning: Guidance for Marin County Local Governments*

## 4. Policy and Regulatory Measures

Policy and regulatory measures are non-physical ways of influencing land use and the built environment to manage risk.

### Overlay Zones/Districts

Overlay zones/districts can create new requirements for vulnerable development to deal with flooding, habitat, and other priorities. For example, a sea level rise overlay zone could require specific building resilience measures, widen setbacks from the shoreline, cluster development away from the water, and restrict building after a major flood. Overlay zones can be used to pursue these strategies:

- **Elevate development** in which the height of land or existing development is raised above a prescribed flood elevation, based on projected sea level rise and the life expectancy of the project.
- **Floating development** on the surface of the water, or development that may be floated occasionally during a flood.
- **Floodable development** designed to withstand flooding.
- **Managed retreat** that safely removes development from advancing shorelines and bans new development in areas likely to be inundated.

Although they can be effective regulatory tools, zoning designations and standards are often controversial because they effect the development type and developable area on private property.

San Rafael General Plan 2040 contains program S-3.1C to adopt an overlay zone on the City Zoning Map that incorporates the Sea Level Rise Projection Map (Figure S-2). This overlay zone will include land use regulations for site planning and a minimum construction elevation that reflects flooding and sea level rise data.

### Building Requirements

Cities can establish building code standards that require structures to address flooding risks. Many cities, like San Rafael, already require new and remodeled structures to be built so that the elevation of the building's lowest floor is above the minimum base flood elevation (BFE) established by FEMA. Adding height to the BFE to accommodate anticipated sea level rise is one way that governments can protect buildings from sea level rise. Local governments can also require structures to be designed to be flood resistant or flood-proof so that they can withstand occasional flooding.

General Plan 2040 Safety Element program S-3.4A requires new development, redevelopment projects, and substantial additions to existing development to consider and address increased flooding and sea level rise impact, and to integrate resilience and adaptation measures into project design, where appropriate. Program S-3.5A recommends that the City update and adopt zoning, building and public works code requirements to establish and mandate a minimum finished floor elevation for new development, redevelopment, and substantial additions to existing development. The City will consider adopting a minimum, finished floor elevation requirement of +3 feet above the FEMA 100-year flood elevation requirement.

### **Coastal Flooding Disclosures**

Coastal flooding disclosures for real estate transactions spread public awareness about sea level rise and allow community members to make informed decision about the risks of purchasing certain coastal properties.

General Plan 2040 Safety Element program S-3.3A recommends the City revise the residential building resale report template to include a disclosure of potential property risk to increased flooding and sea level rise. The City would use the Sea Level Rise Prediction map to confirm property vulnerability.

### **Conservation Easements**

Conservation easements are voluntary agreements not to develop on a property to preserve it for habitat, open space, recreation, or farmland, in exchange for compensation or tax benefits.

Conservation easements allow a property to remain in private ownership, with land development limited by certain terms that bind all future owners of the property. In exchange for maintaining land as open space, a property owner obtains tax relief or incentives, and compensation for forgoing the right to develop. Easements may include terms that specify allowable types of shoreline treatment, erosion control, or other activities, and can stipulate that space must be set aside for the upland migration of marsh or beaches. “Rolling” conservation easements could prevent certain activities on the shoreline, the terms of which would “roll” upward as the high-tide line moves inland but maintain economic uses until certain levels of sea level rise are reached. The new high-tide line, and the area subject to restrictions under the easement, would typically be reset after a major storm event.

### **Transfer of Development Rights (TDR)**

In a TDR program, local governments support smart growth and infill development away from high-hazard areas by designating “sending” areas and “receiving” areas through zoning. Property owners in “sending” areas can sell development credits in exchange for a conservation easement on their property and forgoing additional development; property owners/developers in “receiving” areas can buy credits to exceed allowable densities, heights, or floor areas. These programs create market incentives to shift development to preferred areas without “takings.”

As one measure to address sea level rise and flooding, local governments could designate sending areas in vulnerable locations, designate receiving areas on higher ground where development should occur, and then establish a credit market. Sending areas could be converted to conservation easements or downzoned in the future once development rights have been sold.

Several Marin jurisdictions have TDR programs in their general plans, but they are rarely used. TDRs are complicated and require a great deal of staff time. It can also be difficult to find a receiver site.

### **Acquisitions**

Governments can acquire property at risk from sea level rise from willing sellers, particularly when the property is needed to protect public safety, such as gray infrastructure designed to protect the shoreline

from rising seas and/or a nature-based mitigation project. Property is expensive in Marin, however, and funding sources are limited. A dedicated impact fee or tax could raise funds for strategic acquisitions.

## 5. Financing and Insurance

### Taxes

Special taxes are taxes imposed for specific purposes and can be used to finance various public improvements and services, including adaptation and resilience projects. These are added to the property taxes charged to parcels within a defined geographical area that will benefit from the project. Typically, special taxes are levied on a per parcel basis either according to the square footage of the parcel or on a flat rate. In California, a special tax must be approved by a 2/3rds majority of the qualified voters in the service area.

Measure AA is an example of a special tax. The tax is levied annually at \$12 for each parcel in the nine-county San Francisco Bay Area. Measure AA provides funding for habitat restoration projects in the San Francisco Bay, as well as flood protection projects that are part of a habitat restoration program. The tax raises approximately \$25 million each year and will be in effect through June 30, 2037.

Measure AA, or the San Francisco Bay Clean Water, Pollution Prevention and Habitat Restoration Measure, was a revenue generating measure placed on the ballots of the nine-county San Francisco Bay Area by the Restoration Authority. Passed in 2016, the measure enacted a \$12 parcel tax to raise approximately \$25 million annually, or \$500 million over twenty years, to fund restoration projects in the Bay. The San Francisco Bay Restoration Authority identifies projects to fund that protect, restore, and enhance the Bay, including

1. habitat restoration projects;
2. flood protection projects that are part of a habitat restoration project; and
3. shoreline access and recreational amenity projects that are part of a habitat restoration project.

Priority is given to projects that:

- Have the greatest positive impact on the Bay as a whole, in terms of clean water, wildlife habitat and beneficial use to Bay Area residents.
- Have the greatest long-term impact on the Bay, to benefit future generations.
- Provide for geographic distribution across the region and ensure that there are projects funded in each of the nine counties in the San Francisco Bay Area over the life of Measure AA.
- Increase impact value by leveraging state and federal resources and public/private partnerships.
- Benefit economically disadvantaged communities.
- Benefit the region's economy, including local workforce development, employment opportunities for Bay Area residents, and nature-based flood protection for critical infrastructure and existing shoreline communities.



- Work with local organizations and businesses to engage youth and young adults and assist them in gaining skills related to natural resource protection.
- Incorporate monitoring, maintenance, and stewardship to develop the most efficient and effective strategies for restoration and achievement of intended benefits.
- Meet the selection criteria of the Coastal Conservancy's San Francisco Bay Area Conservancy Program and are consistent with the San Francisco Bay Conservation and Development Commission's coastal management program and with the San Francisco Bay Joint Venture's implementation strategy.

Marin County projects funded to date include the Deer Island Tidal Basin Wetlands restoration project in the lower Novato Creek watershed. The project will restore up to 154 acres of diked, subsided, and degraded historic tidal marsh to full tidal natural conditions and will serve as demonstration as a natural levee approach to address sea level rise. The Marin County Flood Control District was awarded \$630,000 for the project.

In 2019, approximately \$969,000 in Measure AA funds were awarded to the Marin Audubon Society to prepare technical studies, refine designs, and conduct environmental review and public outreach for restoration and sea level rise adaptation at Tiscornia Marsh. The project will increase flood protection and provide public access for the underserved Canal community in San Rafael.

### **Development Impact Fees**

Development impact fees are levied on new development to raise revenue for the construction or expansion of community facilities and infrastructure or to compensate for development project impacts upon infrastructure. An impact fee could be imposed on new development located in a sea level rise hazard zone that will require public infrastructure to keep it safe.

### **Bonds**

General obligation bonds are commonly used to finance public infrastructure and may be backed by revenues generated from local property taxes or fees. In California, general obligation bonds require two-thirds approval of the voters in the issuing jurisdiction.

Other types of bonds are available to local governments. Catastrophe bonds help insure against damages and fund recovery efforts in the case of a natural disaster. These bonds are triggered when a pre-defined event occurs, such a windspeed, seismic rating, or flood level. Resilience Bonds are similar to Catastrophe Bonds in that they provide coverage against climate impacts and extreme events, but they also provide financing for adaptation and resilience projects that reduce risk. The insurer takes the expected benefit from the project into account and lowers the premium the city must pay. Green Bonds may be issued to finance projects with environmental or climate adaptation benefits.

### **Grants**

Government agencies and philanthropies offer grants that can be used for adaptation and resiliency projects. Typically, grants do not cover the full project cost but can be used to leverage other sources of

funding (money that does not need to be repaid, such as grants, fees, and taxes) and financing (money that must be repaid, such as loans and bonds).

Examples of federal grant programs for adaptation and resiliency projects include:

- Coastal Resilience Grants offered by the National Oceanic and Atmospheric Administration to help communities increase preparation for extreme weather events and climate change, and to recover after a disaster.
- FEMA’s Hazard Mitigation Grant Program to help communities promote resilience both pre- and post-disaster.
- The National Coastal Wetlands Conservation Grant Program administered by the U.S. Fish and Wildlife Service to acquire, restore, and enhance wetlands and protect habitat.

There are quite a few sources for State funding. ResilientCA.org, developed by the Governor’s Office of Planning and Research, maintains a list of current state funding opportunities at <https://resilientca.org/topics/investing-in-adaptation/>. Although not intended to be a comprehensive list of all California grant programs, the site is updated periodically.

The following grant aggregation sites provide information on open grant applications from federal and state agencies, as well as philanthropic and private grant makers.

[Funding Wizard](#). The Funding Wizard, hosted and maintained by the California Air Resources Board, is a searchable database of grants, rebates and incentives for categories such as energy, air quality and climate change mitigation and adaptation, transportation, urban development, waste management, water and more.

[Grants.Gov](#). Grants.gov provides a searchable database of federal grants.

[Uplift](#). UpLift provides a database of resources searchable by categories such as sustainable communities, clean transportation, energy efficiency, greening, recycling, etc.

### **Geologic Hazard Abatement Districts**

Geologic Hazard Abatement Districts (GHAD) are independent governmental districts that can assess properties within a defined area and dedicate the revenue to abating or controlling hazards such as landslides, earthquakes, and erosion.

GHADs are formed to identify, monitor, address, and mitigate geologic hazards through district-wide or individual property improvements. Through special assessments, GHADs provide a means to pay for maintenance, monitoring of hazards, and other upgrades necessary for flood protection and erosion management, thereby providing long-term security of property values, or a form of insurance for probable geologic issues. The money can be used to construct coastal resilience measures, pay for seismic upgrades, build green infrastructure, and more. There are no limits to size, number of units, or contiguity of the property within the GHAD.

To establish a GHAD, 10% of property owners within the proposed district must petition for its creation; assessments then must go through the Proposition 218 process and be adopted by the city

council/board of supervisors. The GHAD is governed by a Plan of Control and a Board of Directors, often an existing legislative body. GHADs can own and acquire land and conduct preventive work. GHADs were enabled by California state law in 1979 and are exempt from Local Agency Formation Commissions (LAFCOs) and CEQA.

### **Special Assessment Districts**

Special Assessment Districts are government districts formed by a public agency, usually to pay for new or improved public infrastructure. Special Assessment Districts assess an additional tax on top of the existing property tax for property owners within the district. This revenue is then used to finance improvements that provide a direct benefit to the properties with the district.

To establish an assessment district, a local agency holds a public hearing to notify property owners of the intent to establish the assessment district, and then mails a ballot to each property owner within the proposed district that will directly benefit from the improvements to be constructed. A majority of ballots in favor of forming the assessment district, weighted by the proportional financial obligation, is required to form the assessment district. Once approved, there is an initial period when property owners may payoff the assessment in full. Financing is arranged for those who do not want to pay off the assessment property owners, and the assessment district constructs the proposed improvements. A Special Assessment Lien is recorded against each property with an unpaid assessment. Then, these parcels will pay their total assessment through annual installments on the county property tax bill. Assessments are based on mathematical formulas that take into account how much each property will benefit from the installation of the improvements.

### **Buyouts**

Voluntary buyout programs use public resources to acquire land and demolish buildings for hazard mitigation and to promote public safety. They may be most suitable for high-hazard areas to prevent repeat losses and to reduce overall community vulnerability. They can be a practical approach for property owners who no longer want to live in high-risk areas to move somewhere safer. Buyouts are a mechanism for managed retreat; however, if they are implemented voluntarily and not everyone participates, they may create a “checkerboard effect” causing blight and making complete retreat difficult.

Mandatory buyouts, or eminent domain, may be used to prevent immediate health, safety, and life risks, but are typically not eligible for cost-sharing by the federal government so are much more expensive and difficult. Leasebacks are buyout programs in which properties are leased to their current owners for a specified period so that they can continue to use them without economic loss.

The high cost of property in Marin makes it difficult to implement buyout programs.

### **Insurance**

The escalating frequency and severity of climate-change related events, from wildfire to hurricanes, are changing the way insurance companies evaluate risk. Insurers are beginning to seek ways to minimize their exposure to climate change impacts. They may start to exclude climate change-related impacts from liability policies or require a separate rider and additional premiums to cover those risks. They may

also limit coverage in areas with higher risk or abandon an insurance market entirely. At some point, some buildings or and/areas will simply be uninsurable.

Local governments will face these same challenges in trying to insure and finance their own buildings and facilities. Infrastructure projects that are financed with municipal bonds will need to address climate change impacts in order to make them attractive to potential bond purchasers. Projects that do not will require higher risk premiums to finance them.

In addition, insurers are most likely going to demand more protection through land use policies and stricter building codes that discourage development in unsafe areas and require buildings to withstand hazards like flooding and wildfire. Governments that fail to address climate change hazards may expose themselves to litigation.

Local governments may consider parametric insurance, or index-based insurance, to finance recovery from climate impacts and extreme events. With parametric insurance, coverage is triggered by a defined parameter, such a metric or index that is objective, transparent, and consistent. In the case of climate change, parametric insurance could be indexed to a number of annual heat events or average sea level. Parametric insurance products have mostly been used in the past for weather-sensitive businesses, but they are becoming increasingly popular as a way to mitigate climate change impacts.

Local government may also advocate for the state to impose surcharges on certain insurance products. Surcharge revenues could be used to float bonds that finance local adaptation projects.

## **E. SAN RAFAEL SEA LEVEL RISE ADAPTATION TECHNICAL GUIDANCE STUDY**

General Plan 2040 Safety Element Program S-3.6A recommends that a comprehensive sea level rise adaptation plan be prepared at a future date. As a first step in developing a comprehensive adaptation plan, in 2018, the City Public Works Department commissioned the preparation of a study to assess flood hazards that will be exacerbated by future sea level rise. The goal of the study was to begin to identify potential short-term to long-term measures for addressing increased flooding and sea level rise. To meet this goal, Environmental Sciences Associates, Inc. (ESA), was hired and prepared [The San Rafael Sea Level Rise Adaptation Technical Guidance Study \(hyper link\)](#) (2019). The objectives of this study are to: a) assess existing flood risk and future flood risk that includes sea level rise projections; b) develop reasonable and feasible adaptation measures that are appropriate to the City's shoreline; c) evaluate the suggested measures to characterize costs and benefits; and d) integrate the suggested measures.

This adaptation study builds on countywide and City efforts addressing sea level rise projections and adaptation, specifically, the City-prepared Climate Adaptation- Sea Level Rise White Paper (2014) and the County of Marin BayWAVE Vulnerability Assessment (2017). In addition, a number of the suggested measures and actions in this adaptation study are consistent with the County of Marin Adaptation Land Use Planning Guidance for Marin Local Governments.

### **Shoreline Regions Studied**

Utilizing information from BayWAVE and other sources referenced in this report, the adaptation study defines seven (7) shoreline regions in San Rafael that are vulnerable to flooding and flood hazard, which are:

- Canal North and Downtown- the northern shoreline of San Rafael Creek commencing from US 101 extending eastward to Summit Drive and Sea Way (just west of the mouth of San Rafael Creek). This region includes the low-lying and flood prone areas west of US 101, which includes San Rafael, Mahon, and Irwin Creeks (portions of Downtown).
- Bayfront South – the southeast San Rafael shoreline commencing east of the mouth of San Rafael Creek and extending southward to Point San Quentin.
- Canal South – the southern shoreline of San Rafael Creek commencing from the east of US 101 and extending to Kerner Boulevard. This area includes the Canal neighborhood.
- Loch Lomond – the shoreline and environs around the Loch Lomond Marina, including lower portions of the Loch Lomond and San Pedro Cove neighborhoods.
- Point San Pedro Road – the shoreline bordering the Glenwood and Peacock Gap neighborhoods.
- Las Gallinas – low-lying areas along the north and south forks of Gallinas Creek, which include and border the Contempo Marin and Marin Lagoon communities and the San Rafael Airport.

### **Suggested Adaptation Strategies & Measures**

The study includes suggested adaptation strategies and measures, which are presented in Table 5. The strategies and measures are presented in two categories: a) Citywide; and b) by shoreline region. Citywide measures include the following:

1. Canal Feasibility Study – The Canal South region has the greatest number of vulnerable roadways and building assets, including the highest concentration of higher density, lower-income housing. A Canal Feasibility Study is recommended to identify localized measures such as flood barriers (levees or flood walls) or a hydraulic structure and pump station.
2. Sea Level Rise Overlay Zone – As discussed above, General Plan 2040 Safety Element Program S-3.1C recommends adoption of a sea level rise overlay zone, which would be used to: a) develop and adopt land use regulations for site planning and minimum construction elevation requirements; b) provide awareness and disclosure; and c) used as a tool for financing adaptation (e.g., establishing an assessment district).
3. Shoreline Pump Station Assessment – An assessment is recommended to develop and apply protocols for assessing pump station inflows, discharge capacity, and resilience to climate change.

4. Minimum Construction Elevation – As discussed above, General Plan 2040 Safety Element Program C-3.5A recommends City code amendments to raise the minimum floor elevation requirements for construction. A finished floor elevation of 3 feet above the FEMA 100-year flood elevation requirement is recommended.

For each of the shoreline regions, the adaptation study identifies focus areas for recommended adaptation. For example, within the Bayfront South area, the focus of review is the shoreline levee, and the varying conditions of this levee. For each focus area, the study suggests a combination of engineering-based (short-term) and nature-based (medium- and long-term) adaptation strategies/measures that fall into the following categories:

- Raising and lowering portions of the shoreline.
- Installing backflow prevention devices on culverts that discharge storm water to the bay.
- Increasing pump station capacity.
- Conducting additional targeted local flood studies of combined storm water runoff and high tides.
- Considering marsh restoration and retreat combined with construction of setback of levees where opportunities exist.
- Nature-based measures such as ecotones (horizontal levees outboard of the shoreline).

Table 8 also includes an estimated cost for implementation of the suggested strategies/measures and the financing measures and funding sources that can be considered. Funding sources are presented in Table 9 of the study, which are included above under Section D.5. (Financing and Insurance) of this report.

The suggested strategies/measures presented in the study are not intended to cover all adaptation opportunities, such as adaptation for the circulation network, protection of private property, or the protection of specific assets (e.g., essential public facilities and utilities). However, what has been presented and suggested provides a starting point for the greater planning effort of developing a comprehensive multi-hazard adaptation plan. Further, some of the recommended measures can conceivably be funded and implemented in the short-term, which allows for capital improvement planning prior to completing a comprehensive sea level rise adaptation plan.

## **F. NEXT STEP – DEVELOP AN ADAPTATION PLAN**

General Plan 2040 Safety Element Program S-3.6A calls for the preparation and adoption of a Sea Level Rise Adaptation Plan to address increased flooding and sea level rise. A comprehensive adaptation plan that addresses all climate change impacts, including sea level rise, will be prepared utilizing the information and resources compiled in this report and the recommendations presented in [The San Rafael Sea Level Rise Adaptation Study \(hyper link\)](#) (2019). The plan will be developed within two to three years of adoption of General Plan 2040. Other General Plan programs cited in this report, such as adopting an overlay zone, land use regulations, and a minimum construction elevation to address future sea level rise flooding, may be implemented while the adaptation plan is under development.

The Plan will be developed in accordance with [SB 379](#), which requires local jurisdictions to include climate adaptation and resiliency strategies in the safety elements of their general plans. This legislation is codified at Government Code section 65302(g)(4). SB 379 requires local governments to conduct a vulnerability assessment of risks from climate change impacts, including sea level rise, and to create a plan that includes a set of adaptation goals, policies, and objectives as well as feasible implementation measures. Measures must include feasible methods to avoid or minimize climate change impacts associated with new uses of land and the location, when feasible, of new essential public facilities and infrastructure outside of at-risk areas. The legislation prioritizes the use of existing natural features and ecosystems in adaptation projects, such as floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days.

SB 379 directs local jurisdictions to incorporate information from the Internet-based [Cal-Adapt](#) tool and the most recent version of the [California Adaptation Planning Guide](#) (APG). The APG provides a step-by-step process that communities can use to develop an adaptation plan. There are four phases of the planning process:

**Phase 1, Explore, Define, and Initiate:** This phase includes scoping the process and project, such as identifying the potential climate change effects and important physical, social, and natural assets in the community. It also identifies the key stakeholders in the local government and throughout the community.

Stakeholder engagement is a vital part of the adaptation planning process. In San Rafael, where neighborhoods that will be impacted by climate change impacts and sea level rise are often disadvantaged, equity and environmental justice is critical to both the process and the outcome. The City will establish a project team to guide the development of the adaptation plan and will coordinate with local, county, state, regional and federal agencies with bay and shoreline oversight, major property owners, and owners of critical infrastructure and facilities in the preparation of the plan. The project team may include, among others, representatives from City staff, the County of Marin, local agencies, nonprofits, environmental organizations, and neighborhood groups.

The City will also utilize best practices to achieve meaningful engagement with disadvantaged communities. Partnering with community organizations will facilitate engagement. Communication materials will be prepared in multiple languages, and meetings will provide translation services. Community workshops will be held in public venues that are easily accessible and scheduled when community members are most likely to attend.

**Phase 2, Assess Vulnerability:** This phase includes analysis of potential impacts and adaptive capacity to determine the vulnerability for populations, natural resources, and community assets. The vulnerability assessment identifies how climate change could affect the community.

As discussed in Section B.5 of this report, the County of Marin developed the [BayWAVE Marin Shoreline Sea Level Rise Vulnerability Assessment](#) in 2017. The City will use this vulnerability assessment for sea level rise planning and adaptation, utilizing the same sea level rise model and scenarios as well as the General Plan's sea level rise projection map. The City will use the [San Rafael Local Hazard Mitigation Plan](#) as the foundation for a vulnerability assessment that addresses other climate change impacts,



including wildfire, extreme heat events, drought, and severe storm events. The Cal-Adapt tool will be used to identify and project climate change impacts, and the project team will determine how these impacts will affect vulnerable populations and assets, including existing development (private and public), utilities and infrastructure, the transportation network, and natural resources.

**Phase 3, Define Adaptation Framework and Strategies:** This phase focuses on creating an adaptation framework and developing adaptation strategies based on the results of the vulnerability assessment. The adaptation strategies are the community’s response to the vulnerability assessment—that is, how the community will address the potential for harm identified in the vulnerability assessment, given the community’s resources, goals, values, needs, and regional context.

San Rafael’s adaption plan will identify specific adaptation strategies for each climate change impact. Sea level rise adaptation measures will draw on and incorporate the resources and strategies that are referenced in this report, including the recommendation presented in the San Rafael Sea Level Rise Adaptation Study and the [Adaptation Land Use Planning: Guidance for Marin County Local Governments](#). As identified in General Plan Safety Element Program S-3.6A, sea level rise strategies will include, but not be limited to, the following:

- Managed retreat, especially on low-lying, undeveloped, and underdeveloped sites; in areas that are permanent open space; and in areas that are environmentally constrained. Transfer of development rights from such areas should be encouraged.
- Innovative green shoreline protection and nature-based adaptation measures such as wetlands and habitat restoration, and horizontal levees where most practical and feasible.
- Hard line armoring measures (sea walls, levees, breakwater, locks, etc.) in densely developed areas to minimize the potential for displacement of permanent residents and businesses.
- Elevating areas, structures, and infrastructure to reduce risks.

The plan will also include an inventory of potential areas and sites suitable for mid- to large-scale adaptation projects.

**Phase 4, Implement, Monitor, Evaluate, and Adjust:** In this phase, the adaptation framework is implemented, consistently monitored, and evaluated, and adjusted based on continual learning, feedback, and/or triggers.

In order to guide implementation, the adaptation plan will identify the responsible department and the timing and phasing of each measure. The plan will also include a discussion of potential financing tools and opportunities, drawing on the information and resources presented in this report.

## G. LOCAL ADAPTATION PROJECTS IN PROCESS

The following section describes adaptation projects that have been completed, or are in process, in the San Rafael planning area. The project locations are shown on Figure 3.

### 1. Tiscornia Marsh & Pickleweed Park Diked Marsh

*Marin Audubon Society/City of San Rafael (2016)*

The Tiscornia Marsh & Pickleweed Park Dike Marsh project will prepare technical studies, refine designs, and conduct CEQA review and public outreach for marsh restoration and sea level rise adaptation actions at Tiscornia Marsh, which are expected to expand marsh habitat, increase flood protection, and provide public access at the mouth of the San Rafael Canal in Marin County.

The planning project is expected to evaluate feasibility and environmental effects of various potential improvements including:

- Expanding the existing marsh (up to 10 acres) through placement of beneficially reused dredged material;
- Restoring the six-acre diked marsh to tidal action;
- Constructing a new setback levee on the City's property;
- Improving an additional 2,000 feet of the existing levee by raising it and incorporating an ecotone slope;
- Creating a coarse beach along the eastern marsh boundary to protect against marsh erosion and trap sediments;
- Creating a living seawall/rock jetty along the north marsh boundary in response to boat wake in the San Rafael Canal;
- Constructing a segment of the Bay Trail on the new setback levee; and
- Providing additional recreation amenities, which may include interpretive signage, benches, picnic tables, and a bicycle rack.

### 2. San Rafael Bay Oyster Bed/Eelgrass Pilot Project

*California State Coastal Conservancy (2012-2017)*

Beginning in 2012, the California State Coastal Conservancy advanced its San Francisco Bay restoration efforts with a project to analyze subtidal restoration techniques and restore critical eelgrass and oyster habitat, while learning more about the potential physical benefits of biological reefs along the shoreline. A pilot project was conducted in two locations: in San Rafael Bay and along the Hayward shoreline.

Eelgrass is a foundation species that supports diverse communities of invertebrates, fishes, and waterfowl. Native oysters form beds that increase living space for many other species, thus promoting

diversity and providing food for fishes and other invertebrates. Historically, both eelgrass and native oysters were abundant along the West Coast, but human activities have greatly reduced their numbers.

The project tested planting and placement of eelgrass units with various oyster substrate units to compare growth rates, densities, and recruitment. The San Rafael site was completed in summer 2012 and monitoring conducted through December 2017. During that period, more than four million native oysters settled at the San Rafael site at the height of recruitment, as well as more than 10 taxa and dozens of species of plants (seaweeds), invertebrates, fish, and birds. Eelgrass plantings were successful and expanded up to 300% during certain time periods, but both eelgrass and oysters were subject to impacts from periods of freshwater, and the researchers documented loss of both species during the major atmospheric river event in winter 2016-17. Native oysters were recruiting at the San Rafael site again as of Fall 2017. The reefs also provided an increase of 30% in wave attenuation during mean tide levels.

Findings from the pilot project have been used to inform subsequent projects. Most recently, the Coastal Conservancy funded a project to install 350 reef structures at Giant Marsh in North Richmond. The project integrates oyster shell mounds and eel grass beds in the sub-tidal area and restores the tidal marsh with native plants. The approach connects habitats and supports species through various life stages.

### **3. McInnis Marsh Restoration Project**

*County of Marin (2019)*

The McInnis Marsh project proposes to restore subtidal and intertidal habitat at a 180-acre area of diked wetlands within McInnis Park. It is designed to protect park and sanitary district facilities, as well as important ecosystems that support special status systems.

The project includes replacing a non-engineered levee system, which dates to the early 1900s, with a new environmentally-friendly levee closer to the County-owned McInnis Golf Course the adjacent Las Gallinas Valley Sanitary District water treatment plant, allowing the bay to reclaim historic tidelands.

The project entails intentional breaches of Gallinas and Miller creeks to allow water flow into the marsh at low tide. The new gentle sloping levee design would not only protect the park and the water treatment plant but combine ecological function with more modern and effective flood control. With a design that incorporates vegetation to mimic the natural shoreline, the levee will improve habitats for threatened and endangered species such as Ridgway's rail, the California black rail, the saltmarsh harvest mouse, and the steelhead trout.

The project will also construct a trail on top of the new levee that will be more accessible for hikers of all ages and physical abilities. The new trail will connect to nature trails on sanitary district land and would be part of the San Francisco Bay Trail, a planned 500-mile walking and cycling path that runs through all nine Bay Area counties.

*Link*

McInnis Marsh Restoration Project

<https://www.marincountyparks.org/projectsplans/land-and-habitat-restoration/marsh-restoration-mcinnis-park>

#### **4. China Camp State Park Road Project**

*County of Marin (2019)*

North San Pedro Road runs along the shoreline of China Camp State Park in San Rafael. It is an important transportation corridor, serving as the only entry point to China Camp state park, an alternate route for commuters during heavy traffic, and a critical evacuation route for local communities. However, the road crosses the landmark historic tidal marsh and routinely floods during king tides and winter storms.

A community stakeholder process conducted in 2018-2019 formulated adaptation goals for the project and identified and evaluated road reconfiguration options. Project goals included maintaining the functionality of and access to China Camp recreational resources; protecting and enhancing natural resources, especially marsh habitats; maintain the roadway for commuting, evacuation, and emergency response; and providing a road corridor that function in the medium term (to 2050) and 3 feet of sea level rise, and to the extent practical, to the longer term (approx.. 2100) and seven feet of sea level rise.

Adaptation alternatives included raising the road in place, rerouting the roadway, and maintaining or slightly improving the existing roadway. Project staff created a scoring system and an alternative evaluation matrix to facilitate evaluation of nine project alternatives. The following five alternatives were selected for future feasibility assessment:

1. Raise road on current alignment via solid fill and improve marsh hydrology
2. Raise road on current alignment via pile-supported modular causeway
3. Reroute road on the “low road” alternative around Back Ranch and/or Miwok Meadows
4. Retain current road and improve marsh hydrology
5. Maintain the status quo

*Link*

Options and Qualitative Evaluation Report (October 2019)

[http://www.nerrsciencecollaborative.org/media/resources/Alternatives%20Options%20Report\\_CC%20Road\\_Final\\_Nov%202019.pdf](http://www.nerrsciencecollaborative.org/media/resources/Alternatives%20Options%20Report_CC%20Road_Final_Nov%202019.pdf)

#### **5. Santa Venetia Levee Upgrade Project**

*County of Marin (2019)*

The Santa Venetia levee project is a timber-reinforced berm improvement project design to protect Santa Venetia from 100-year floods, as well as reduce related maintenance costs. The project will replace the existing timber-reinforced berm with a new berm that is one to two feet taller and made of

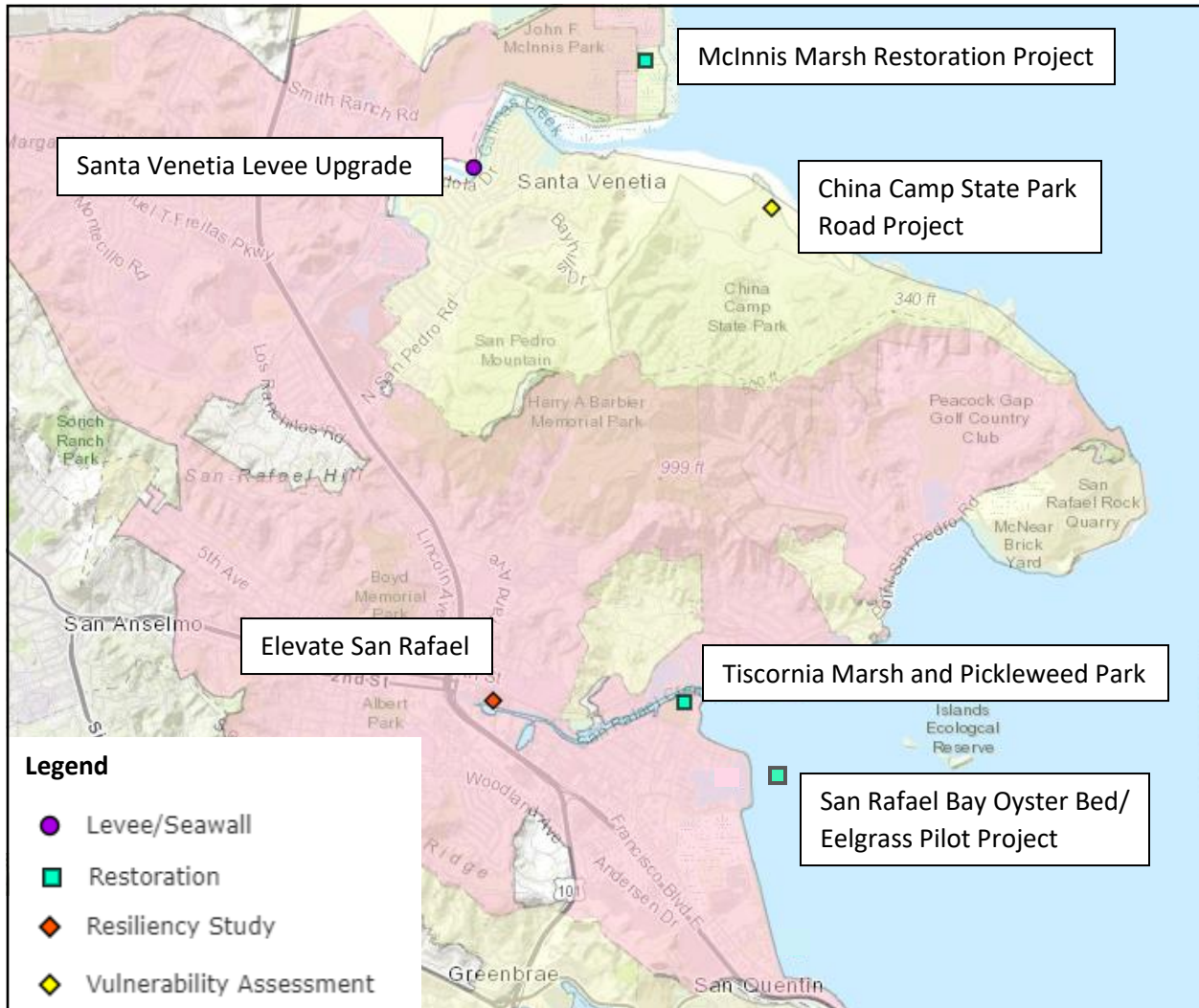
a durable wood composite material that will not require replacement until approximately 2050. The location of the improved berm will be roughly the same footprint as the existing berm. However, in some locations where there is not an existing berm, it will be built on top of the existing levee.

Santa Venetia is vulnerable to both sea level rise and subsidence. The Federal Emergency Management Agency's (FEMA) latest model in March 2016 raised the 100- year tidal flooding elevation nearly one foot in Santa Venetia. A 2016 elevation settlement survey showed that Santa Venetia and its levee system continues to slowly sink, and a 2013 geotechnical analysis predicted that the land would sink up to three to four inches every 10 years for the next several decades.

Link

<https://www.marinwatersheds.org/resources/projects/gallinas-levee-upgrade-project>

FIGURE 3: LOCATION OF LOCAL ADAPTATION PROJECTS



Adapted from the CHARG Sea Level Rise Resiliency Map, accessed 1/21/20

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