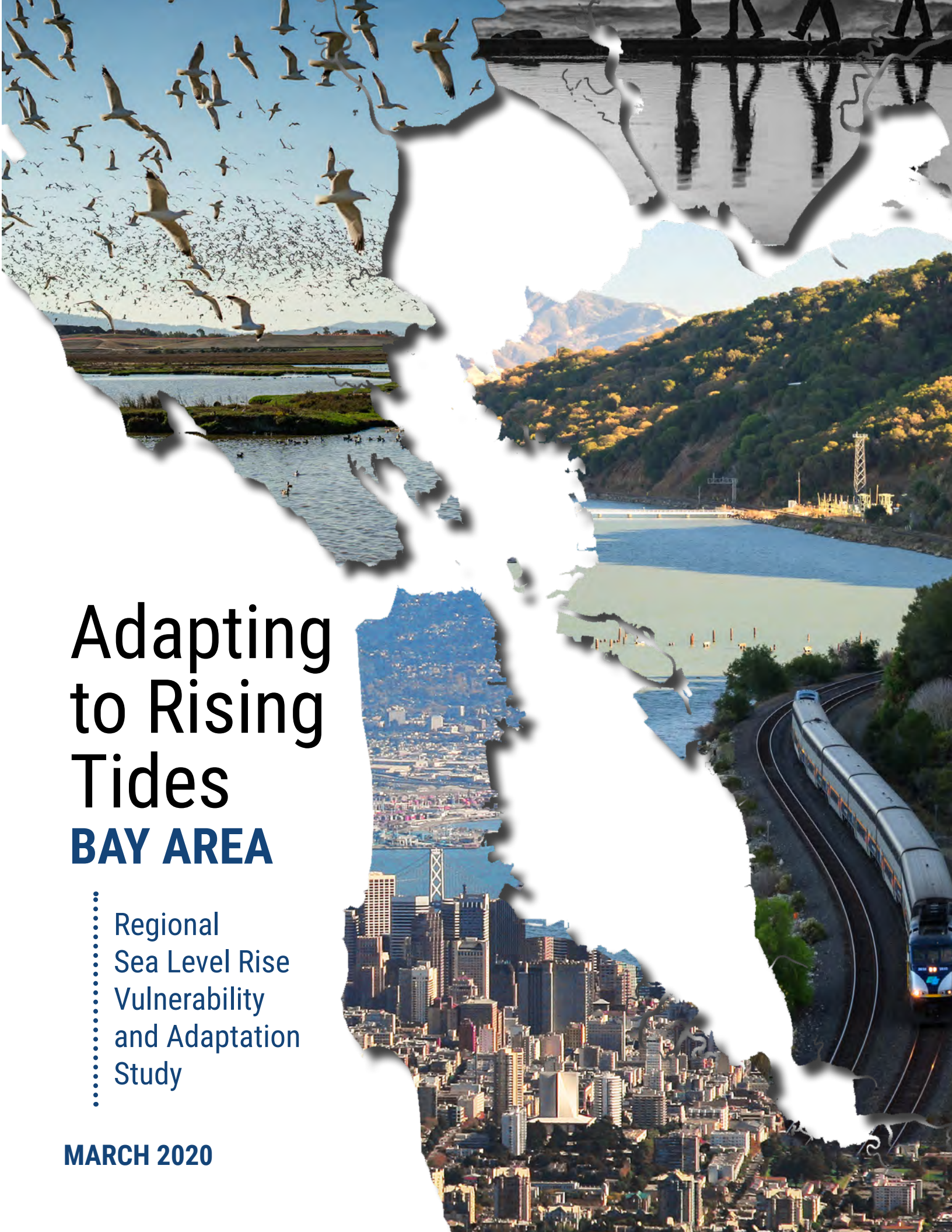

Adapting to Rising Tides

BAY AREA

Regional Sea Level Rise Vulnerability and Adaptation Study

MARCH 2020

Adapting to Rising Tides
BAY AREA

Regional Sea Level Rise Vulnerability and Adaptation Study

MARCH 2020

Prepared by Bay Conservation and Development Commission (BCDC)

In Partnership With California Department of Transportation (Caltrans), Metropolitan Transportation Commission/Association of Bay Area Governments (MTC/ABAG), and Bay Area Regional Collaborative (BARC)

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ACCESSIBILITY

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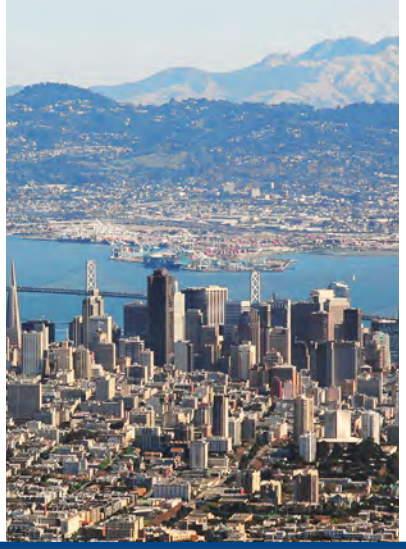


Adapting to Rising Tides BAY AREA

Regional Sea Level Rise Vulnerability and Adaptation Study

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Flooding at the San Francisco Embarcadero during King Tides in January 2020. King Tides are extreme high tides that show us what future sea level rise will look like. Photo courtesy of California King Tides Project.

A SHARED VISION FOR THE BAY

The Adapting to Rising Tides Bay Area (ART Bay Area) report presents a story of what consequences the Bay Area may face as sea levels rise in the absence of coordinated, prioritized adaptation. A product of a partnership between Caltrans District 4, the Metropolitan Transportation Commission/Association of Bay Area Governments (MTC/ABAG), Bay Area Regional Collaborative (BARC), the San Francisco Bay Conservation and Development Commission (BCDC) and many public, private, and nonprofit partners, this report represents a commitment by the agencies responsible to proactively managing the functionality and sustainability of our critical regional assets in an uncertain future. It also speaks directly to the Bay Area's most critical regional transportation and land use plan, Plan Bay Area 2050.

Flooding and rising sea level pose a risk everyone in the Bay Area, from local communities where homes and jobs may flood, to residents who rely on the regional-serving systems like transportation to connect us, keep our economy humming, and potentially play a role in mitigating the impacts of climate change down the line.

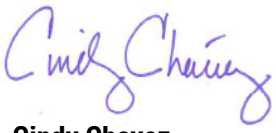
While the findings in this report may cause some alarm and concern, having this data at our fingertips gives us the information we need at the local, regional, state and federal levels to do what needs to be done to reduce the risks we face from flooding and rising sea level. In fact, while the vulnerability analyses in this report list many risks faced by the Bay Area from flooding and rising sea level, its underlining premise is that the severity of each of those risks can be avoided, and each of the challenges can be overcome, if we work together as a region to develop an ongoing adaptation strategy that embraces habitat, safeguards property, and protects people. In short, we can't let inaction or prejudice be our default, and we can't let perfect solutions be the enemy of workable and fair ones.

By wearing both our local and regional hats and taking the appropriate actions at each of those levels to reduce our risk, we can ensure that the entire Bay Area – its residents, its habitats, and its success – can prosper in the face of rising sea level. ART Bay Area lays out a blueprint for that future that involves all of our interests. Let's embrace it and make that future ours.

Zack Wasserman
Chair, Bay Conservation and Development Commission

Scott Haggerty
Chair, Metropolitan Transportation Commission

Tony Tavarez
Caltrans District 4 Director



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Chair, Bay Area Regional Collaborative

bcdc

METROPOLITAN TRANSPORTATION COMMISSION

Caltrans

Bay Area **Regional Collaborative**

CONTENTS

People enjoying the waterfront of the San Francisco Bay at Albany Bulb. Photo by Charlie Nguyen licensed CC BY 2.0.

*Various parts of this report are available in separate PDF downloads. Links to all downloads are available within this document.

Acronyms and Abbreviations

AADT	Average Annual Daily Traffic
AADTT	Average Annual Daily Truck Traffic
ABAG	Association of Bay Area Governments
AC Transit	Alameda County Transit
ACS	American Community Survey
APA	American Planning Association
ART	Adapting to Rising Tides
BAFPA	Bay Area Flood Protection Agency
BARC	Bay Area Regional Collaborative
BARHII	Bay Area Regional Health Inequities Initiative
BART	Bay Area Rapid Transit
BATA	Bay Area Toll Authority
BayCAN	Bay Area Climate Adaptation Network
BCDC	Bay Conservation and Development Commission
BNSF	Burlington Northern Santa Fe
BPAD	Bay Area Protected Areas Database
BRRIT	Bay Restoration Regulatory Integration Team
CA DTSC	California Department of Toxic Substances Control
CA DPH	California Department of Public Health
CA EPA	California Environmental Protection Agency
CalOES	California Office of Emergency Service
Caltrans	California Department of Transportation
CBO	Community Based Organization
CC/ACE	Capital Corridor/Altamont Corridor Express
CCC	California Coastal Commission
CDC	California Department of Conservation
CA DFW	California Department of Fish and Wildlife
CA DWR	California Department of Water Resources
CFNR	California Northern Railroad
CHARG	Coastal Hazards Adaptation Resiliency Group
CSP	California State Parks
CTA	County Transportation Authority
FEMA	Federal Emergency Management Agency
HCD	California Department of Housing and Community Development
HOA	High Opportunity Area
IRWMP	Integrated Regional Water Management Plan
MHHW	Mean Higher High Water
MTC	Metropolitan Transportation Commission

King Tides impact the Lucy Evans Baylands Nature Interpretive Center, Palo Alto. Photo courtesy of California Bay King Tides Project.

Muni	San Francisco Municipal Railway
NatCap	The Natural Capital Project
NERR	National Estuarine Research Reserve
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Association
NPS	National Park Service
NWP	Northwestern Pacific Railroad
OAK	Oakland International Airport
OBAG	One Bay Area Grant
OLU	Operational Landscape Unit
OMMF	One Map, Many Futures
OPC	Ocean Protection Council
PCA	Priority Conservation Area
PCJPB	Peninsula Corridor Joint Powers Board/Caltrain
PDA	Priority Development Area
PPA	Priority Production Area
RPRC	Richmond Pacific Railroad Company
RWG	Regional Working Group
RWQCB	Regional Water Quality Control Boards
SCC	State Coastal Conservancy
SCS	Sustainable Communities Strategy
SFBRA	San Francisco Bay Restoration Authority
SFEI	San Francisco Estuary Institute
SFEP	San Francisco Estuary Partnership
SFO	San Francisco International Airport
SJC	San Jose International Airport
SLR	Sea Level Rise
SMART	Sonoma Marin Area Rapid Transit
Soltrans	Solano County Transit
SR	State Route
TPA	Transit Priority Area
TWL	Total Water Level
UC ACE	United States Army Corps of Engineers
UPRR	Union Pacific Railroad
US EPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VTA	Santa Clara Valley Transportation Authority
WestCAT	Western Contra Costa County Transit

High winds during King Tides bring water from the Bay onto the Embarcadero in San Francisco. Photo courtesy of California King Tides Project.

EXECUTIVE SUMMARY

LAYING THE GROUNDWORK FOR INFORMED DECISION-MAKING

ART Bay Area is the first regional study to assess the impacts of rising sea level to four systems that are critical to the continued functioning and prosperity of communities in the Bay Area, designed to support and encourage regional collaboration for adaptation planning. By both looking at impacts that cut across the region and diving deep into certain localities, we illuminate broad, region-wide issues as well as ground-level complexities. We then offer a suite of potential actions to address these vulnerabilities through coordination and collaboration. The findings in this report will be critical to drive region-wide and local decision making as we prepare to respond to rising sea levels.

This report outlines the worst-case scenario for impacts and consequences to four critical regional systems – transportation networks, vulnerable communities, future growth areas, and natural lands – for ten different flooding scenarios in the absence of action.

The findings here represent potential impacts in the face of many uncertainties, including uncertainty about the exact timing of flooding, what assets may be along the shoreline in the future, and, most importantly, what actions we take to prevent flooding from sea level rise. The findings of ART Bay Area will be critical to drive region-wide and local decision making as we prepare to respond to rising sea levels. The findings are, like all projections, best guesses given current conditions and current data. See Chapter 1.0 Introduction for more background information.

THE REGIONAL PICTURE

What did ART Bay Area assess for impacts from flooding and rising sea level?

Regional analysis was conducted across four regional systems: transportation networks, vulnerable communities, future growth areas and natural lands (Figure i). Within each of these systems, a variety of categories were evaluated within (Figure ii).

In transportation network analysis, this includes highways and bridges, commuter and freight rail, airports and seaports, among others. For vulnerable communities, this includes block groups with social vulnerability and those with contamination burdens.

Future growth areas evaluates impacts within MTC/ABAG's Priority Development Area (PDA) framework, and those in PDA-eligible areas. Natural lands includes areas both within MTC/ABAG's Priority Conservation Area (PCA) framework as well as ecosystem services of natural lands outside the PCA network.

This data-driven quantitative assessment contains four major chapters on each regional system and provides a snapshot of regional consequences across ten flooding scenarios, from 12" (or 1 foot) above today's average high tide, through 108" (or 9 feet), an extreme sea level rise scenario.

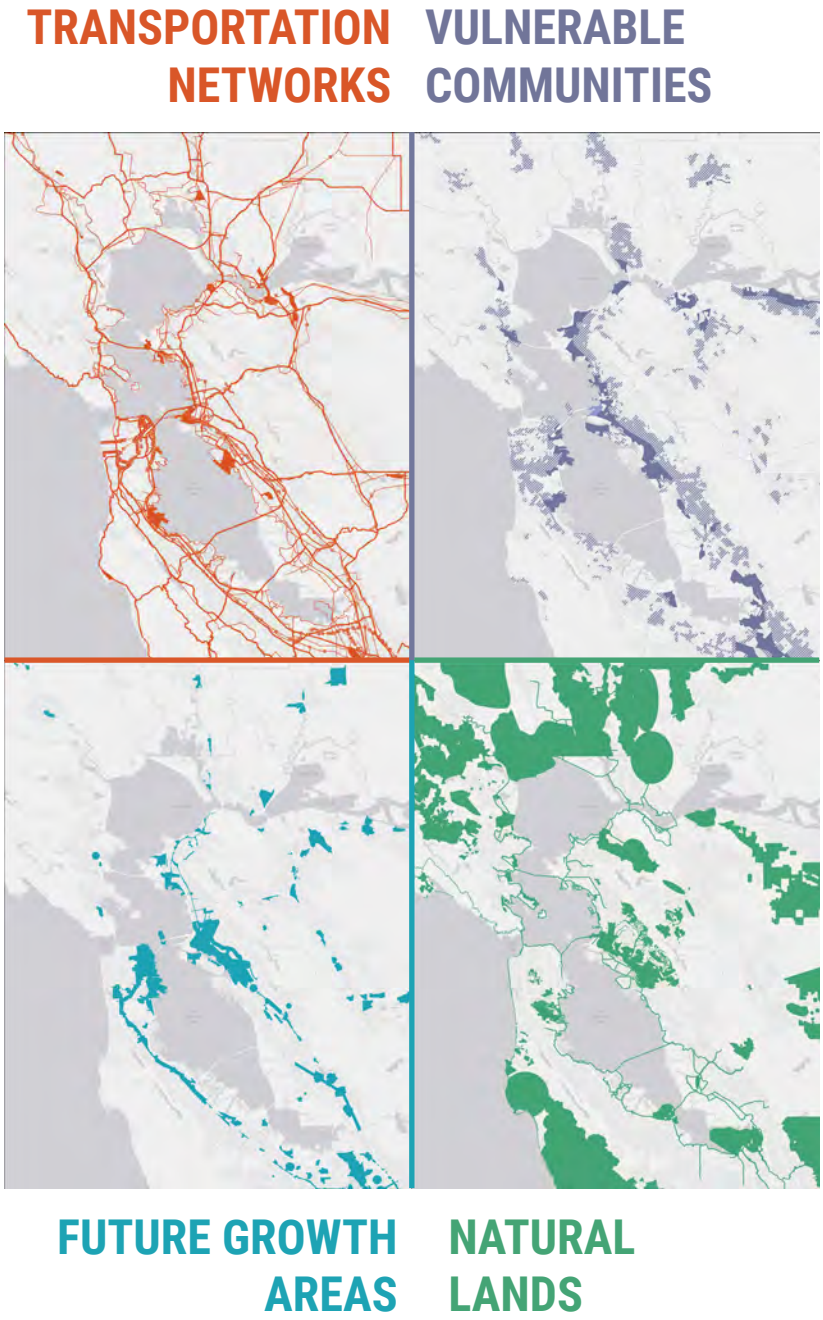


Figure i. Maps of the four regional systems assessed in ART Bay Area, including Transportation networks, Vulnerable Communities, Future Growth Areas and Natural Lands. For Future Growth Areas and Natural Lands, only existing Priority Development Areas (PDAs) and Priority Conservation Areas (PCAs) are shown, respectively.

TRANSPORTATION NETWORKS

- Highways and Bridges
- Commuter Rail
- Freight Rail
- Airports
- Seaports
- Ferries
- Buses
- Active Transportation

VULNERABLE COMMUNITIES

- Social Vulnerability Characteristics
- Contamination Burden

FUTURE GROWTH AREAS

- Existing Priority Development Areas (PDAs)
- PDA-Eligible Areas

NATURAL LANDS

- Priority Conservation Areas (PCAs)
- Bay Area Protected Areas Database
- Other Natural Lands (as classified by the National Land Cover Database)

Figure ii. Analyses across the four regional systems include exposure and consequence of flooding impacts. Bullets above refer to the various categories evaluated within each regional system. For each of the bullets, datasets were identified and used to provide a measure of consequence. A table of indicators of consequences can be found in Chapter 2.1 Regional Vulnerability: Shared Impacts Across Systems of the ART Bay Area report. Each system was assessed in depth and can be found in separate sections within Chapter 2.0 Regional Systems Assessment. These include 2.5 Transportation Networks, 2.6 Vulnerable Communities, 2.7 Future Growth Areas, and 2.8 Natural Lands. Photo credits above from left to right: Amtrak train along Martinez shoreline by Cadet Wilson CC BY 2.0; Silhouettes along the water by Thomas Hawk CC BY 2.0; San Francisco and East Bay by Jitze Couperus CC BY 2.0; Birds at Palo Alto Baylands Nature Preserve by Stanislav Sedov CC BY 2.0.

INDICATORS OF CONSEQUENCE

To what extent will our regional systems get wet, and which impacts will have the greatest consequences to the region?

In addition to evaluating the flooding exposure of assets within each of these systems, ART Bay Area conducted an analysis based on factors that pointed to "regional significance" – impacts that would create rippling consequences that would be felt throughout the region. These factors – called *indicators* – vary across each regional system but provide a measure of impact not captured by flood exposure alone.

Thirty-two indicators across the four systems give a measure of impacts, or consequences as they are referred to in this report, to people, the economy, and the environment that could happen as rising sea leads to shoreline flooding. For example, transportation indicators of consequence vary from the number of average daily vehicles that would no longer be able to use a segment of a highway to the number of billions of dollars of cargo that would not be able to leave or enter a seaport.

For vulnerable communities and future growth areas, residential housing units and jobs provide a measure of consequence, while for natural lands, endangered species habitat, stormwater services, recreation, carbon storage and other ecosystem services are used as indicators of consequences. See Chapter 2.1 Regional Vulnerability: Shared Impacts Across Systems for more on indicators.

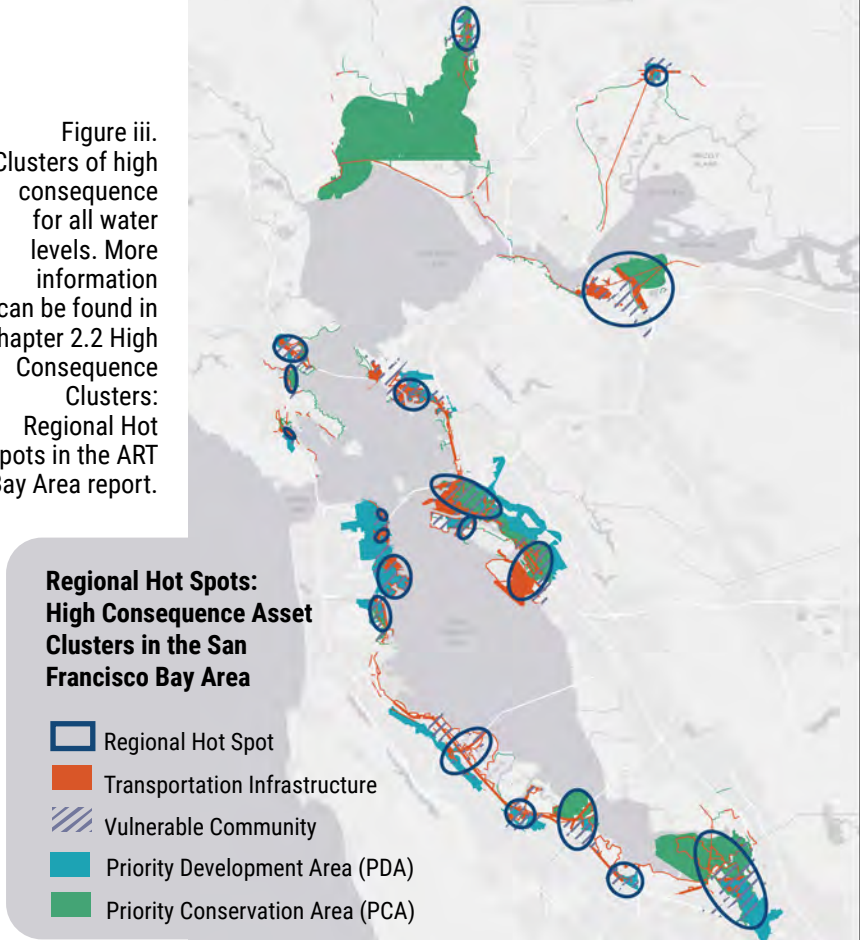


Figure iii. Clusters of high consequence for all water levels. More information can be found in Chapter 2.2 High Consequence Clusters: Regional Hot Spots in the ART Bay Area report.

REGIONAL HOT SPOTS

Where are consequences most severe, and where are these high-consequence assets clustered together?

Critical to effective adaptation planning is the identification of areas where many regionally significant assets from each of the regional systems are located – and flood – together. This study identified regional "hot spots" where high-consequence assets are clustered.

Because exposure and consequence changes as water levels rise, this analysis was conducted for all ten water levels. While the hot spots shifted around the region as water levels rose, many locations remained consistently critical over many water levels. These findings may serve as a tool for targeting areas with significant impacts to the region and areas ripe for coordinated adaptation planning at the local and regional level. See Chapter 2.2 High Consequence Clusters: Regional Hot Spots for more information.

Flooding from Redwood Creek impacts trails during King Tides in January 2020. Photo courtesy of California King Tides Project.

REGIONAL KEY PLANNING ISSUES

What are cross-cutting issues the region must come together to address as sea level rises?

In addition to the regional quantitative assesment, ART Bay Area conducted local assessments in thirty-two specific areas to dive deeper into the nuances of shared, interconnected vulnerabilities across the systems. These assessments culminated in thirteen local assessments and identification of eight regional key planning issues (found in Chapter 2.3 Common Vulnerability Themes: Regional Key Planning Issues):

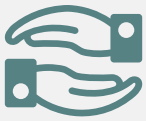
1. **Local and Regional Transportation Hubs Come Together and Flood Together**
2. **Sea Level Rise Decision-Making is Complicated by Ownership, Governance, Management, and Regulatory Issues**
3. **Interconnected Local and Regional Emergency and Critical Service Functions are at Risk**
4. **Contamination Complicates and Exacerbates Flooding Issues**
5. **Rising Sea Level will Amplify Existing Housing Displacement Concerns**
6. **Future Development Areas can be Critical Tools for Resilience**
7. **Rising Sea Level will Put Pressure on the Relationship Between Regional Recreation and Habitat**
8. **Nearshore Habitats and the Ecosystem Services they Provide are Sensitive to Sea Level Rise Early On**

LOCAL ASSESSMENTS INFORM THE REGION

Local assessments provide a link between local vulnerability and shared regional impacts. Shifting vulnerability towards *shared* stories elevates common stories throughout the region and highlights the interdependency amongst networks of regionally-critical systems. This increases the opportunity for shared solutions and helps move the region toward effectively tackling large problems through broader coordination and collective funding. Thirteen local assessments are available for individual download in Chapter 3.0 Local Assessments as part of ART Bay Area, covering thirty-two focus areas and areas of impact.

REGIONAL ADAPTATION RESPONSES

Over 80 adaptation responses were developed to address these eight regional planning issues (see Chapter 4.0 Regional Adaptation). Adapting to sea level rise in the Bay Area will require a multi-scale effort involving planning and policy changes, capacity-building, built projects, and financing within individual jurisdictions and across jurisdictional boundaries. Adaptation responses in the ART Bay Area study consist of more than just built projects, but include a variety of different risk reduction actions (Figure iii).



Capacity Building

Actions that increase the ability to solve problems and implement actions.

Plans and Policies

Actions to update, revise, or develop new local and regional plans, policies, and guidelines to address rising sea level.

Programs and Operations

Actions to include new or ongoing programs to improve procedures or management activities to address rising sea level.

Funding and Financing Mechanisms

Actions that identify funding mechanisms that can be used for planning and implementing strategies.

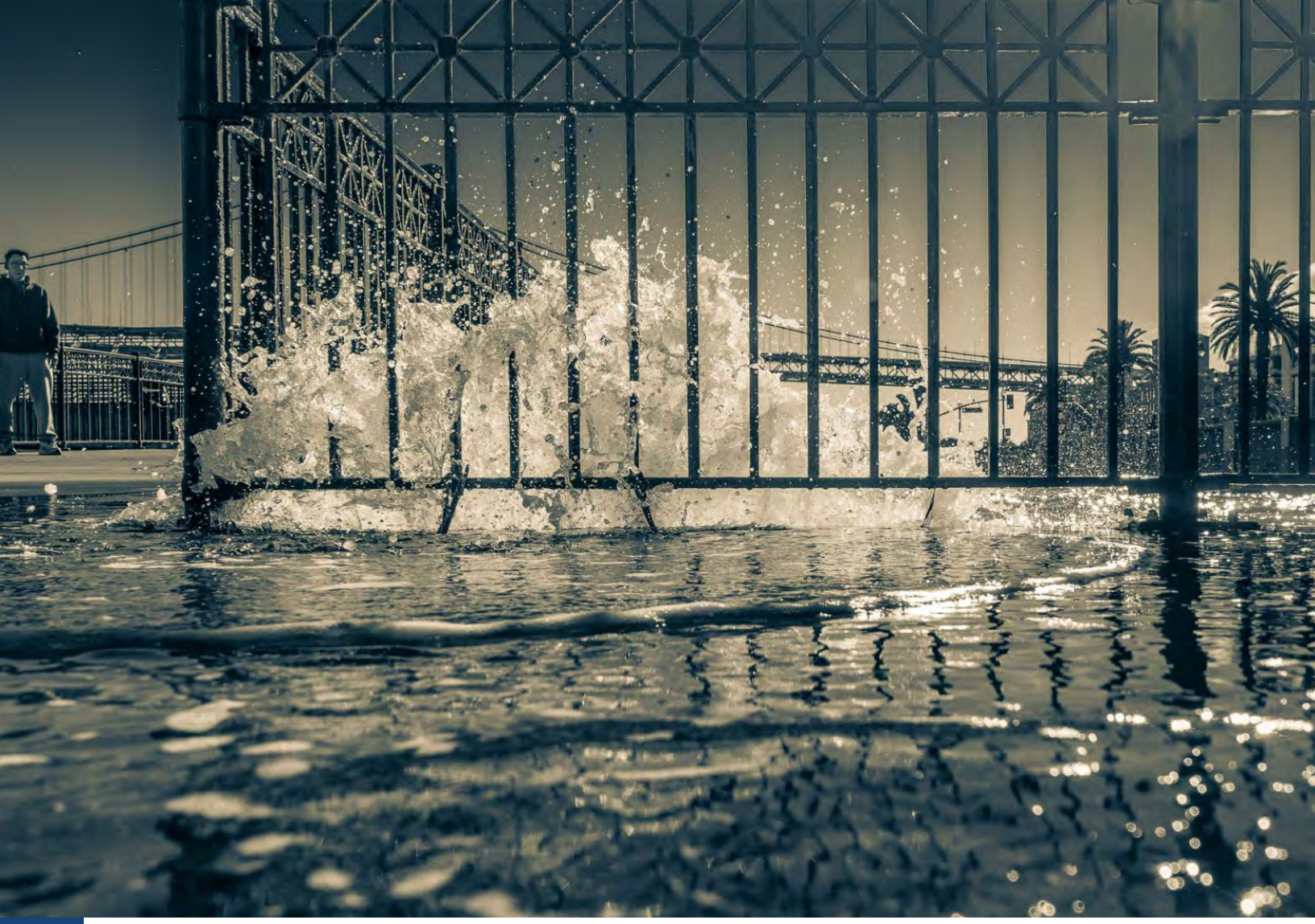
Build a Project

Actions that employ best available science to identify large-scale shoreline adaptation solutions that may be appropriate around the Bay.

LOOKING FORWARD

ART Bay Area provides an extensive and detailed foundation for future sea level rise planning in the Bay Area, with analyses that can be used by community members, staff and elected officials from cities and counties, regional agencies, and state agencies alike. Closing thoughts can be found in Chapter 5.0 Looking Forward. We are excited to share this knowledge and data to help inform more coordinated, collaborative, equitable, and environmentally sustainable adaptation responses to address our rising bay.

Figure iii. The ART Program views adaptation responses as more than just what can get built in the ground, it also includes other actions to prepare for climate impacts. Adaptation responses can be found in Chapter 4.0 Regional Adaptation in the ART Bay Area report.



View of the Embarcadero at Pier 14, San Francisco during a King Tide in 2019. Photo courtesy of California Bay King Tides Project.

Chapter 1.0

INTRODUCTION

1.1 Vulnerability Across the Region: Adapting to Rising Tides Bay Area

The San Francisco Bay Area is the fourth largest metropolitan area in the country, with a current population of 7.4 million people (as of 2014, as reported by the Department of Finance). The region, made up of nine counties (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma), is diverse in every way – the people, the economy, the environment. A significant proportion of the region's communities, job centers, and transportation infrastructure, among other critical assets, are located along the San Francisco Bay shoreline with some locations at risk of flooding today and others at risk of future flooding due to the changing climate.

While the region has been dealing with the current challenge of upgrading an aging transportation network, we are also now faced with infrastructure that was not designed to be resilient to changes in precipitation, temperature, and increased flooding due to rising sea levels. Given that the Bay Area's expansive and growing transportation network, open space networks, development areas, and populations are critical to the health, well-being, mobility, and long-term prosperity of Bay Area communities, it is essential the region clearly understands our shared vulnerabilities to flooding and sea level rise so that we can implement strategies necessary to make our communities and transportation infrastructure more resilient now and into the future.

ART Bay Area is the first ever region-wide, cross-sector, asset-based analysis of vulnerability of the bay shoreline to sea level rise.

San Francisco Bay Area. Photo courtesy of NASA satellite imagery.

The Bay Area is no stranger to disasters, having weathered multiple damaging earthquakes on the Hayward and San Andreas faults, and, more recently, devastating wildfires in the North Bay that flattened entire communities. Smaller earthquakes, floods, and fires disrupt daily life on a regular basis, reminding us all of the daily coexistence of nature and our built environment and systems.

Rising sea level is unlike any disaster we have seen before. As opposed to temporary flooding from King Tides or storms, the encroachment of the bay onto our shoreline will be permanent, widespread, and constantly worsening. Without proactive action, widespread consequences will be felt throughout our transportation system, utilities, housing markets, ecosystems and recreation spaces, economy, and, most critically, the region's residents, especially the most vulnerable residents. Sea level rise impacts could reduce the competitiveness of the region in terms of jobs, production of resources, tourism, and attracting and maintaining residents. Many residents could experience a significant decline in their quality of life, while others with means may retreat to higher and drier locations, further exacerbating inequality.

Adapting to Rising Tides (ART) Bay Area is the first ever region-wide, cross-sector, asset-based vulnerability analysis of the bay shoreline to sea level rise. The product of a multi-agency collaboration, the project illuminates shared vulnerability to sea level rise across regional systems that Bay Area residents depend on to live and thrive.

BUILDING ON A HISTORY OF REGIONAL COLLABORATION

ART Bay Area was developed to build upon several years of collaboration between the Metropolitan Transportation Commission/Association of Bay Area Governments (MTC/ABAG), Bay Area Regional Collaborative (BARC), and the Bay Conservation and Development Commission (BCDC) around the topic of climate adaptation. Each agency saw the need for region-wide understanding of vulnerability to sea level rise to underpin collaborative, large-scale, coordinated responses to risks that impact the region. The project was supported by a Caltrans Sustainable Transportation Planning Grant (Caltrans) and matching funds from the Bay Area Toll Authority (BATA).

MTC/ABAG, BARC, BCDC, and Caltrans District 4 have been working together over the last nine years through grants and partnerships with the National Oceanic and Atmospheric Administration, the Federal Highway Administration, the Federal Emergency Management Administration, and the Environmental Protection Agency. Much of this work has occurred through previous projects led by BCDC's Adapting to Rising Tides Program (ART), which has brought federal, state, regional, local and non-governmental organizations together to study how the region is vulnerable to current and future flooding in order to develop strategies to reduce these risks.

ART Bay Area was designed to deliver findings directly into the plans, policies, and funding tools that already dictate how the region grows, specifically Caltrans District 4's planning tools and MTC/ABAG's Plan Bay Area 2050, the region's long-range transportation and land use plan. These existing tools help institutionalize resilient planning decisions and link adaptation decision-making to tools that exist today. The project also deepens support for BCDC's climate change policies, which were added to the Bay Plan, BCDC's guiding policy document, in 2011.

Some of the collaborative partnerships involved in the Adapting to Rising Tides (ART) projects over the years include NOAA, FEMA, Caltrans, MTC/ABAG, and BARC, among others.

WHAT DOES THE ART BAY AREA REPORT DO?

ART Bay Area is intended to create a range of outcomes that help build capacity both locally and regionally to advance actions that improve the resilience of the Bay Area transportation system, promote sustainable, safe and healthy communities, and increase participation of socioeconomically vulnerable communities in both the fact finding and decision-making processes.

ART Bay Area Project Goals:

1. ***Conduct a robust, region-wide assessment of critical regional systems;***

2. ***Develop a suite of regionally-applicable adaptation responses*** that can be advanced at agency, local, regional, state, and federal scales;

3. ***Engage partners and stakeholders in an inclusive process*** where different ideas, values, knowledge sets are leveraged to ensure that findings and outcomes are being addressed at appropriate scales, with a focus on representation and engagement of vulnerable and disadvantaged communities;

4. ***Increase regional agreement on the tools, processes, models and data*** used in adaptation planning to build capacity among federal, state, and local agencies and organizations to work together towards multi-benefit, shared solutions.

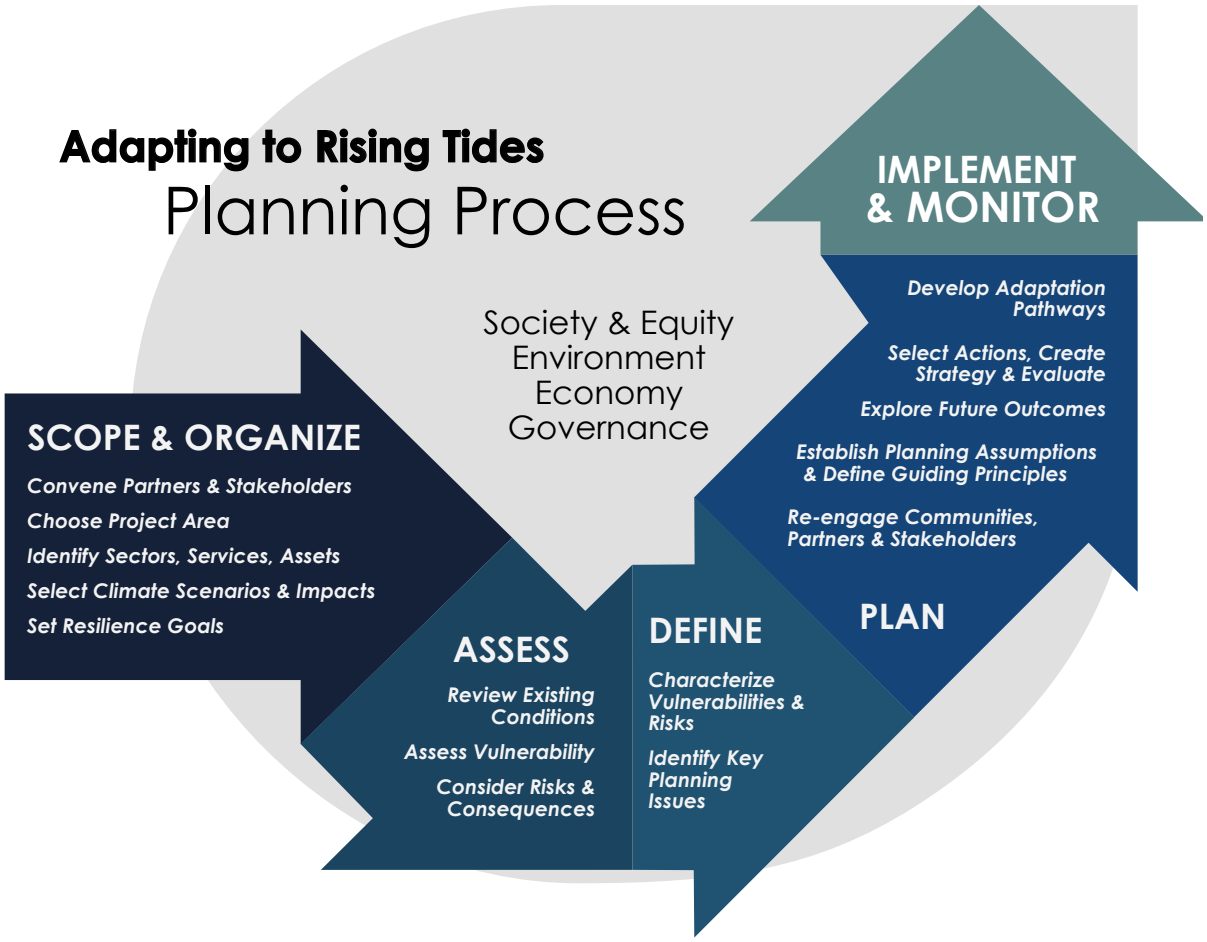


Figure 1-1. The Adapting to Rising Tides (ART) Approach provides in-depth guidance on the steps necessary to undertake a vulnerability and adaptation planning process.

ASSESSING VULNERABILITY THROUGHOUT THE REGION: PROJECT APPROACH

ART Bay Area follows the ART Approach, a five-step process to conduct vulnerability assessments and arrive at appropriate, specific adaptation responses (Figure 1-1). This process has been developed through numerous projects beginning in 2011 and tested in real-world applications across the San Francisco Bay Area. This process is described in more detail here: ***http://www.adaptingtorisingtides.org/howto/art-approach/.***

Due to the regional scale of ART Bay Area, the ART Approach was adapted to meet the needs of a larger scale project. In addition to assessing and conducting assessments on individual assets, ART Bay Area also conducted a regional scale assessment of vulnerability, which is described in greater detail in the following pages.

Step 1. Setting the Stage: Scope and Organize

Project Area

Previous ART projects have focused on local scale understanding of vulnerability, risk, and adaptive responses to these risks. These projects have identified how local scale vulnerability can:

- Create region-wide patterns that add up to greater vulnerability than what is apparent at a local level, elevating issues in importance that may not be elevated locally;
- Repeat in similar ways many places throughout the region, creating an opportunity for a common approach to both understanding and responding to vulnerability;
- Have ripple effects beyond the local scale both within and across regional systems and identifying some areas as especially regionally critical due to these ripple effects.

For these reasons, ART Bay Area looks at shoreline vulnerability across the entire nine county Bay Area, at a high level as well as a deeper level in a number of Focus Areas. Since the scale of this project was very large, the project scope was limited by the number of regional systems as well as the number of Focus Areas. The intent was to gather enough of an overall picture to identify patterns and trends, not to complete a comprehensive, region-wide vulnerability assessment.

For each of the four regional systems (Figure 1-2), the project extent included all of the assets within the region that were within the maximum mapped inundation area. For each of the Focus Areas, the project extent included all assets within the asset category that were within the maximum mapped inundation area of a specific location, with the occasional addition of nearby relevant assets, such as networked or dependent assets that would help create a comprehensive overall picture of vulnerability.

Figure 1-2. Four regional systems assessed in ART Bay Area.

Regional Working Group

As the project commenced, the ART team sought to apply the local process for stakeholder engagement at a regional scale. The Regional Working Group (RWG) was formed to provide critical technical expertise and strategic guidance to the process. Adaptation professionals, academics, community advocates, local planners, and elected officials from across the Bay were approached to participate in a series of twelve meetings over a 2.5-year time period.

In each meeting, RWG members were briefed on project progress and asked to give guidance on both big picture strategy and fine-grained details of the analysis. The ART team also shared presentations from partners across the region, including the Natural Capital Project, Metropolitan Transportation Commission/Association of Bay Area Governments, Bay Area Regional Health Inequities Initiative, San Francisco Estuary Institute, and AECOM.

In total, approximately 600 stakeholders attend the RWG meeting series. Stakeholders represented a wide range of perspectives, expertise, and sectors across the region. Representatives in cities and counties ranged across departments such as Planning, Public Works, Office of Sustainability, Environmental Services, Community Development, Public Health and Safety, Mosquito Abatement, and Flood Control. Figure 1-3 provides a list of organizations, agencies or groups who attended or registered for ART Bay Area Regional Working Groups. This list does not represent partners of the project, only those who participated in meetings.

Community Engagement

In the spring of 2018, the ART team also began working with the Bay Area Regional Health Inequities Initiative (BARHII), an organization that strives to engage marginalized populations and build community power toward achieving health equity. Because the ART team recognized a critical lack of capacity and funding for deep community engagement, especially within low income and communities of color, BARHII's expertise and capacity presented an opportunity for beneficial partnership.

Through projects in East Palo Alto and Contra Costa County, the ART team worked alongside BARHII to build relationships and trust toward critical input on the ART process. Community forums were held in partnership with BARHII and community groups in the region, and over 40 community members participated in community engagement meetings in East Palo Alto, Pittsburg and Antioch.

A white paper on Community Engagement in East Palo Alto will be available in summer 2020, including lessons learned and recommendations for improving community engagement for public agencies. Outcomes of the Antioch and Pittsburg engagement are available in the ART East Contra Costa Report, released in 2020.

Top: Stakeholders participating in the Regional Working Group. Photo by BCDC. Bottom: Community Engagement in East Palo Alto with Nuestra Casa. Photo by Roxana Franco.

ART Bay Area

Regional Working Group Members

Counties and Cities

Alameda County
- Alameda County Mosquito Abatement
- Alameda County Planning Department

City and County of San Francisco

Contra Costa County (CCC)
- CCC Mosquito & Vector Control District
- CCC Health Services, Hazardous Materials
- CCC Resources Conservation District

Marin County
- Marin County Community Development Agency
- Marin County Public Works

Napa County

San Mateo County (SMC)
- SMC Flood Resilience Program
- SMC Office of Sustainability
- SMC Mosquito & Vector Control District

Santa Clara County (SCC)
- SCC Office of Sustainability

Sonoma County
- Regional Climate Protection Authority

City of Benicia
City of Brisbane
City of Burlingame
City of Emeryville
City of Fremont
City of Hayward
City of Martinez
City of Mountain View
City of Newark
City of East Palo Alto
City of Palo Alto
City of San Leandro
City of Sunnyvale
City of Vallejo

State or Regional Agencies

Bay Conservation and Development Commission
Bay Area Regional Collaborative
CA Department of Fish and Game
California Department of Transportation
Delta Stewardship Council
Metropolitan Transportation Commission/ Association of Bay Area Governments (MTC-ABAG)
San Francisco Estuary Partnership
San Francisco Bay Regional Water Quality Control Board
State Coastal Conservancy

Federal Government Agencies

FEMA Region-IX
NASA Ames Research Center
National Estuarine Research Reserve
National Park Service
NOAA Office of Coastal Management
San Francisco Bay Don Edwards National Wildlife Sanctuary
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

Transportation Agencies, Ports, Airports and Other Special Districts

Alameda County Transportation Commission
Bay Area Rapid Transit (BART)
East Bay Regional Park District
Midpenisula Regional Open Space District
Port of Oakland
Port of San Francisco
SamTrans
San Francisco International Airport
San Francisquito Joint Powers Authority
San Francisco Metropolitan Transportation Agency
Sonoma County Transportation Authority

Figure 1-3. List of organizations, agencies, or groups that were involved in ART Bay Area by either attending or registering for one or more ART Bay Area Regional Working Group Meetings.

Community Based Organizations

Bay Area Health Inequities Initiative
Environmental Justice Coalition for Water
Nuestra Casa
Resilient Communities Initiative
Resilient Shore San Rafael
Shore Up Marin
World Institute on Disability

Environmental Groups

Baykeeper
Citizens Committee to Complete the Refuge
Committee for Green Foothill
Parks Conservancy
Point Blue Conservation Science
San Francisco Bay Bird Observatory
San Francisco Bay Wildlife Society
Sierra Club
Sonoma Land Trust
The Watershed Nursery

Public Utilities

East Bay Municipal Water District
Pacific Gas & Electric (PG&E)

Private Sector/Consultants

AECOM
Cargill Salt
Ducks Unlimited
ERG Consultants
ESA Consultants

Organizations/Associations

Bay Planning Coalition
The Bay Area Climate Adaptation Network (BayCAN)
Coastal Hazards Adaptation Resiliency Group (CHARG)
Marin Conservation League
San Francisco Joint Venture
San Francisco Estuary Institute
Silicon Valley Joint Venture

Universities/Research

San Francisco State University
Stanford University
University of California Berkeley
University of California Davis
University of California Los Angeles

Regional/Large-Scale Projects

Resilient by Design
South Bay Salt Ponds Restoration

Elected Officials

Residents

***Important Note:** The names listed under "Regional Working Group Members" reflects organizations, agencies or groups that either attended or registered for at least one ART Bay Area Regional Working Group Meeting. This list does not reflect partnerships among participants. This list may also not reflect every organization or group.*

Climate Impacts

ART Bay Area evaluated the following current and future flooding impacts influenced by climate change:

- **Areas that currently flood or may flood more frequently.** Rising sea levels can lead to more frequent temporary flooding in existing flood-prone areas.
- **More extensive, longer-duration flooding in areas that currently flood and flooding of new areas.** As sea levels rise, there is the potential that storm events will flood larger areas for longer periods of time, including areas that flood now and areas that do not currently experience flooding.
- **Permanent inundation of areas currently not exposed to regular tides.** Sea level rise can cause areas that are not currently exposed to regular high tide inundation to be flooded on a daily basis, resulting in the need to either protect or move people and infrastructure, and the loss of shoreline recreation areas, agriculture spaces, and ecosystems.
- **Shoreline erosion and overtopping.** More extensive, longer duration flooding can cause shoreline protection, such as levees, berms and revetments, to be overtopped, damaged, or fail due to increased water levels and wave energy.

Linking with Best Available Climate Science

ART Bay Area looks to the latest climate models on global and local sea level projections for an understanding of the likely impacts on the region's natural and community assets and services. While the ART methodology is informed by these projections, the methodology is also designed to accommodate the uncertainty contained in the projections despite advances in sea level rise science and modeling. The California Ocean Protection Council (OPC) published their latest projections the 2018 report "*State of California Sea-Level Rise Guidance*". OPC explains that near-term uncertainty in the projections is due to the natural variability in the Earth's climate system, with uncertainty in the latter half of the century tied to differences in models and a range of scenarios for anthropogenic greenhouse gas emissions.[1]

ART Bay Area also includes the extreme scenario of rapid Antarctic ice sheet mass loss, identified in the OPC guidance as the 'H++' or 'extreme risk aversion' scenario, by identifying the area exposed under the corresponding water level (Mean Higher High Water, or MHHW + 120") on project maps. This enables consideration of this extreme scenario in the assessment and adaptation phases of the project. Table 1-1 illustrates how the ART Total Water Levels (TWLs) correspond to OPC's 2018 sea level rise projections. See page 1-26 for more information on Total Water Levels.

Table 1-1. The table compares the California State Guidance from the Ocean Protection Council (2018) to the Total Water Levels (TWLs) used in the ART Flood Mapping data to understand how our project water levels may relate to time horizons for sea level rise. *The three categories of risk are described in greater detail in the OPC guidance and refer to probabilities of occurrence. The extreme risk scenario, however, does not have a probability associated with it. **Refers to values that do not have a corresponding ART total water level.

COMPARING CALIFORNIA STATE GUIDANCE ON SEA LEVEL RISE TO ART TOTAL WATER LEVELS

			Likely Range*	1-200 Chance*	Extreme Risk*
2030	**State Guidance (High Emissions)**		**6"**	**9.6"**	**12"**
	ART Maps Equivalent	***MHHW+***	********	***12"***	***12"***
	Sea Level Rise + 5-Year Storm	MHHW+	**	36"	36"
	Sea Level Rise + 50-Year Storm	MHHW+	**	48"	48"
	Sea Level Rise + 100-Year Storm	MHHW+	48"	52"	52"
2040	**State Guidance (High Emissions)**		**9.6"**	**15.6"**	**21.6**
	ART Maps Equivalent	***MHHW+***	***12"***	********	***24"***
	Sea Level Rise + 5-Year Storm	MHHW+	36"	36"	48"
	Sea Level Rise + 50-Year Storm	MHHW+	48"	52"	**
	Sea Level Rise + 100-Year Storm	MHHW+	52"	**	66"
2050	**State Guidance (High Emissions)**		**13.2"**	**22.8**	**32.4**
	ART Maps Equivalent	***MHHW+***	***12"***	***24"***	***36"***
	Sea Level Rise + 5-Year Storm	MHHW+	36"	48"	**
	Sea Level Rise + 50-Year Storm	MHHW+	48"	**	**
	Sea Level Rise + 100-Year Storm	MHHW+	52"	66"	77"
2060	**State Guidance (High Emissions)**		**18"**	**31.2"**	**46.8"**
	ART Maps Equivalent	***MHHW+***	********	********	***48"***
	Sea Level Rise + 5-Year Storm	MHHW+	**	52"	**
	Sea Level Rise + 50-Year Storm	MHHW+	52"	66"	84"
	Sea Level Rise + 100-Year Storm	MHHW+	**	**	**
2070	**State Guidance (High Emissions)**		**22.8"**	**42"**	**62.4"**
	ART Maps Equivalent	***MHHW+***	***24"***	********	***66"***
	Sea Level Rise + 5-Year Storm	MHHW+	48"	66"	84"
	Sea Level Rise + 50-Year Storm	MHHW+	**	77"	96"
	Sea Level Rise + 100-Year Storm	MHHW+	66"	84"	108"
2100	**State Guidance (High Emissions)**		**40.8"**	**82.8"**	**122.4"**
	ART Maps Equivalent	***MHHW+***	********	***84"***	********
	Sea Level Rise + 5-Year Storm	MHHW+	66"	108"	**
	Sea Level Rise + 50-Year Storm	MHHW+	77"	**	**
	Sea Level Rise + 100-Year Storm	MHHW+	84"	**	**

Regional Systems and Assets

Past ART projects that assess vulnerability and consequences and develop adaptation responses have occurred at smaller scale than ART Bay Area, ranging from a focused project area to the entire Alameda County shoreline. These projects are comprehensive and thorough in scope and designed to lead the audience directly to local adaptation projects. However, to scale the project to the nine county Bay Area and more easily integrate into relevant regional transportation and land use planning processes, the ART Bay Area scope was simultaneously streamlined to focus on critical regional systems most relevant to the targeted tools previously identified, and expanded to look at these systems at multiple scales.

Four regional systems were assessed in ART Bay Area (Figure 1-4) including Transportation Networks, Vulnerable Communities, Future Growth Areas, and Natural Lands. Each of these systems contains a number of asset types as well as hundreds of individual assets.

TRANSPORTATION NETWORKS

- Highways and Bridges
- Commuter Rail
- Freight Rail
- Airports
- Seaports
- Ferries
- Buses
- Active Transportation

VULNERABLE COMMUNITIES

- Social Vulnerability Characteristics
- Contamination Burdens

Analyses of exposure and consequences to flooding from sea level rise and storms were conducted within each of the four regional systems and across the interconnected systems, the results of which are discussed throughout this report.

For each of the four systems, this report dives into the details of both system-wide quantitatively driven analysis and qualitatively driven assessments on a subset of assets within each of the systems. Each of the four regional systems have a corresponding color and icon used throughout the report to help with navigation of the document: Transportation (orange), Vulnerable Communities (Purple), Future Growth Areas (blue), and Natural Lands (green).

Figure 1-4. The four regional systems assessed in ART Bay Area are shown, including lists of asset types within each of the four systems evaluated in this project.

Photos, starting from left on page 1-14 to 1-15: Amtrak train along Martinez shoreline by Cadet Wilson CC BY 2.0; Silhouettes along the water by Thomas Hawk CC BY 2.0; San Francisco and East Bay by Jitze Couperus CC BY 2.0; Birds at Palo Alto Baylands Nature Preserve by Stanislav Sedov CC BY 2.0.

Figure 1-5. The ART Program uses four Frames of Sustainability in which to consider project Resilience Goals.

Project Resilience Goals

Regional Resilience Goals guide the process and outcomes of the ART Bay Area analysis and development of adaptation strategies. Designed to act as both goal post and aspiration, the Resilience Goals project a broad vision for the future. Resilience Goals are organized by the four ART Frames of Sustainability, as illustrated in Figure 1-5.

Although this project is regional in scope and scale, the resilience of the region depends upon the resilience of local communities. Because of the interdependence of the regional and local scales, the following Resilience Goals reflect issues at both scales and are intended to be used in a way that acknowledge the similarities and differences among the region's local communities and the importance of the scales.

GOVERNANCE

- Build capacity in local governments to lead work in collaboration with local and regional Bay Area communities, agencies, non-governmental organizations, and private entities to build regional resilience by facilitating and funding innovative participation throughout climate adaptation processes. This broad and ongoing participation should focus on the inclusion of diverse stakeholders (e.g. income, ethnicity, age, etc.) in the critical processes of scoping, framing, decision-making, program development, project implementation, and integration with parallel community planning efforts to ensure participation impacts outcomes.
- Improve or create governance structures to build a shared set of priorities based on creating consensus around appropriate and distinct areas of responsibility, funding mechanisms, accountability measures, and opportunities to streamline permitting for regional, state, local, and district-scale jurisdictions.
- Build collaboration within the Bay Area by forming coalitions, collaboratives, district-scale organizations, and Joint Powers Authorities (JPAs) among

Households near San Leandro Bay during King Tides 2019. Photo courtesy of California Bay King Tides Project.

agencies, organizations, and communities to promote regional planning across jurisdictions that addresses issues such as flood management, environmental restoration and protection, infrastructure improvement, public access to the Bay, public health, displacement, and affordable housing.

SOCIETY AND EQUITY

- Protect and improve all Bay Area communities', and particularly vulnerable communities', ability to access services, affordable and safe housing for all income levels, a healthy environment, diverse jobs, transportation, recreation, education, information, and opportunities for advancement, while avoiding displacement whenever possible and creating structures for equitable relocation when necessary.
- Prioritize the empowerment of vulnerable communities subjected to disproportionate environmental and socioeconomic burdens to lead efforts to improve resilience in their communities through development of community leaders, community engagement, funding mechanisms, and education forums.
- Build on existing community strengths and social capital to increase political power, access to funding, and control in inclusive decision-making processes.

ECONOMY

- Support vibrant, self-sufficient local and regional economies that are designed to be resilient to changing environmental conditions, are supportive of small and large businesses, provide living wage jobs, tax revenues to cities and counties, protect public health, and provide access to affordable housing for all income levels, goods, infrastructure, and social services.
- Focus on enhancing the function of regional job centers and job training, recreation and tourism sectors, ecosystem services, transportation networks, and infrastructure and concentrates new development in more resilient areas.

Wetlands and development near Highway 37. Map data ©2019 by Google Earth Pro.

- Maintain robust local and regional linkages in a multi-modal transportation network to deliver people, goods, and services throughout the cities, counties, region, nation, and globe, while achieving greenhouse gas reduction targets and encouraging development in more resilient areas.

ENVIRONMENT

- Promote the long-term vitality and biodiversity of natural areas, including habitat for native and endangered species, wetlands, creeks, headwater ecosystems, wetland-upland transition zones, streams, upland ecosystems, subtidal habitat, habitat migration space, and working lands, through protection and restoration of complete systems, sediment management, and other aligned actions that ensure natural areas remain resilient in a changing climate.
- Preserve, enhance, and restore healthy and vibrant ecological systems to provide multiple benefits to human and natural communities, including improved water quality and supply, flood risk management, cultural resources, carbon sequestration, and recreation.
- Mitigate environmental risks, such as contaminated lands and hazardous materials, while also supporting co-benefits, including improved air quality and emissions reductions, through development that reduces the effects of future climate change by supporting lower carbon intensity forms of transport and energy.

Step 2. What's at Stake? Assess

Analysis on regional systems was done quantitatively, revealing the magnitude of exposure and consequence for each of these systems and asset types. Spatial data of the location of the assets that compose each asset type and system was analyzed to determine if they were exposed to current and/or potential future flooding. Additionally, for each asset type, indicators of consequence were developed by the project team, consultants, and stakeholders (unique to that asset type) to measure magnitude of consequence for exposed areas. More information on this methodology, and results, can be found in Chapter 2, Regional Systems Assessment.

Additionally, individual assets within certain geographic areas were also assessed in a more in-depth manner, to reveal the specific asset vulnerabilities that lead to the vulnerability of the system as a whole, and also to identify shared vulnerabilities across systems due to co-location or interdependencies. This assessment was largely qualitative, using a questionnaire to better understand existing conditions, informational gaps, governance conditions, functional and dependency characteristics, and consequences of vulnerabilities to society and equity, environment, and economy. See Chapter 3, Local Assessments for more information.

A visual representation of how ART Bay Area conducted this assessment across regional and local scales is described in Figure 1-6.

ART Bay Area

Systems and Scales of Analysis

SYSTEMS

TRANSPORTATION NETWORKS

- Highways and Bridges
- Commuter Rail
- Freight Rail
- Airports
- Seaports
- Ferries
- Buses
- Active Transportation

VULNERABLE COMMUNITIES

- Social Vulnerability
- Contamination Burdens

FUTURE GROWTH AREAS

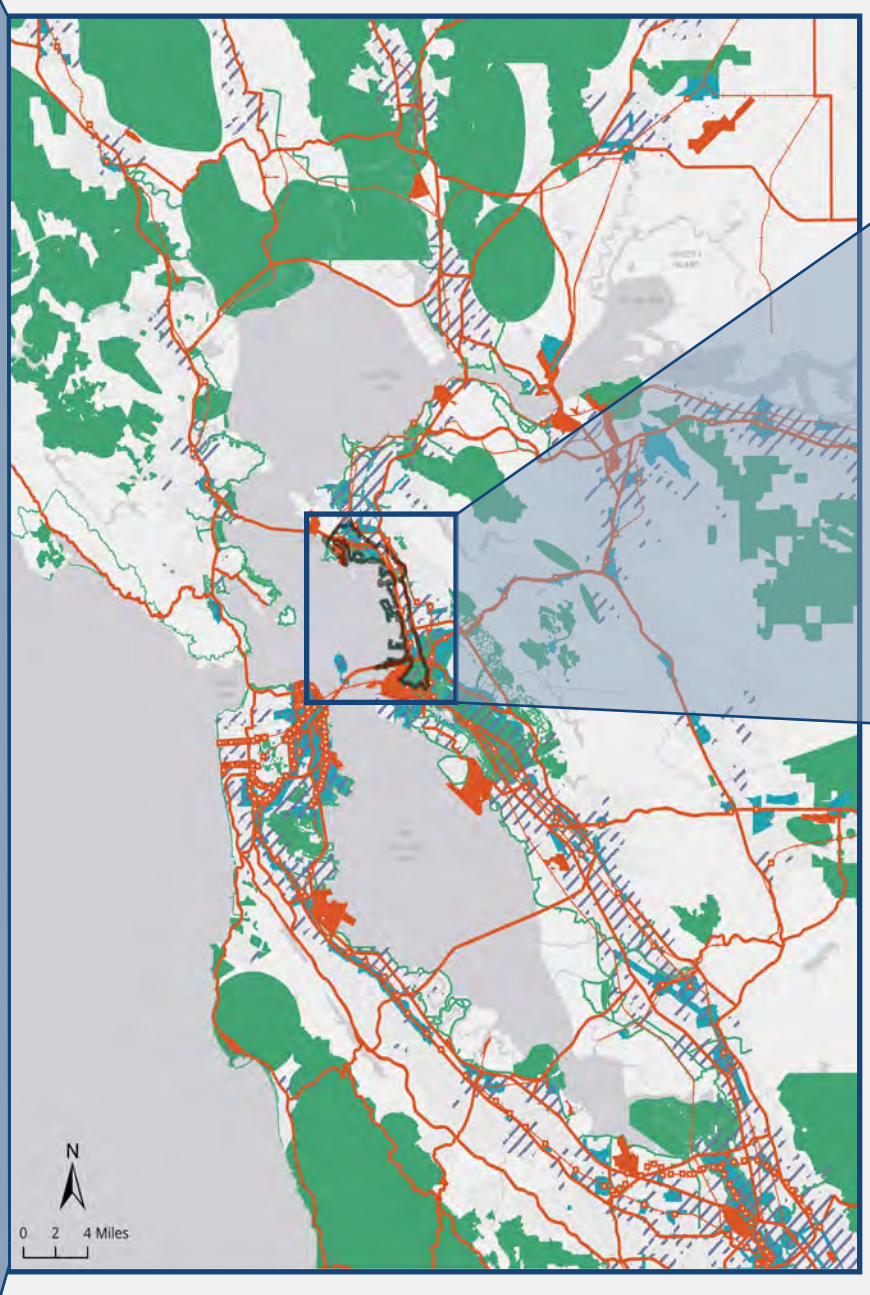
- Existing Priority Development Areas (PDAs)
- PDA-Eligible Areas

NATURAL LANDS

- Priority Conservation Areas (PCAs)
- Bay Area Protected Areas Database
- Other Natural Lands

SCALES

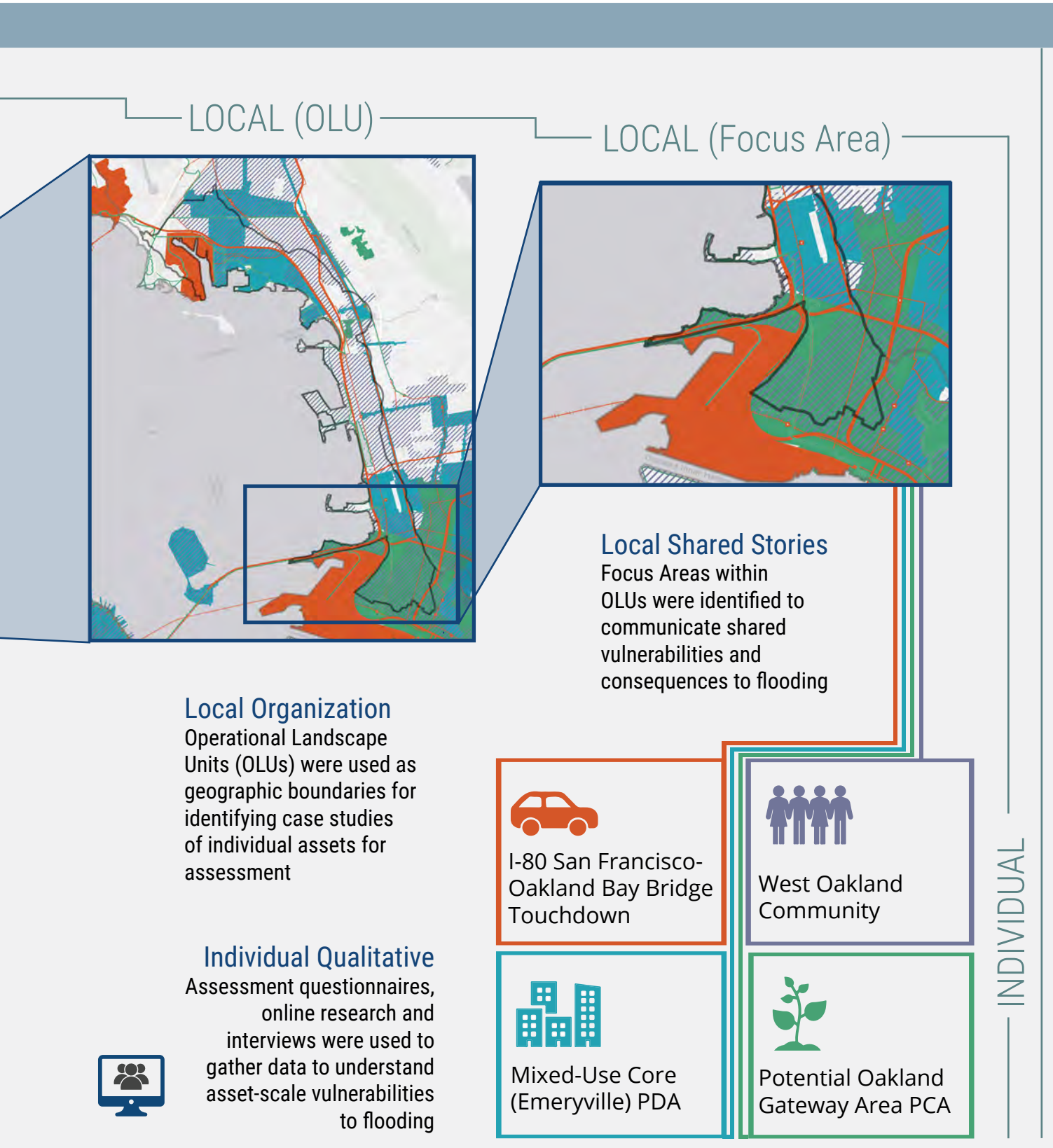
REGIONAL



ANALYSES METHODS

▲ **Regional Quantitative**
Regionally available data layers intersected with flooding maps

Figure 1-6. Diagram reflecting the different scales and methods of analysis for ART Bay Area. Quantitative analysis was conducted on the regional scale, while qualitative vulnerability assessments were conducted on individual assets and communicated through shared stories of vulnerabilities in local assessments at the Operational Landscape Unit (OLU) and Focus Area/Area of Impact scale.



Step 3. Pulling it All Together: Define

To better understand the vast quantities of qualitative and quantitative information coming out of the Assess step, findings were summarized within Focus Areas into Issue Statements and also summarized region-wide into eight Regional Key Planning Issues. Regional Key Planning Issues synthesize and summarize cross-cutting and priority issues emerging from the assessment. See Chapter 2, Regional Systems Assessment for more details on Regional Key Planning Issues. These issues include:

5. **Local and Regional Transportation Hubs Come Together and Flood Together**
6. **Sea Level Rise Decision-Making is Complicated by Ownership, Governance, Management and Regulatory Issues**
7. **Interconnected Local and Regional Emergency and Critical Services Are at Risk**
8. **Contamination Complicated and Exacerbates Flooding Issues**
9. **Rising Sea Level Will Amplify Existing Housing and Displacement Concerns**
10. **Future Development Areas Can Be Critical Tools for Resilience**
11. **Rising Sea Level Will Put Pressure on the Relationship Between Regional Recreation and Habitat**
12. **Nearshore Habitats and the Ecosystem Services they Provide are Sensitive to Sea Level Rise Early On**

Step 4. Solving Problems Regionally: Plan

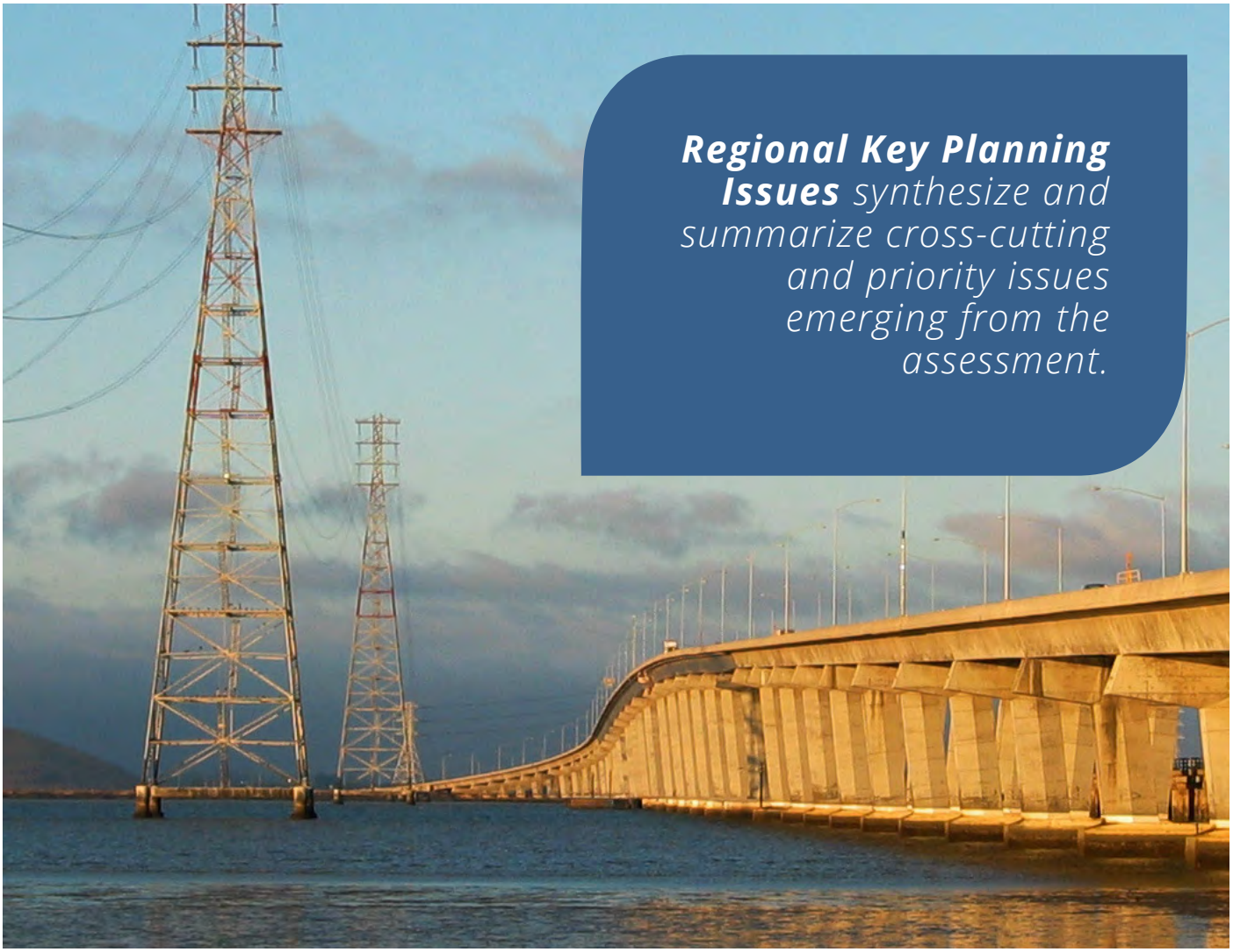
The Plan Step is the final step before implementation, identifying adaption responses that uniquely respond to the vulnerabilities identified and summarized in the previous steps. This step was treated differently in ART Bay Area than in previous ART projects, given the broadened scope of the project and the need for stakeholder buy-in for effective adaptation responses. Rather than detailed adaptation responses with implementation options for every asset within every Focus Area, adaptation responses were developed for the eight Regional Key Planning Issues. These 80+ responses identify actions that the region should coordinate on because they require a regional body to initiate, fund, or coordinate, or they are strategic responses that address common vulnerabilities across the region and would be most effective if a number of local governments took them on at the same time, with the coordinated support of a regional entity.

Additionally, the ART team identified the need for greater support for local

jurisdictions transitioning from assessment to project development in a way that incorporates deep community and stakeholder engagement as well as the newest thinking around scenario planning and adaptation pathways. This resulted in updated Plan Step guidance that will be published separately from ART Bay Area as part of the ART Portfolio in 2020. This local adaptation guidance, when published, will include a How-To Guide, illustrative process diagram, worksheets, an online Adaptation Catalog, and two case studies on the application of the process. See Chapter 4, Regional Adaptation for more details on adaptation responses.

Step 5. Implement and Monitor

The final step of the ART process is where we depend on partnerships with local jurisdictions, regional agencies, and other stakeholders to use the information gathered from this analysis and incorporate into collaborative and coordinated efforts, planning processes, programs and operations, funding mechanisms, and construction of shoreline adaptation solutions.



CA-84 Dumbarton Bridge and power lines at sunset. Photo by Darin Marshall licensed under CC BY 2.0.

1.2 Adapting to Rising Tides Program

BUILDING ON EXPERIENCE

In 2011, The San Francisco Bay Conservation and Development Commission (BCDC) and NOAA's Office for Coastal Management (OCM) brought together local, regional, state, and federal agencies and organizations, as well as non-profit and private associations for a collaborative planning project along the Alameda County shoreline to identify how current and future flooding will affect communities, infrastructure, ecosystems, and the economy.

Since then, the ART Program has continued to both lead and support multi-sector, cross-jurisdictional projects that build local and regional capacity in the San Francisco Bay Area to plan for and adapt to sea level rise and storm event flooding. Through these efforts, the ART Program also continues to test and refine a stepwise adaptation process that guides best practices for adaptation planning.

Throughout the Bay Area, the ART Program is helping integrate adaptation in local and regional planning and decision-making in multiple ways:

- **Leading collaborative adaptation planning projects** that build a comprehensive understanding of climate vulnerability and risk, develop effective and equitable adaptation responses, identify opportunities for implementing these responses and build capacity across the region to increase resilience.
- **Assisting adaptation planning efforts** with consistent staff support that includes recommendations, tools and approaches for selecting climate impact scenarios, decision-support tools, and data to identify vulnerabilities and consequences, assist with evaluating adaptation responses, public process and meeting design, review of work products, and more.
- **Providing the ART Portfolio** which combines a comprehensive set of online resources, including how-to guides, tools and findings, with Help Desk support from experienced ART Program staff to enable users to make use of Portfolio resources to efficiently and effectively assess and plan for climate impacts.
- **Building regional capacity for adaptation** by working with local, regional, state and federal agencies to find funding, and develop capacity and support at all scales for this work.
- **Advocating for adaptation** through communicating findings, issues, processes and needs to state and federal agencies to ensure that grant and other assistance programs are informed by and responsive to conditions in the Bay Area.

Waters rising at Arrowhead Marsh in Oakland during a King Tides in December 2018. Photo courtesy of California Bay King Tides Project.

FACTORS FOR SUCCESS

The ART Program emphasizes three factors for success:

1. **Collaborative by design.** Climate change, similar to hazard planning, requires planning across jurisdictions, geographies, sectors, and time frames to address complex, cross-cutting issues. ART emphasizes convening and closely collaborating throughout a planning process with a stakeholder working group representing the diverse values, viewpoints and responsibilities relevant to the project, to build relationships that lead to future collaborations.

2. **Transparent process.** To build a strong, actionable case for adaptation, the ART approach adheres to transparent decision-making throughout the planning process. ART Design Your Project guidance and supplies help maintain transparency and support clear communication to stakeholders about decisions and project outcomes, including resilience goals developed and agreed upon by the working group, and evaluation criteria that clearly reflect priorities and objectives.

3. **Sustainability from start to finish.** A core aspect of ART is consideration of the relevance and implications of all aspects of sustainability in each step of the planning process, from who is included in the initial working group list to what evaluation criteria are selected to evaluate adaptation responses.

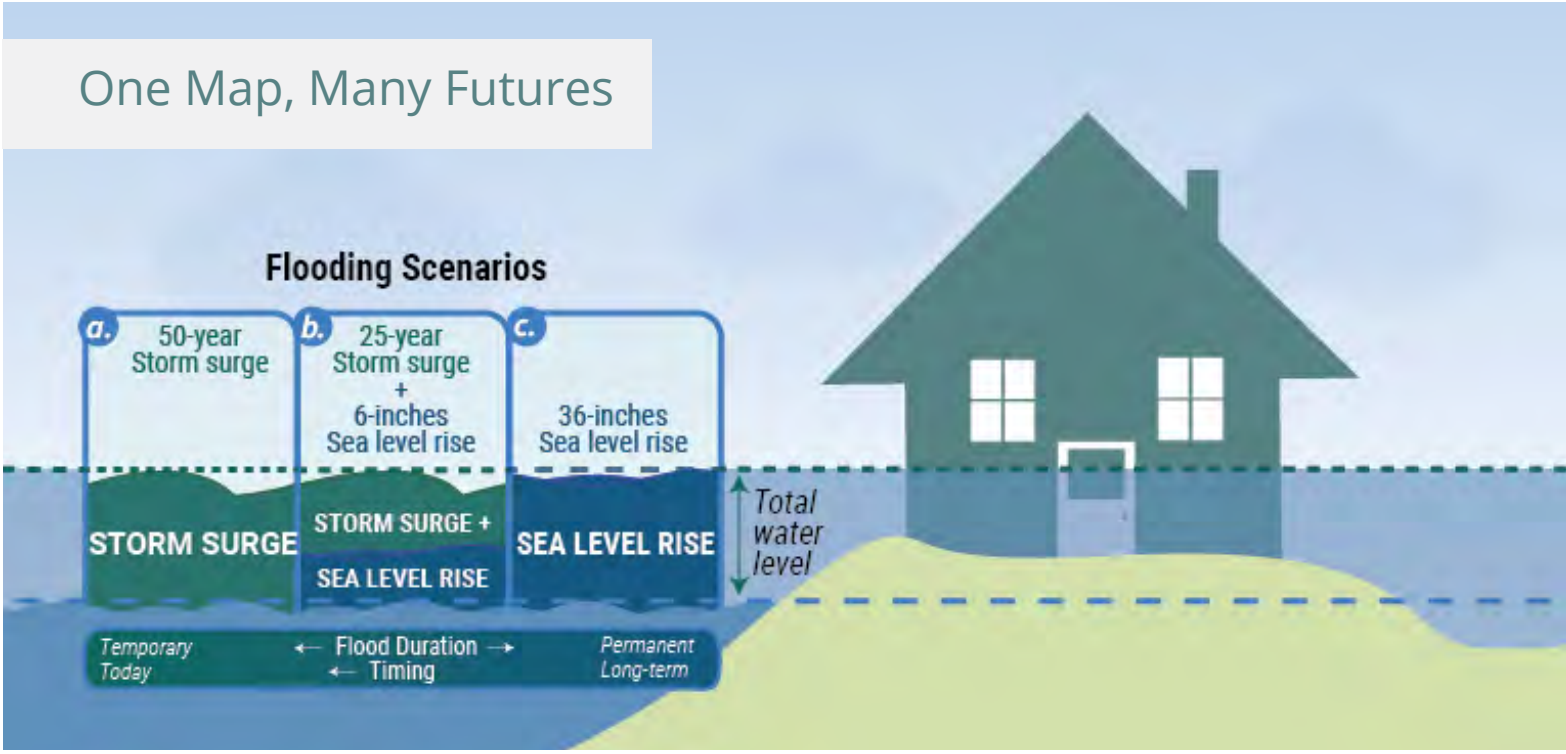


Figure 1-7. "One Map, Many Futures" refers to using Total Water Levels to signify different flooding scenarios.

MAPPING CURRENT AND FUTURE FLOODING, THE ART WAY

One Map, Many Futures

The ART approach to evaluating future coastal flooding uses a "One Map, Many Futures" approach, which allows each map to represent multiple potential future combinations of sea level rise and storm surge. Sea level rise is often visualized using specific flooding scenarios (e.g., 12" sea level rise or 100-year-storm), however, it is not always a simple process to decide which scenario is most appropriate for planning and analysis. The "One Map, Many Futures" approach avoids the need to select scenarios, and instead uses the concept of Total Water Level (TWL) to signify a number of possible sea level rise and storm surge combinations contributing to the same level of flooding. An illustrated description of the "One Map, Many Futures" approach can be seen in Figure 1-7.

ART utilizes ten TWLs that represent 59 combinations of permanent and temporary flooding above Mean Higher High Water (MHHW), from 12" to 108" TWL. An example of how these combinations of sea level rise and storm surge correlate to total water levels is shown in Figure 1-8.

The full ART mapping methodology can be accessed online here: ***http://www.adaptingtorisingtides.org/wp-content/uploads/2018/07/BATA-ART-SLR-Analysis-and-Mapping-Report-Final-20170908.pdf.***

Scenarios from Sea Level Rise (SLR) and Storm Surge

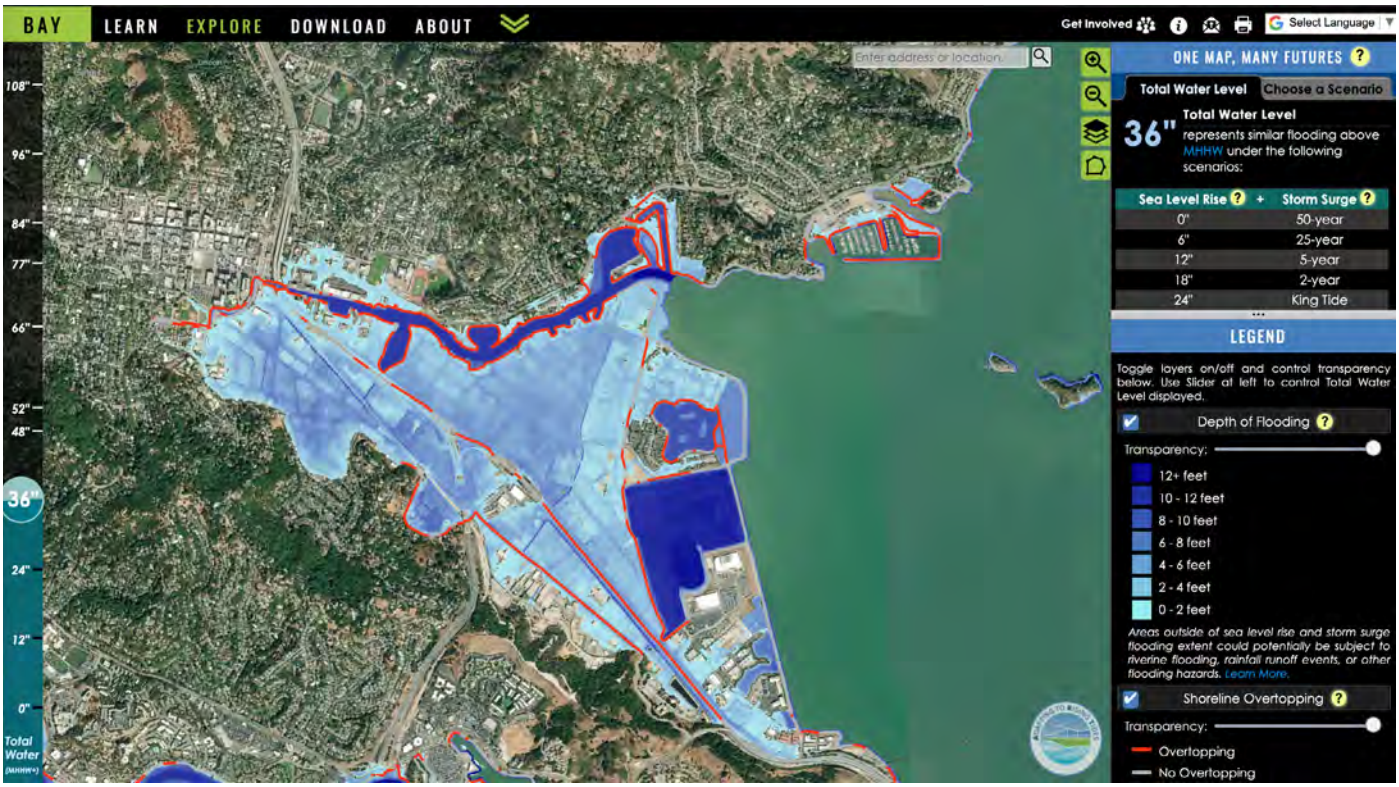
Daily Tide	Extreme Tide (Storm Surge) = Percent (%) Probability						
+ SLR (inches)	**1-year** *King Tide*	**2-year** *50% chance*	**5-year** *20% chance*	**10-year** *10% chance*	**25-year** *4% chance*	**50-year** *2% chance*	**100-year** *1% chance*
	Water Level Above MHHW (inches)						
Existing Conditions	0	14	18	23	27	32	37	42
MHHW + 6”	6	20	24	29	33	38	43	48
MHHW + 12”	12	26	30	35	39	44	49	54
MHHW + 18”	18	32	36	41	45	50	55	60
MHHW + 24”	24	38	42	47	51	56	61	66
MHHW + 30”	30	44	48	53	57	62	67	72
MHHW + 36”	36	50	54	59	63	68	73	78
MHHW + 42”	42	56	60	65	69	74	79	84
MHHW + 48”	48	62	66	71	75	80	85	90
MHHW + 52”	52	66	70	75	79	84	89	94
MHHW + 54”	54	68	72	77	81	86	91	96
MHHW + 60”	60	74	78	83	87	92	97	102
MHHW + 66”	66	80	84	89	93	98	103	108

**MHHW = Mean Higher High Water*

Depth of Flooding and Overtopping

In addition to showing what could get wet, the maps indicate where water is coming from. Shoreline overtopping occurs when the water elevation is greater than the shoreline elevation, overtopping segments of the shoreline that were previously preventing inland areas from flooding. The ART mapping process identifies low points in the shoreline that can lead to inland flooding, enabling users to identify critical shoreline locations and flooding pathways that could be prioritized for adaptation. The water depth at these points of entry to land is what ART maps call “shoreline overtopping depth.”

Figure 1-8. Example Sea Level Rise Matrix shown for Marin County (Graphic adapted from AECOM). Matrix shows various combinations of sea level rise and storm surge scenarios, where the colors represent the ten Total Water Levels (TWLs) used in the ART program to communicate flooding scenarios.



The ART Bay Shoreline Flood Explorer tool can be used to illustrate flooding, total water levels and overtopping. Image from BCDC.

Bay Shoreline Flood Explorer

The ART Bay Shoreline Flood Explorer was released in 2018 to provide an online mapping platform and educational tool to help the public understand the where the Bay Area may be at risk from current and future flooding from sea level rise and storm surges. The Flood Explorer and associated flood maps are intended to be used to raise awareness about this issue and support regional adaptation planning.

The maps support adaptation planning by:

- Identifying low points along the shoreline that can lead to inland flooding, enabling resources to be directed to areas that pose the greatest risk.
- Presenting flooding as a "Total Water Level" above mean higher high water (MHHW), which represents various combinations of storm-surge and sea level rise. In using this approach, the Flood Explorer communicates that some areas will be temporarily flooded before they are permanently inundated and therefore, supports development of early-, mid-, and long-, term thresholds for action.
- Providing high quality spatial information to support planning given that these high-resolution maps were carefully reviewed by local stakeholders.

It is important to note that while the maps depict flooding that would result if water levels were higher, the shoreline is shown as it appears today. Thus, the maps represent flooding that would occur absent any preparatory action or shoreline changes.

WHAT ELSE HAS ART DONE?

Past Projects

ART Program staff have convened and led multiple adaptation planning efforts at the county and community scales, working closely with partners at local and regional agencies and organizations. Previous projects include:

- ***Regional***
  - Sea Level Rise and Shoreline Analysis Maps *(2011 - 2019)*
  - Stronger Housing, Safer Communities *(Published Spring 2015)*
  - Local Hazard Mitigation and Climate Adaptation Plans *(Ongoing)*
  - Regional Resilience Partnerships *(Ongoing)*
- ***Local***
  - Alameda County ART Project *(Published January 2014)*
  - Hayward Shoreline Resilience Study *(Published March 2015)*
  - Oakland/Alameda Resilience Study *(Published August 2016)*
  - Contra Costa County ART Project *(Published March 2017)*
  - East Contra Costa County ART Project *(Published January 2020)*
- ***Sector***
  - Corte Madera Baylands *(Published May 2013)*
  - Tidal Creeks and Flood Control Channels *(Published June 2014)*
  - Capitol Corridor Passenger Rail *(Published August 2014)*
  - Bay Area Transportation Climate Resilience *(Published December 2014)*
  - East Bay Regional Park District *(Published September 2015)*
  - Accelerating Implementation of Local and Regional Resilience to Climate Change *(To be completed 2020)*

Example of past reports that the Adapting to Rising Tides staff have led or done in collaboration with project partners over the years.

1.3 Lessons Learned: Scaling Up and Scaling Down

CHALLENGES OF A REGIONAL SCALE ANALYSIS

ART Bay Area was aimed at understanding problems that will need to be solved through regional collaboration and through regional planning. These are the issues that are too big for any one jurisdiction to solve alone, and that will impact the entire region.

Identifying these issues and areas of high impact is no small task; the socio-ecological systems that make up the fabric of life in the Bay Area are vast and entangled. In assigning our 'assets' into four broad categories and using those designations as a proxy for these interconnected systems, we are inherently using a blunt tool to describe complex and nuanced processes. The goal of such an analysis is to arrive at a general understanding of the vulnerabilities we will face in order to begin to craft practicable strategies to address them. Regional-scale analysis provides an important scale for looking at large-scale patterns and trends, while local-scale analysis is critical for ground-truthing and gaining local context.

In order to tease out these impacts, ART Bay Area looked at impacts to the four systems articulated in *Plan Bay Area,* the region's comprehensive land use and transportation plan. This was done in order to provide the best possible regional sea level rise impact estimates for the most relevant, effective, and current regional planning process.

> ***Regional-scale analysis*** *provides an important scale for looking at large-scale patterns and trends, while* ***local-scale analysis*** *is critical for ground-truthing and gaining local context.*

Corte Madera Stormwater Pump Station Easement. Flooding during King Tides January 2020. Photo courtesy of California Bay King Tides Project.

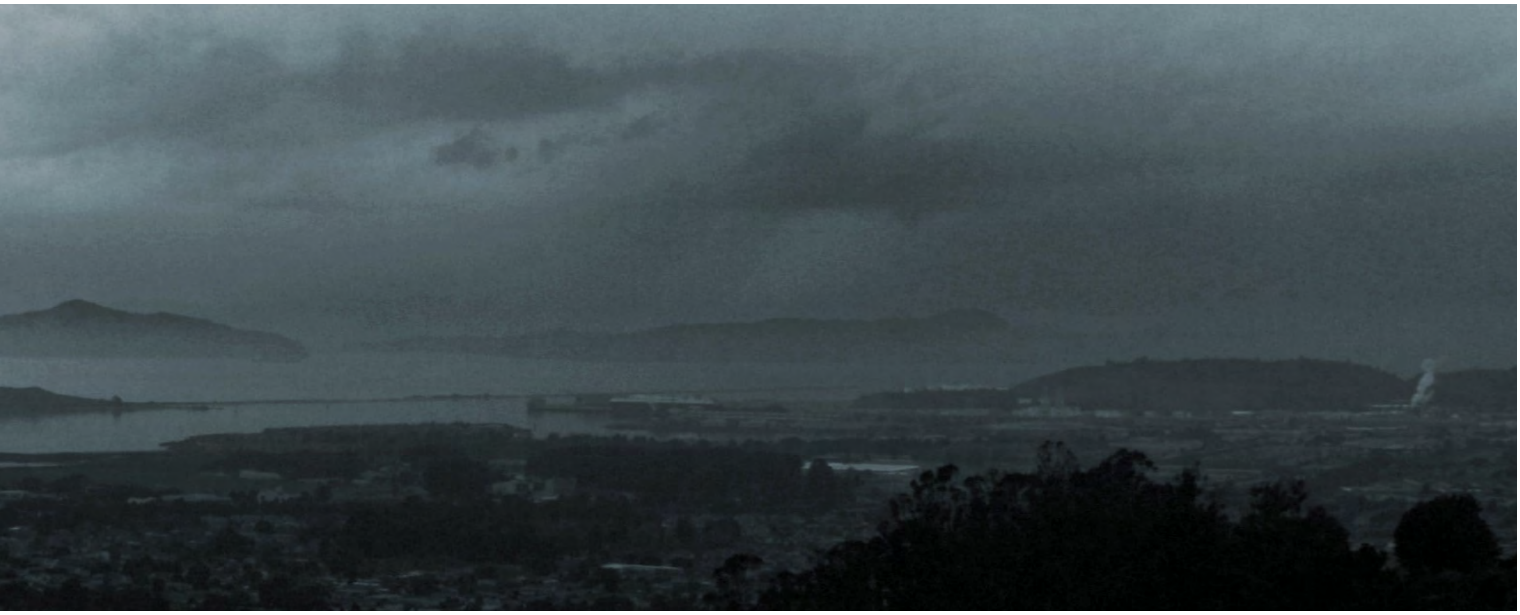
January storms in the Bay Area. Photo by TJ Gehling licensed under CC BY 2.0.

LIMITATIONS: WHAT WAS NOT INCLUDED

Climate Impacts and Other Hazards

Shoreline flooding due to temporary and permanent inundation are not the only factors that contribute to vulnerability of shoreline communities. Other flooding and climate factors are also at play that were not included in this analysis. These include:

- **Elevated groundwater and increased salinity intrusion**. As sea levels rise, groundwater and salinity levels are also predicted to rise. These two factors provide additional sources of flooding and vulnerability to infrastructure and natural systems.
- **Joint riverine and coastal flooding.** The creeks and channels that connect and drain to the Bay and ocean are vulnerable to both rising sea levels and precipitation changes due to climate change. As the tide rises, it pushes higher into the mouths of creeks and channels, reducing their capacity to discharge riverine flows and stormwater. This renders low-lying areas adjacent to tidal creek and channel mouths vulnerable to "joint" flooding events caused by storm water flowing downstream meeting up with already high Bay and coastal water levels elevated by tides and sea level rise.
- **Stormwater contribution to flood risk**. Rainfall over impervious surfaces such as streets and urban areas produces stormwater runoff, which can exacerbate the flood risk of low-lying areas, populations, and assets. Current and future areas susceptible to flooding as a result of rising sea levels and changes in precipitation intensity will experience increased flooding frequency and duration as stormwater combines with floodwater from higher tides.



- **Heat, drought, and wildfire.** Changing weather patterns can lead to increased hot days and decreased overall precipitation. Together, these set the stage for increased wildfire risk, leading to more wildfires that burn hotter, last longer, and are much more difficult to control. The Bay Area has seen a number of these kinds of wildfires in the past few years and pose a critical short and long-term risk for the region. While the shoreline may not be as vulnerable to these risks than upland areas, wildfire is a risk that could occur anywhere.
- **Earthquakes and liquefaction.** The Bay Area is a well-known hotbed for earthquakes, with dozens of faults crisscrossing the region. Small earthquakes occur on a daily basis, with damaging earthquakes occurring every few decades. Along the shoreline, many areas that are vulnerable to flooding are also extremely vulnerable to liquefaction, which occurs when loose soils are shaken long and hard enough by a seismic event. Liquefaction weakens the soils, which can lead to damage to foundations, roadways, pipelines, rail tracks, and airport runways. An earthquake, and especially liquefaction along the shoreline, could alter shoreline flood patterns as well. Some assessment of liquefaction vulnerability was conducted qualitatively in local assessments where liquefaction is a clear risk, but a comprehensive regional assessment of earthquake risk was not conducted.

Flood Exposure

The ART Bay Area exposure analysis counts assets as 'exposed' the moment they 'get wet.' In doing so we are comparing the impacts across different facets of people's lives in different ways- we are tallying up apples and oranges. A flooded road is not the same as a flooded first floor rental apartment. The goal of such an analysis is to arrive at a general understanding of the vulnerabilities we will face in order to craft actionable strategies to address them.

Aggregating Impacts Across Socio-ecological Systems

There is an inherent tension in assessing a problem based on aggregated impacts to people or environments. Impacts to one rider on their morning commute is not equal to one home flooded. A flooded office building is not equal to an acre of flooded wetland. This is further complicated when considering preexisting social and economic conditions that put marginalized populations at greater disadvantage than their more privileged counterparts.

For these and many other reasons, it is critical that the results of this report be used with great care. While this can serve as a first-pass regional scan to identify potential priority areas for shoreline adaptation, it should be paired with additional ground-truthing, site-scale vulnerability assessment, and robust community and stakeholder engagement.

Our two-pronged approach to regional vulnerability assessment, while robust, has some unevenness in detail across assets that may be critical to highlight for adaptation planning. There is more detailed and descriptive data associated with focus areas (as defined in the OLU or sub-regional assessments) than with exposed assets on their own. This means that there could be:

- High-consequence single assets that were not assessed in great detail;
- Clusters of high-consequence assets that were not in an assessed OLU because they do not share the OLU stretch of shoreline with other high-impact assets sufficient to have been prioritized for sub-regional assessment. In short, there could be a 'focus area' for which we did not conduct a full qualitative assessment. Similarly, there could be a single very high consequence asset that did not receive a qualitative assessment, or a set of assets of high consequence that did not share an OLU with enough other assets to rise to prioritization for the 13 OLUs first assessed.

Equity Analysis

The ART Bay Area team was not able to incorporate an equity analysis of either our process or vulnerability outcomes for this study. Our process, scope, staffing, and other factors were not subject to an equity analysis during the course of this project. Conducting an equity analysis should be a part of any planning process that utilizes this document or the associated data. There would be significant benefit in identifying any areas where actions could result in negative outcomes for marginalized populations without an appropriate understanding of the social equity context. This would involve the inclusion of more individuals and organizations in the process that have lived experience and local expertise to inform the data, interpretation, and its uses.

Population-Based User and Rider Data

Population and demographic data were only used in mapping vulnerable communities and are not reflected in other assets. Ridership, PCA visitation rates, and PDA jobs and housing are not associated with demographic or population data within the scope of this study. This could result in an underestimation of impact to marginalized populations. For instance, the impact on one rider is also influenced by their job or financial security one missed day could be a minor inconvenience or a life-changing hardship. Because of this, there may be additional insight gained from investigation into the impacts to different communities, from asset exposure especially for marginalized communities. A robust population and demographic impact analysis should be considered in adaptation planning processes.

Economic Analysis

ART Bay Area did not include and economic analysis of impacts to assets assessed. This type of analysis can be helpful because it puts concrete terms to impacts in a way that can be comparable across different asset types. It can also help with developing cost-benefit ratios to understand "low hanging fruit" for adaptation options – that is, adaptation actions that are low cost compared to the potential impacts of inaction. However, economic analysis may not fully consider non-monetizable impacts, such as impacts on people's health or well-being or ecosystem services, which limits the effectiveness of comparing across sectors.

Cultural Resources and Cultural Districts

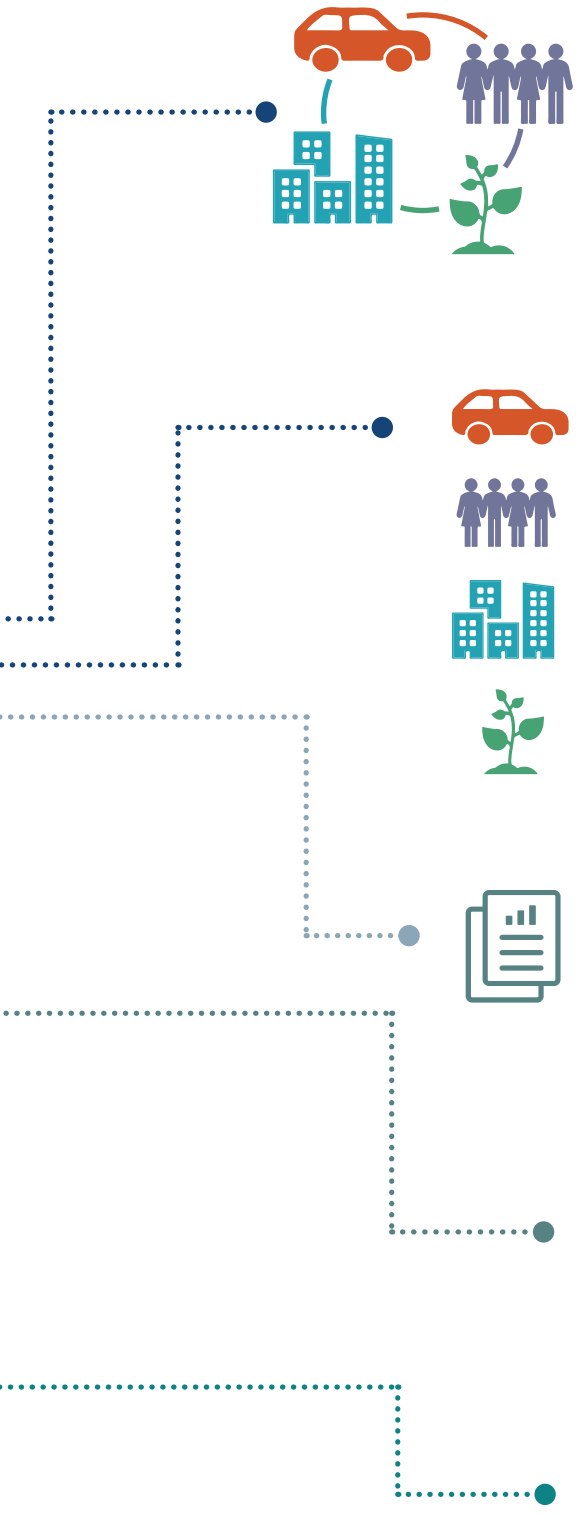
Cultural resources play an important role in creating and sustaining community, connecting with the past, and envisioning the future. The loss of critical cultural resources may have large ripple effects on communities in the Bay Area, especially in disrupting cohesion or deepening marginalization. ART Bay Area was not able to assess indigenous or other cultural assets that may be impacted by sea level rise, due to time and resource constraints. In particular, there may be critical Shellmound sites that are located close to the shore that should be considered carefully in any site scale or regional adaptation planning process. Cultural districts are located in many locations in the Bay that may be vulnerable to flooding inundation but were outside the scope of our exposure analysis. Cultural districts or assets should be carefully considered in any adaptation planning process. Both officially designated sites and yet-to-be designated sites should be considered. Cultural districts aimed at preserving cultural legacy, such as LGBTQ or African American cultural districts, especially in the context of rapid displacement in the Bay Area, should be considered in adaptation planning processes.

1.4 How to Use This Report

HOW THE REPORT IS LAID OUT

This report is organized into multiple pull-apart chapters that can be read through as a whole, or digested individually, based on the interest and time of the reader. In addition to a short summary report published separately, the main body of the report consists of the following:

- **1.0 Introduction Chapter:** Provides the background on ART Bay Area and Adapting to Rising Tides Program and sets context for remainder of the report.
- **2.0 Regional Systems Assessment Chapter:** This chapter contains the regional systems assessment including Regional Hot Spots, Regional Key Planning Issues, and analyses on each of the four Regional Systems:
  - ***2.0 Regional Overview***
  - ***2.5 - 2.8 Regional Systems Sections***
- **3.0 Local Assessments Chapter:** This chapter contains the local-scale analysis for 13 Operational Landscape Units (OLUs) and was derived from our qualitative analysis. The 13 OLUs were selected by identifying geographic areas with a high concentration of vulnerable assets across the four categories. Focus Areas were used as an organizing principle to define places that have vulnerability across each of the four systems. This section can be useful for both local scale planning and to inform and add ground-level nuance to the regional analysis.
- **4.0 Regional Adaptation Chapter:** This chapter offers suggestions for adaptation responses that start to solve the region's most pressing or common vulnerabilities. The 80+ responses identified through this project are organized by the eight Regional Key Planning Issues and represent actions that are either large enough in scope that they need to be initiated or carried out by a regional or state agency, are well-suited to an existing regional or state tool, require coordination across jurisdictions, or are considered low-hanging fruit or standard best practices that any jurisdiction facing flooding could benefit from, even in the absence of an in-depth local vulnerability assessment.
- **5.0 Looking Forward Chapter:** While the findings within this report are extensive and in-depth across the region, in many ways they set up more opportunities to target additional work, rather than answer questions in and of themselves. Additionally, the data serves as a foundation to help guide regional and local decision-making but does not actually make definitive choices about where the region goes next. This section outlines thinking on how ART Bay Area findings can be used to inform critical next steps, both locally and as a coordinated regional whole.



Regional Overview (Page 2-10)

This section provides an overview of the regional system assesment, including introducing the indicators of consequence used in the analyses, results of Regional Hot Spots that identify high consequence clusters in the region, and the Regional Key Planning Issues.

Regional Systems Sections (Page 2-57)

Within the Regional Systems Assessment Chapter, sections 2.5, 2.6, 2.7 and 2.8 provide details on the four regional systems individually. This includes a more detailed description of each system, results from both the qualitative and quantitative analysis, and special analysis for Future Growth Areas and Natural Lands. These chapters also include 'regional vulnerability statements' which are derived from the qualitative analysis. Links will be provided within this document, but sections are available to download separately.

Local Assessment Section (Page 3-1)

This section includes an introduction to what the local assessments are and how they were selected. Each of the 13 local assessments will be available as separate PDF downloads. Links will be provided within this document, but local assessments are available for download separately.

Regional Adaptation Responses (Page 4-1)

Adaptation responses address the eight Regional Key Planning Issues identified from the results of the Regional Systems Assessment and Local Assessments results.

Looking Forward (Page 5-1)

Where ART Bay Area project results are going next!

Endnotes

1 Ocean Protection Council (OPC), "State of California Sea-Level Rise Guidance 2018 Update" (California Natural Resources Agency, 2018), http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf.

The nine-county Bay Area region is home to an array of interconnected systems: transportation networks, communities and businesses, and habitats that line our shore. Photo by Karl Nielsen.

Chapter 2.0

REGIONAL SYSTEMS ASSESSMENT

2.1 Regional Vulnerability: Shared Impacts Across Systems

REGION-WIDE PATTERNS DRIVE SHARED ACTION

This chapter presents the region-wide, cross-cutting vulnerability findings based on both quantitative and qualitative analysis. Conducting region-wide assessments achieves the following outcomes:

- Identifies regionally significant "clusters" of vulnerability, or locations where high-consequence assets are co-located, which can start to point to locations across systems and across the region where adaptation responses could reduce or limit consequences to the region to the greatest degree;
- Allows for region-wide patterns of vulnerabilities to emerge; that is, vulnerabilities that are common across the region, cross jurisdictional boundaries, or point to issues that are larger than a single jurisdiction can handle on their own;
- Identifies vulnerabilities within a system specific to that particular system, identifying geographic patterns of where vulnerability is worst within a system, and understanding common characteristics of vulnerability within the same asset type.

The results of this section on shared impacts across systems includes an analysis conducted across the four regional systems described below. Figure 2-1 shows each of the four systems across the region, and Figure 2-2 shows the distribution of the four interconnected regional systems across the Bay Area.

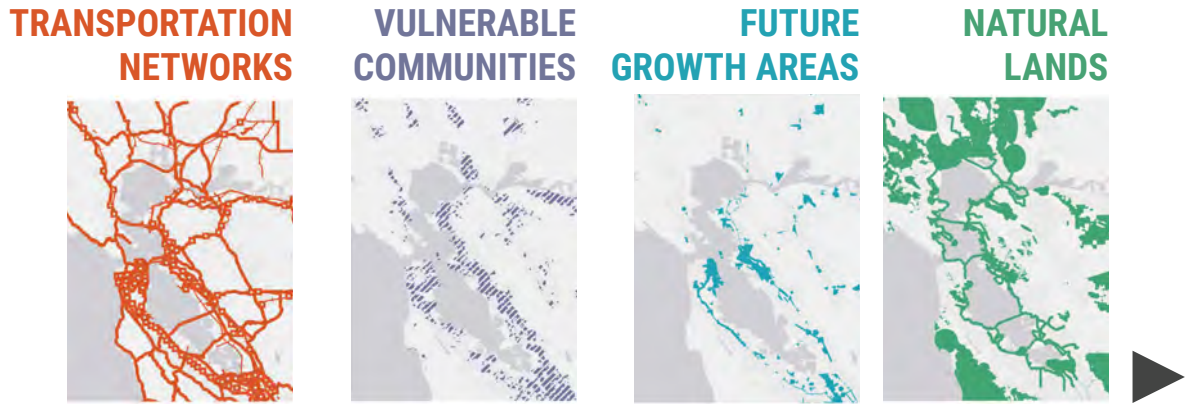
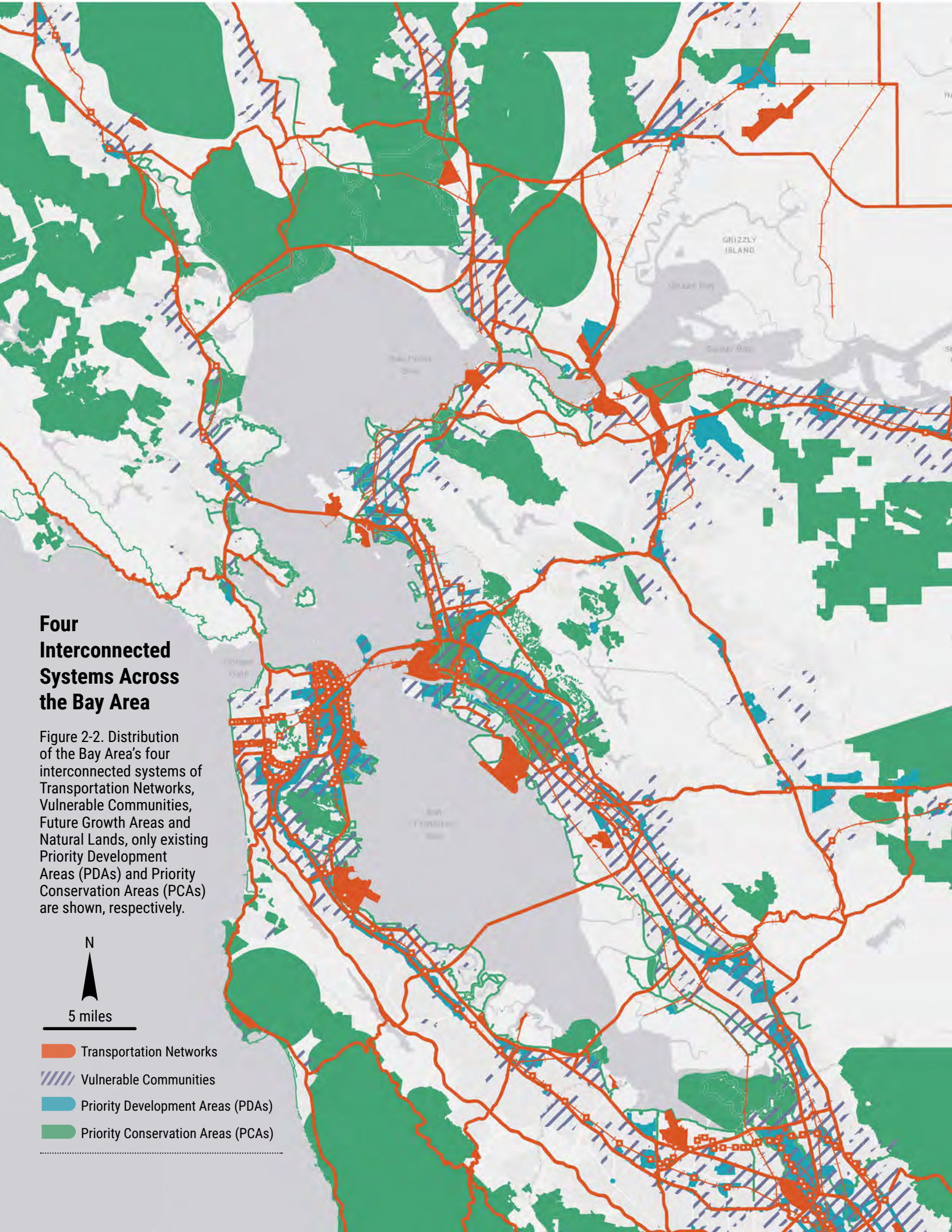


Figure 2-1. Maps of the four regional systems, including Transportation Networks, Vulnerable Communities, Future Growth Areas and Natural Lands. For Future Growth Areas and Natural Lands, only existing Priority Development Areas (PDAs) and Priority Conservation Areas (PCAs) are shown, respectively.



Four Interconnected Systems Across the Bay Area

Figure 2-2. Distribution of the Bay Area's four interconnected systems of Transportation Networks, Vulnerable Communities, Future Growth Areas and Natural Lands, only existing Priority Development Areas (PDAs) and Priority Conservation Areas (PCAs) are shown, respectively.

REGIONAL EXPOSURE AND CONSEQUENCE INDICATORS

High priority assets represent assets that may have significant consequences outside of the local community, perhaps rippling across the region, state, or even wider, if its function is compromised. In ART Bay Area, regional consequences were measured using indicators specific to each of the four systems. This allows for comparisons and rankings across the region within a system and can help quickly identify the worst-consequence assets within the region.

To assess the consequence of flooding for the region-wide systems identified during the project scoping, the ART team worked with AECOM and MTC/ABAG to identify consequence indicators that measure a quantitative degree of impact that the region cares about. These indicators can identify high-consequence assets and help facilitate decision-making around regional prioritization for adaptation strategies. The consequence indicators also provide a common methodology for evaluating and comparing assets for a range of total water levels. Consequence indicators are intended to build toward a common vision of regional vulnerability that is replicable, transparent, and adaptable.

Each consequence indicator is measured for each asset based on the best available data for the chosen indicator for all assets of that asset type. Each of the four asset types has their own set of unique consequence indicators that can only be compared to other assets of that type.

To assign a consequence indicator, flood exposure was first assessed in ArcGIS by overlaying the 10 different total water levels used throughout this assessment with an asset dataset. If an asset or a portion of an asset intersected with one or more of the total water levels, it was considered exposed to flooding. Only exposed assets were assigned consequence indicators.

Consequence indicators for each asset were selected to measure the direct impacts of the asset being assessed, not indirect, cascading, or network effects. For example, indicators for freeways measure the number of cars that would be impacted, not the economic consequences if people are unable to get to work. This means the complete consequences of flooding are underestimated. However, the consequence indicators provide a first pass at flagging assets that may need more detailed study.

Consequence Indicator Criteria

To select and identify the most appropriate consequence indicators, the project team relied on indicator characteristics developed collaboratively by BCDC/ART, AECOM and MTC/ABAG project team. Consequence indicators were chosen that possess the following characteristics:

- **Regionally Available –** Consequence indicators are based on regionally available data and/or model outputs that are defensible and well-supported. The data is spatial (available in GIS format) with appropriate metadata. If a local jurisdiction has better data or model output from a local study, that data can be substituted to better inform a local assessment when utilizing consequence indicators.
- **Quantifiable/Measurable –** Consequence indicators are able to be ranked and compared across a single indicator. This means that the data can be measured quantitatively.
- **Discrete –** Consequence indicators are discrete and independent from other indicators to prevent double counting and cover the attributes as concisely as possible. Indicators do not significantly overlap one another.
- **Updatable –** Consequence indicators can be updated over time when new data becomes available.

In addition to the consequence indicator characteristics noted above, each indicator addresses one or more of the four ART sustainability frames: society and equity, economy, environment, and governance.

Asset data were typically available either as polygons, points, or linear data. For point data (such as commuter rail stations), each point was measured for consequence. For linear data (such as rail lines), lines were split into segments. For example, the California Rail Network was split into segments between rail stations. Polygon data were subdivided differently according to the asset type. For example, Priority Development Area polygons were subdivided into parcels, and only parcels that were flooded were assessed using consequence indicators with the assumption that the indicators (such as residential units) were distributed equally throughout all of the parcels in the polygon. For a complete explanation of the indicator methodology, see the Appendix.

The consequence indicators selected can be seen in Table 2-1. The results of this analysis can be found in the following sections describing the region-wide vulnerability of each system.

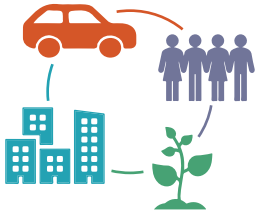
ART Bay Area Regional Systems

Indicators of Consequence

Regional System	Asset Type	Consequence Indicator	Unit of Measurement
Transportation Network	**Highways and Bridges**	AADT	Annual average daily traffic (all vehicles)
		Truck AADT	Annual average daily truck traffic
		Lifeline Route	Binary (yes or no)
	Commuter Rail	Passenger Flow (Rail Lines)	Passengers per average weekday
		Ridership (Rail Stations)	Passengers per average weekday
	Freight Rail	Freight Train Flow	Freight trains per day
	Airports	Passengers	Boardings per year
		Cargo Volume	Pounds of freight per year (millions)
	Seaports	Cargo Volume	Dollar value of exports and imports
	Ferry Terminals	Ridership (by terminal)	Passengers per average weekday
	High Quality (HQ) Bus Routes	Miles of Impacted HQ Bus Routes	HQ Bus Routes (miles)
	San Francisco Bay Trail	Miles of Impacted Trail	Bay Trail (miles)
	Regional Bicycle Network	Miles of Impacted Bicycle Infrastructure	Bicycle routes (miles)
Vulnerable Communities	**Social Vulnerability**	Residential Units 2010	Number of residential units impacted
	Contamination	Residential Units 2010	Number of residential units impacted

Table 2-1. Table illustrating the four regional systems, asset types within that system, consequence indicator(s) for each asset type, and unit of measure for each consequence indicator.

Regional System	Asset Type	Consequence Indicator	Unit of Measurement
Future Growth Areas	**Residential Units**	Residential Units 2010	Number of 2010 residential units impacted
		Residential Units 2040	Number of 2040 residential units impacted
		Residential Units Growth 2010-2040	Number of new residential units impacted
	Job Spaces	Job Spaces 2010	Number of 2010 job spaces impacted
		Job Spaces 2020	Number of 2040 job spaces impacted
		Job Spaces Growth 2010-2040	Number of new job spaces impacted
Natural Lands	**Recreation**	Visitation Rates	Photo-user-days
	Stormwater	Stormwater Retention	Gallons (millions)
		Stormwater Infiltration	Gallons (millions)
	Habitats	Habitat - Depressional Wetlands	Acres
		Habitat - Lagoons	Acres
		Habitat - Tidal Marshes	Acres
	Endangered Species Habitats	Endangered Species - Ridgway's Rail	Acres
		Endangered Species - Snowy Plover	Acres
		Endangered Species - Salt Marsh Harvest Mouse	Acres
	Agriculture	Agricultural Lands	Dollar value of annual crop production
	Carbon Storage	Soil Organic Matter	Area (acres) x Weighted % Soil Organic Matter



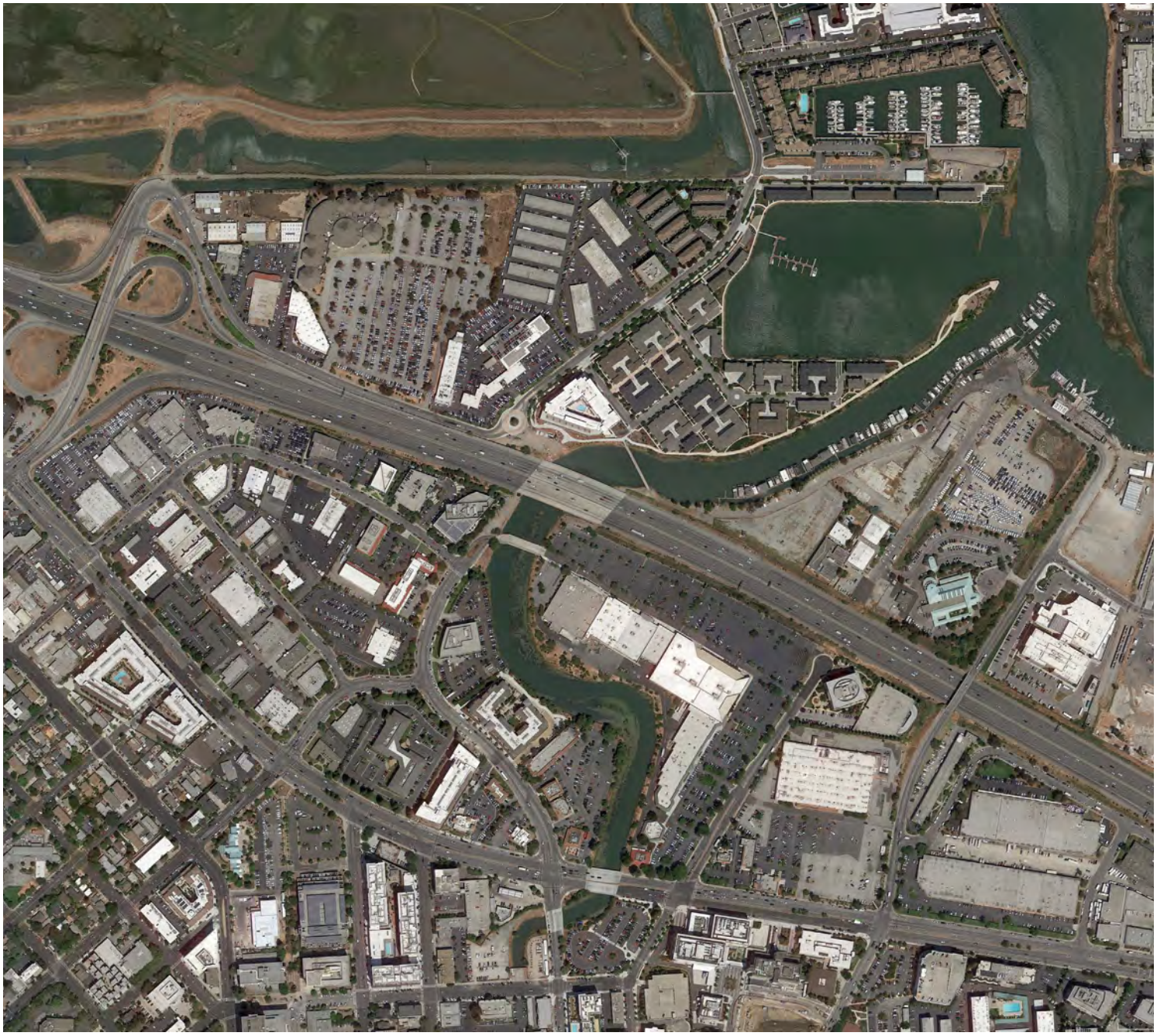
2.2 High Consequence Hot Spots: Regional Clusters

WHERE ARE CRITICAL ASSETS CO-LOCATED?

Regional clusters were identified to locate where assets that drive regionally significant impacts are located together. By identifying high consequence assets that are co-located, regional "hot spots" emerge, which are ripe for coordinated adaptation planning. These regional clusters represent a starting point for the region to identify high-priority areas for adaptation that could receive support from the region through technical assistance, resources, or incentives to ensure that these areas are protected first.

Co-located assets may also point to areas where a single adaptive approach – such as a single green or gray flood control project or zoning change – could protect many assets at once, where decisions made by one asset owner or manager may have significant cascading consequences (positive or negative) for nearby asset owners, or where it may be otherwise beneficial to coordinate across sectors, jurisdictions, or stakeholders. These regional clusters may indicate areas of high importance because, in aggregate, the co-located assets are too significant or represent too complex of a network to not protect. These locations may also provide the "biggest bang for the buck." For example, these regional clusters can lead to protecting many assets the region cares about in a single planning process or project (or coordinated projects), collectively saving time and resources.

The regional clusters change location over time as flooding increases. This is due to more assets being exposed at higher total water levels. Since clusters are driven by highest regional consequence, an asset that may have the highest consequence at 12" TWL may not have the highest consequence at 48" TWL when more assets are exposed. This means that clusters that emerge early on as regionally important may no longer appear to be regionally important later on. This does not mean that these locations are no longer significant *locally,* only that, compared to the rest of the region, they are no longer as *regionally* significant. Overall, identifying the clusters that emerge as significant early on and *stay* significant is the best indicator of regional importance across time.



US-101 Highway crossing over Redwood Creek in Redwood City. Map data ©2019 by Google Earth Pro.

The information provided in this analysis is not a decision-making tool in and of itself; decisions about where to focus regional attention and assets, and when, should be considered through collaboration with a wide variety of both local and regional stakeholders, should consider shared guiding goals and values, and include consideration of assets considered regionally-critical but not assessed within ART Bay Area, such as energy or water infrastructure. Lastly, regional priorities should always be balanced with local priorities to ensure a mix of adaptation around the region that provides value for a wide range of recipients.

IDENTIFYING REGIONAL HOT SPOTS: METHODOLOGY AND LIMITATIONS

Regional clusters were identified for all ten TWLs to illustrate areas where critical assets were co-located, potentially leading to coordinated, shared adaptation responses that can protect multiple assets at once. The methodology to identify clusters is below:

1. Identify and map the five highest consequence assets for each asset class. For example, identify the top five highest consequence segments of highway, the top five highest consequence ferry terminal boarding locations, or the five PCAs with the largest area of tidal wetlands impacted. The exception was for vulnerable community block groups – all vulnerable block groups were considered in this methodology, as there is no benefit to ranking community vulnerability.

2. Map all of the highest scoring indicators for all indicators at each TWL. Co-location. Determine co-location visually. Identify areas containing:

    a. At least one transportation asset that was in the top five for consequence;

    b. At least one PCA or PDA that contains at least one top five consequence indicator; and

    c. At least one vulnerable block group.

No weighting or relative value was accounted for in this methodology. All consequence indicators were ranked and mapped equally across all four systems, despite the relative range of impacts compared to another indicator. For example, Bay Trail segments were treated the same as highway segments, even though the total volume of users impacted by loss of function of a highway segment is much higher than the total volume of users impacted by loss of function of a Bay Trail segment. Additionally, consequences to transportation assets were treated the same as consequences to PDAs and PCAs.

Some inherent weighting occurs due to the number of indicators within each system. For example, there are 13 indicators within transportation, 6 within PDAs, and 11 within PCAs. Therefore, more transportation assets will be measured for consequence than any other class, followed by PCAs and then PDAs. However, this is somewhat mediated due to the size of the assets – transportation assets are measured in much smaller units (points such as ferry terminals or rail stations, or segments of linear assets) than PDAs and PCAs, so while there are more assets to drive a cluster, the large size of PDAs and PCAs increase their likelihood for co-location with another asset.

REGIONAL PATTERNS

At early total water levels, limited exposure of assets to flooding causes clusters to appear in the North Bay, driven largely by transportation assets. Increasing total water levels exposes new assets and worsens consequences of existing exposure, adding clusters around the region. By 36" and 48" TWL, clusters emerge that remain relatively consistent for higher total water levels. Most of these clusters are in the East and South Bays, which reflect locations where high-use transportation assets and critical future growth areas exist in highly developed areas alongside the shoreline. At higher total water levels, some new exposure brings additional clusters into the mix, specifically San Mateo/Foster City and the Brisbane Baylands.

Clusters that emerge early and fall off by higher total water levels remain significant locally and regionally, but their relative significance is eclipsed by high consequence assets elsewhere in the region. These early clusters indicate locations that, while not the most critical compared to other locations, still contain critical assets and may need regional assistance to act quickly enough to protect these assets.

The emergence of steady clusters over several total water levels provides a strong case for focused attention on these locations, as they represent areas of co-located critical assets that remain consistent over time. Many of these locations overlap with areas of focused local assessment as described in the next chapter, offering greater insights into the nature of qualitative vulnerability in these locations, such as functional, governance, and physical vulnerabilities, as well as consequences above and beyond the consequence indicator used to identify regional impacts. This assessment can be used to begin to identify locally-specific adaptation responses that will not only make the local area more resilient, but ensure that the region sees fewer impacts as well.

The emergence of steady clusters over several total water levels provides a strong case for focused attention on these locations, as they represent areas of co-located critical assets that remain consistent over time.

Highways, marshes, homes and businesses near Larkspur, CA. Map data ©2019 by Google Earth Pro.

First Flooding: 12" TWL

At first flooding (Figure 2-3), three clusters emerged: San Rafael, Corte Madera/ Larkspur, and Martinez. The San Rafael cluster is driven by multiple transportation assets, including CA-101, CA-580, the SMART train and the Bay Trail; the Downtown San Rafael PDA, which experiences high impacts to 2010 job spaces and 2040 residential units as well as job spaces, and percent growth of residential units; and by block groups experiencing social vulnerability as well as contamination.

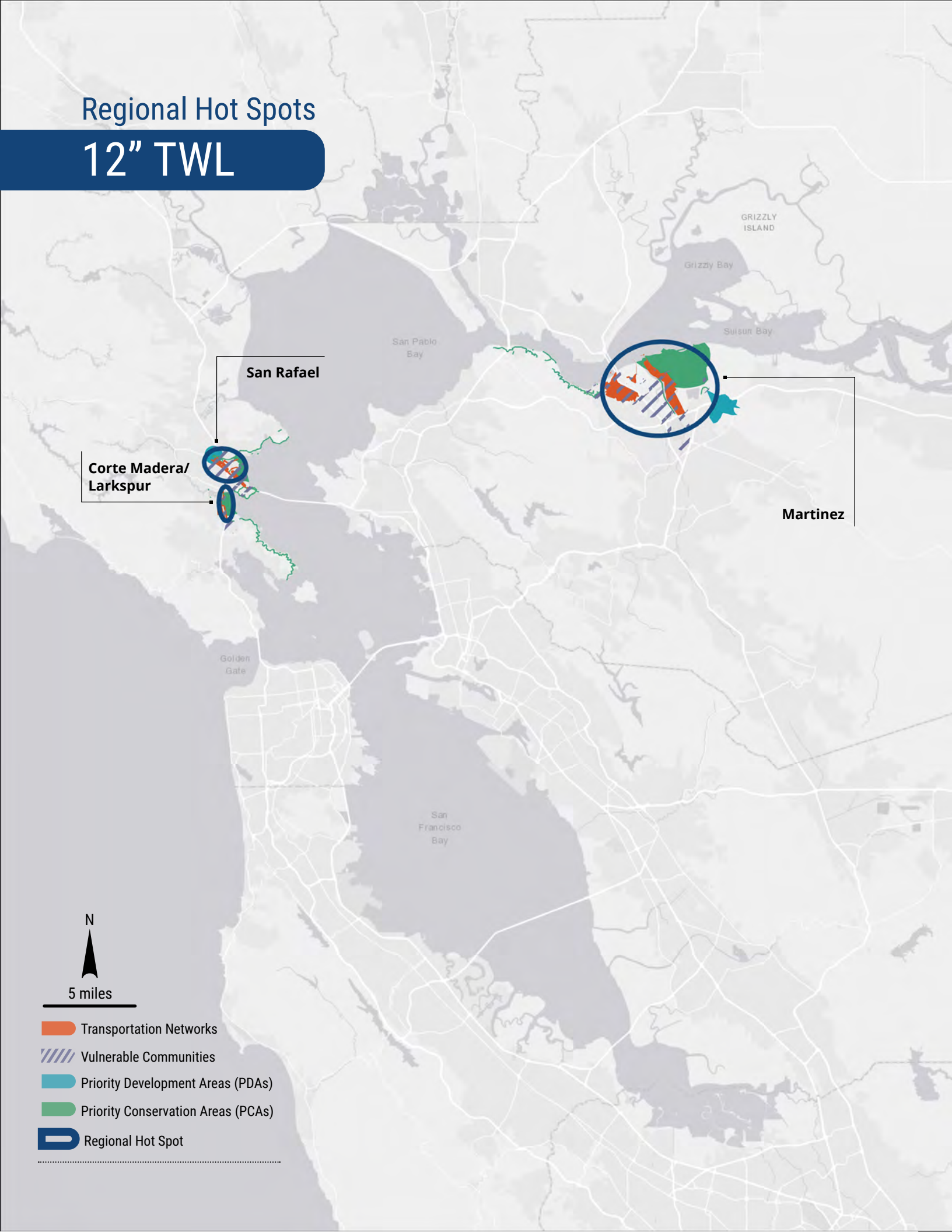
The Corte Madera/Larkspur cluster is driven by impacts to US-101, impacts to the Larkspur Ferry Terminal, and impacts to the Bay Trail and a portion of the Regional Bicycle Network located in Corte Madera; the Central Marin Bayfront PCA, which experiences high impacts to lagoons as well as visitation; and a vulnerable block group.

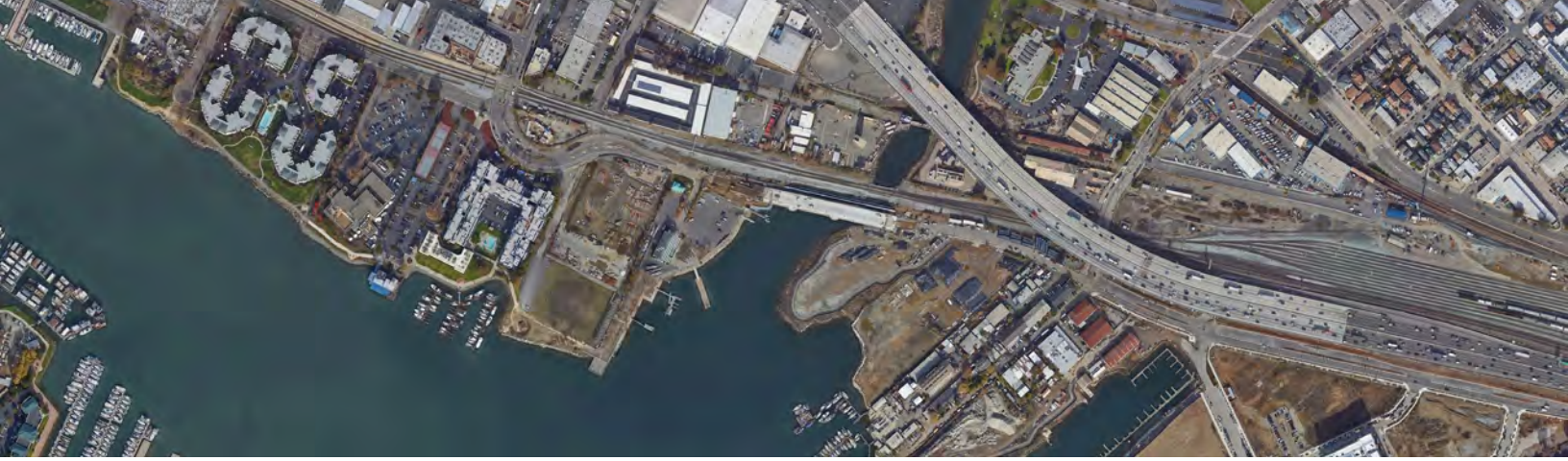
The Martinez cluster is driven by impacts to lagoons, Ridgway's rail habitat, and tidal marsh habitat in the Point Edith Wetlands PCA, as well as impacts to the Port of Martinez and Union Pacific Freight Rail and socially vulnerable and contaminated block groups.

Figure 2-3. Regional Hot Spots at 12" TWL. There are three main areas of impact in San Rafael, Corte Madera/Larkspur, and Martinez.

Regional Hot Spots

12” TWL





Shoreline of Jack London Square in Oakland. Map data ©2019 by Google Earth Pro.

Regional Changes: 24" TWL

As flooding increases, new exposure drives new clusters to emerge and other clusters to fall off as assets with higher consequences start to get wet (Figure 2-4). At 24" TWL, clusters include Corte Madera, Marin City, Suisun City, Martinez, Downtown Oakland/West Oakland, San Jose, and Redwood City. San Rafael no longer appears as a regional cluster, despite worsening impacts within that cluster; local vulnerability and consequences are still critical, but as other assets get wet, higher *regional* consequences occur elsewhere.

The Marin City cluster is driven by the Regional Bicycle Network, visitation to the Bothin Waterfront PCA, and social vulnerability in local block groups.

The Suisun City cluster is driven by the Downtown & Waterfront PDA (2010 and 2040 residential units, residential unit growth, and job units growth), the Suisun-Fairfield passenger rail station, and social vulnerability and contamination.

The Downtown Oakland/West Oakland cluster is driven by the Downtown & Jack London Square PDA (2010 and 2040 residential units, residential unit growth, and job units growth), Port of Oakland, and Jack London Ferry terminal, as well as significant social vulnerability and contamination.

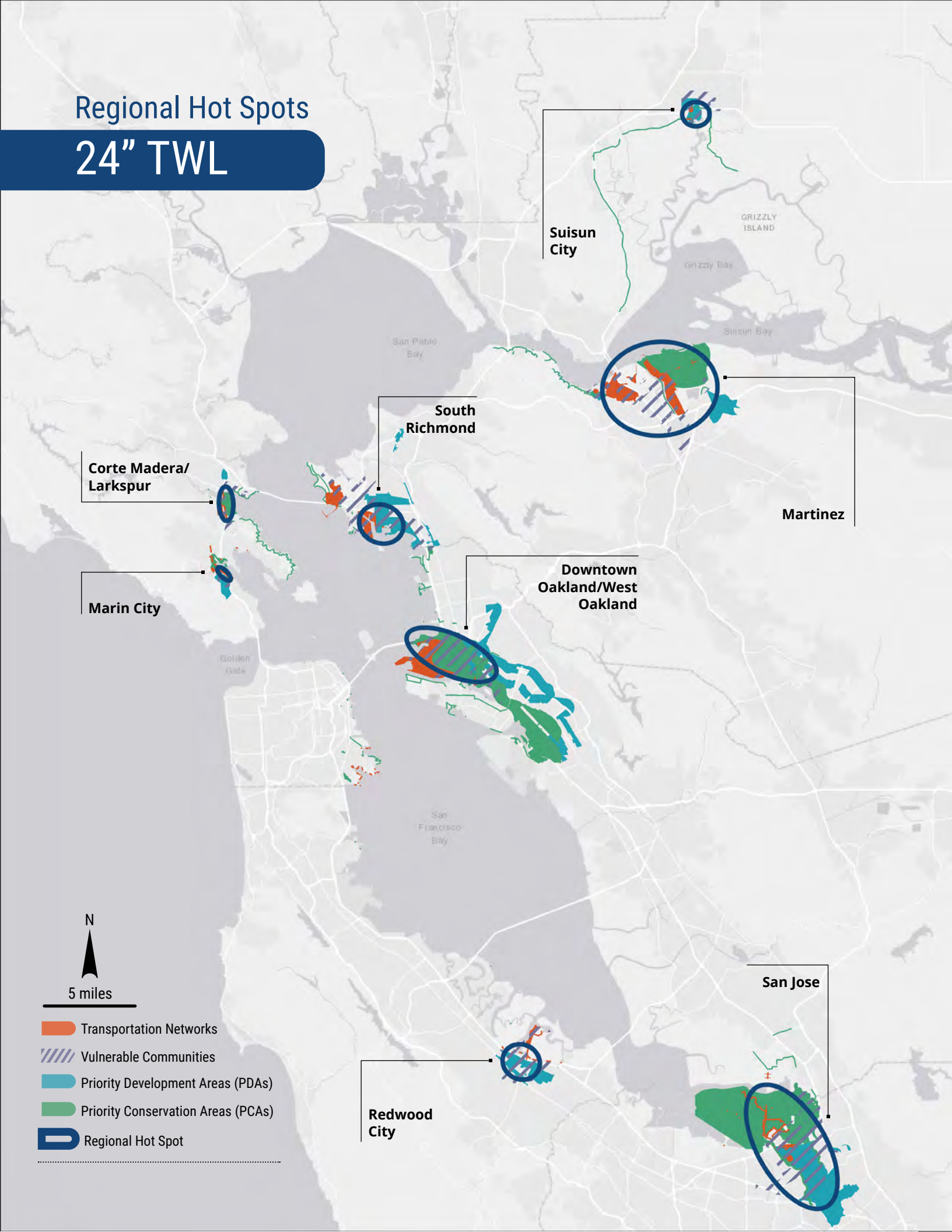
The San Jose cluster is driven by is driven by the North San Jose PDA (2010 and 2040 residential units, 2010 and 2040 job spaces, and residential units and job spaces growth), lagoons, snowy plover habitat, tidal marsh habitat, agricultural lands, and visitation in the Baylands/Santa Clara Valley PCA, and the Bay Trail, Champion Station passenger rail station, VTA and Amtrak passenger rail lines, Union Pacific freight rail line, and truck traffic on SR-237. It also contains both social vulnerability and contamination.

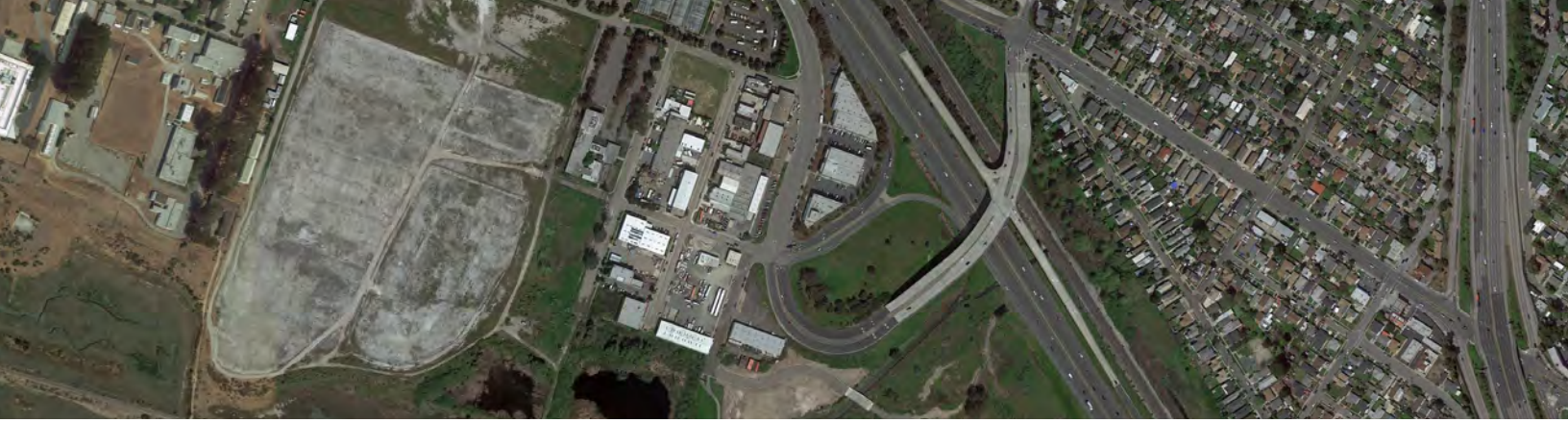
The Redwood City cluster is driven by the Broadway/Veterans Corridor PDA (2010 and 2040 job spaces, and job spaces growth), Union Pacific freight rail, and both social and contamination vulnerability.

Figure 2-4. Regional Hot Spots at 24" TWL. New hot spots emerging across the region. Hot spots in the region include Corte Madera/Larkspur, Marin City, Suisun City, Martinez, Downtown Oakland/West Oakland, San Jose, and Redwood City.

Regional Hot Spots

24” TWL





South Richmond shoreline with wetlands near I-580. Map data ©2019 by Google Earth Pro.

Patterns Stabilizing: 36" TWL

By 36" TWL, new clusters emerge, many of which remain across higher total water levels (Figure 2-5). Clusters at 36" TWL include Napa, Suisun, Martinez, Richmond, Downtown Oakland/West Oakland, East Oakland/Coliseum, Alameda, San Jose, Mountain View, Redwood City, East Palo Alto, and San Francisco Bayview/Hunters Point.

The Napa cluster is driven by impacts to depressional wetlands, Ridgway's rail habitat, snowy plover habitat, tidal marsh habitat, salt marsh harvest mouse habitat, agricultural lands, groundwater recharge and stormwater infiltration, and visitation in the Napa Valley-Napa River Corridor and Napa County Agricultural Lands and Waterways PCAs as well as a Regional Bicycle Network segment, along with socially vulnerable block groups.

The Richmond cluster is largely driven by the South Richmond PDA (2040 job spaces and growth in job spaces) and Port of Richmond, as well as several socially vulnerable and contaminated block groups.

The East Oakland/Coliseum cluster is driven by the Coliseum BART PDA (2010 job spaces, 2040 residential units, and growth in residential units), Oakland Airport (both passenger boardings and cargo), and socially vulnerable and contaminated block groups.

The Alameda cluster is driven by the Naval Air Station PDA (2010 residential units), Alameda Gateway Ferry Terminal, and Bay Trail, as well as socially vulnerable and contaminated block groups.

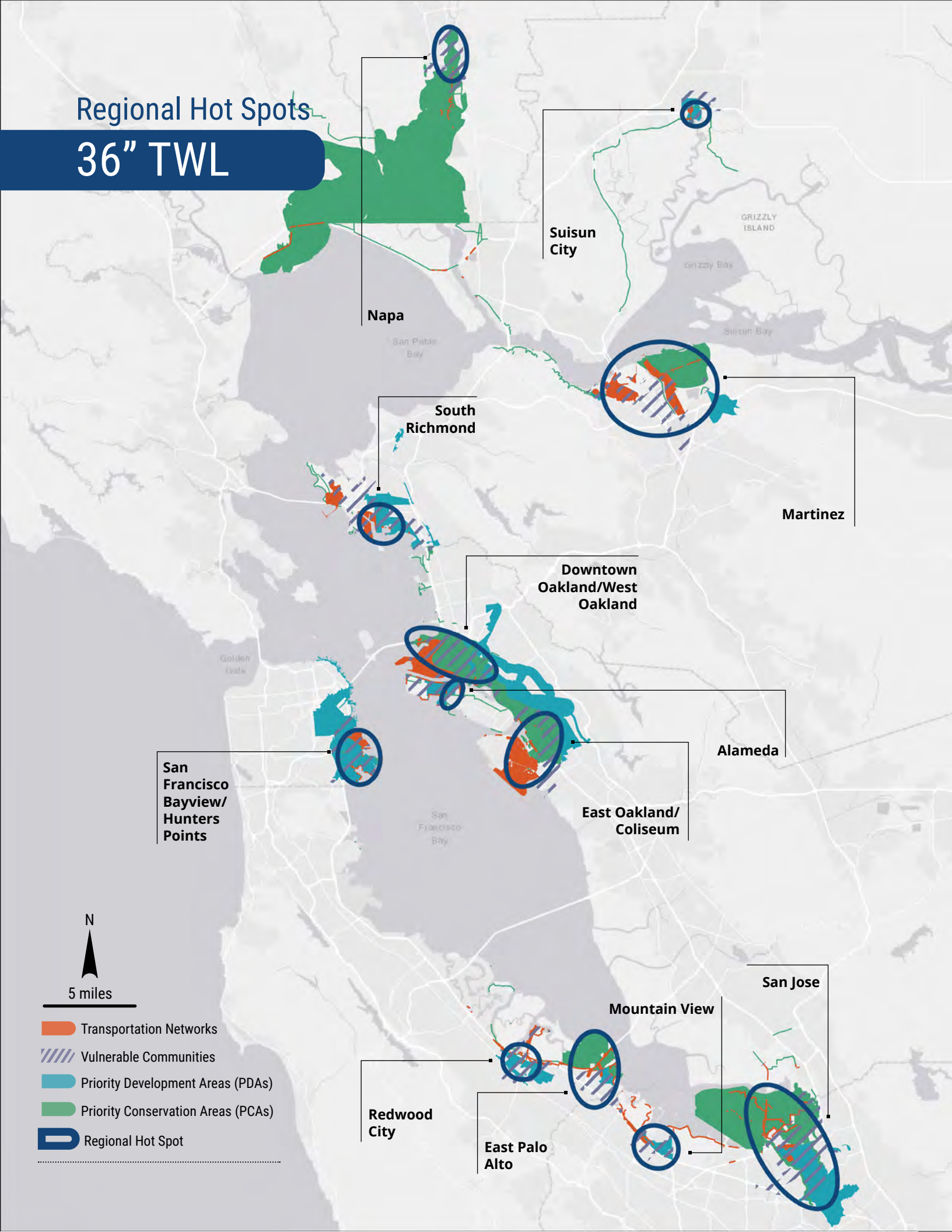
The Mountain View cluster is driven by the North Bayshore PDA (2040 residential units and growth in residential units), a Regional Bicycle Network segment, and truck traffic on US-101, as well as socially vulnerable and contaminated block groups.

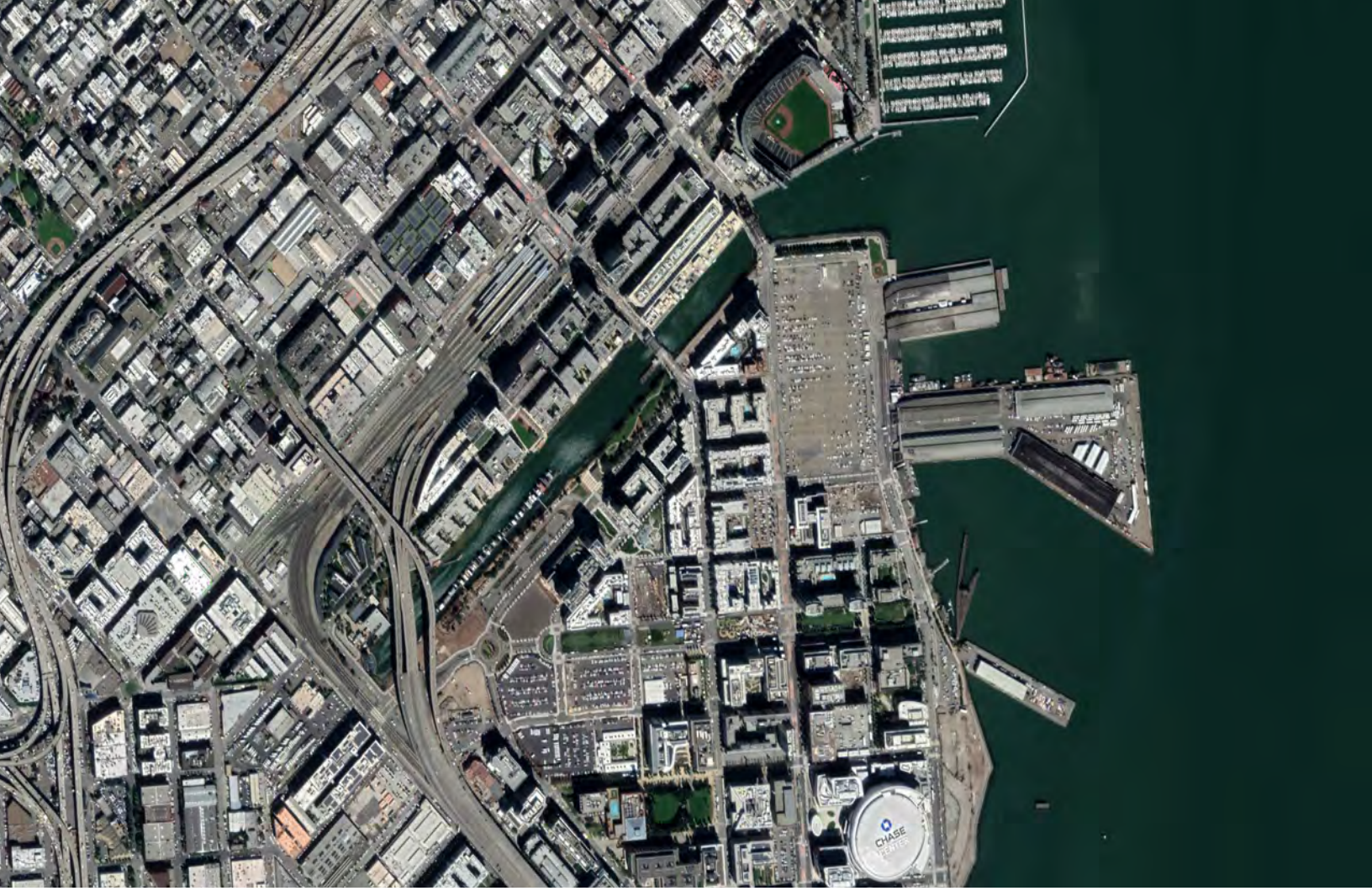
The East Palo Alto cluster is driven by depressional wetlands, lagoons, and snowy plover habitat in the Menlo Park and East Palo Alto Baylands PCA, a Regional Bicycle Segment network, and socially vulnerable and contaminated block groups.

Figure 2-5. Regional Hot Spots at 36" TWL. These include Napa, Suisun City, Martinez, Richmond, Downtown Oakland/West Oakland, East Oakland/Coliseum, Alameda, San Jose, Mountain View, Redwood City, East Palo Alto, and San Francisco Bayview/Hunters Point.

Regional Hot Spots

36” TWL





Islais Creek in Mission Bay, San Francisco. Map data ©2019 by Google Earth Pro.

High Consequence Clusters: 48" TWL

Many of the same clusters from 36" TWL remain at 48" TWL, but a few new ones emerge that remain over higher total water levels (Figure 2-6). In addition to the clusters at 36" TWL, Corte Madera/Larkspur re-emerges, San Francisco Mission Bay and San Francisco Embarcadero emerge as a high-importance clusters. Suisun City and Alameda drop off in regional criticality compared with other assets.

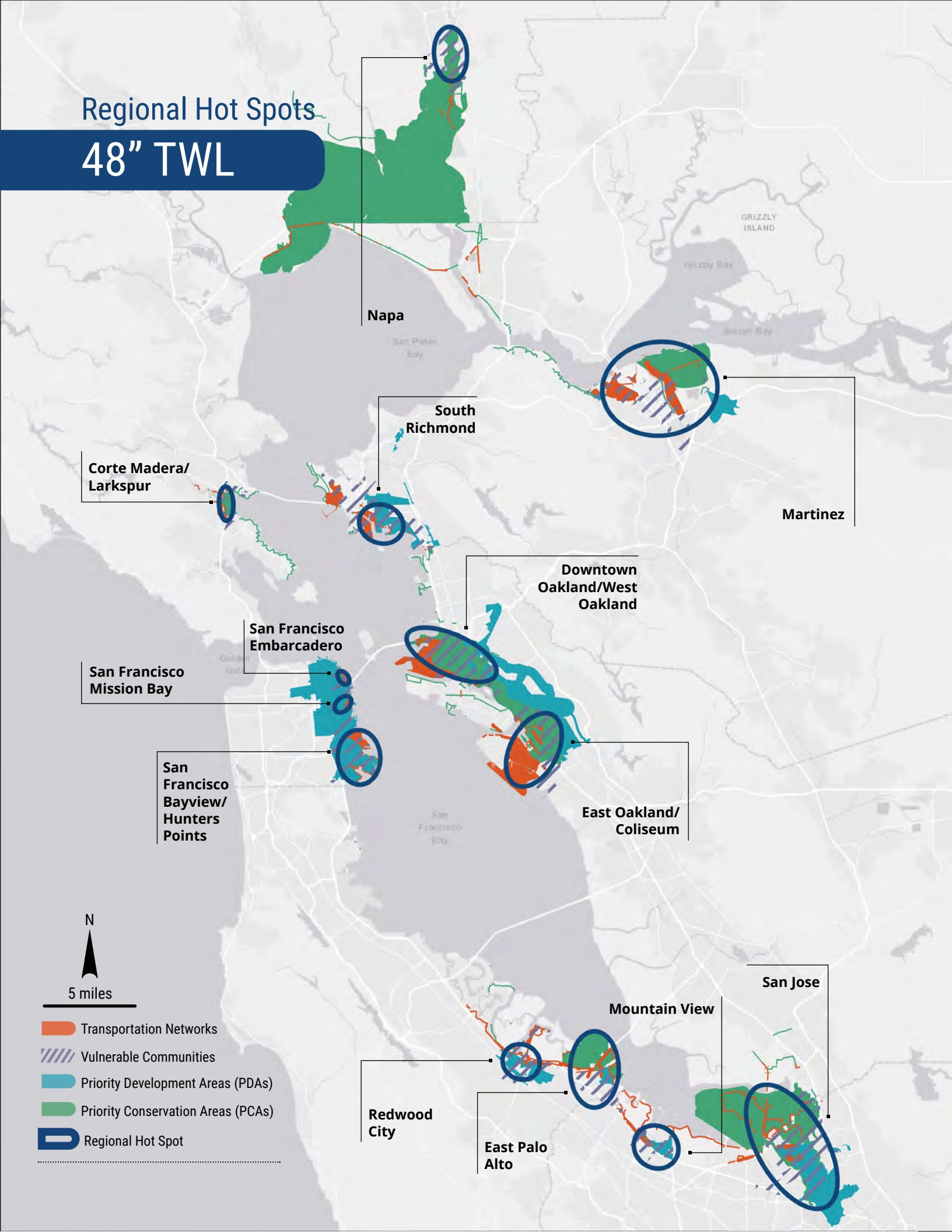
The San Francisco Mission Bay cluster is driven by the Mission Bay PDA (2010 residential units and job spaces), the Third Street Muni Line, and social vulnerability and contamination.

The San Francisco Embarcadero cluster is driven by the Port of San Francisco PDA (2010 and 2040 job spaces), the San Francisco Ferry Terminal, a Muni bus route, and a Muni rail line, along with multiple socially vulnerable and contaminated block groups.

Figure 2-6. Regional Hot Spots at 48" TWL Most hot spots from previous total water levels remain, and only a few new ones emerge. New hot spots include Corte Madera/Larkspur, San Francisco Mission Bay and San Francisco Embarcadero.

Regional Hot Spots

48” TWL



View of the Brisbane Baylands in the San Francisco-San Mateo Bi-County PDA where future development is planned. Map data ©2019 by Google Earth Pro.

Higher Water Levels: Outliers and Exceptions

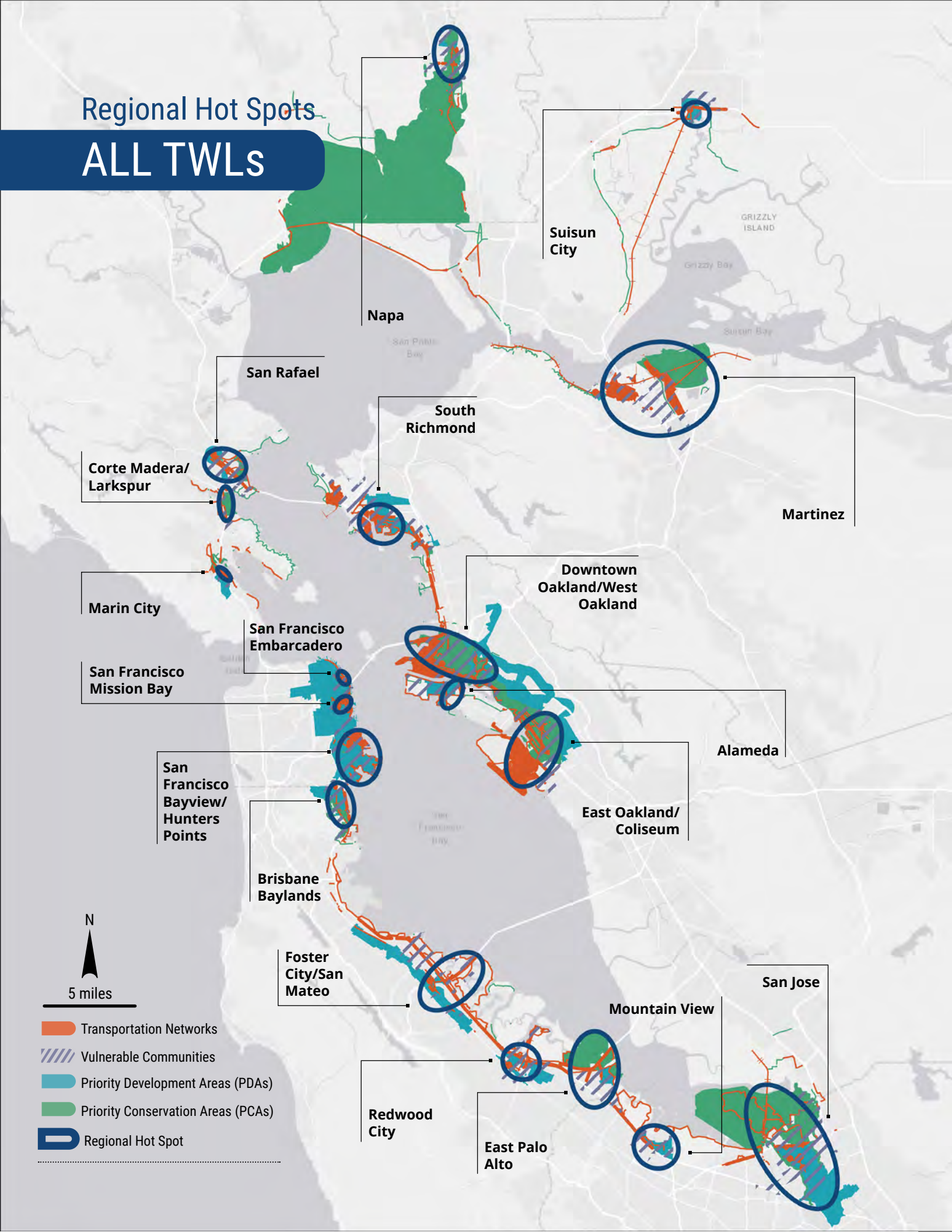
After 48" TWL, the clusters typically remain steady (Figure 2-7). Some other locations are added as top consequence indicators shift due to changing exposure, such as Foster City/San Mateo (driven by multiple transportation assets and the Grand Boulevard PDA) emerging at 52" TWL (Suisun also re-emerges at this TWL) and Brisbane Baylands emerging at 96" TWL, driven by exposure of the Caltrain rail line alongside US-101 and the San Francisco/San Mateo Bi-County Area PDA.

Some clusters also fall off as new assets are exposed, or exposure worsens. At 52" TWL, Corte Madera/Larkspur falls off, and Suisun City, Redwood City, and Foster City/San Mateo fall off at 66" TWL. Corte Madera falls off at 77" TWL and Mountain View falls off at 108" TWL.

Figure 2-7. Regional Hot Spots at all Total Water Levels. After 48" TWL, hot spots remain relatively the same as total water levels rise. The few exceptions include new hot spots in Foster City/San Mateo and Brisbane Baylands. The map represents hot spots that emerged at any total water level.

Regional Hot Spots

ALL TWLs



Water levels rising during a King Tide in Mission Bay in San Francisco. Photo by BCDC.

2.3 Common Vulnerability Themes: Regional Key Planning Issues

DEFINING CROSS-CUTTING ISSUES IN THE REGION

Regional Key Planning Issues are challenges that require the collective focus of the region, either because they represent challenges larger than any single jurisdiction could solve on their own, or they are challenges that are common to many locations within the region and would benefit from a coordinated approach.

Identification of Regional Key Planning Issues that are region-wide serves as a process to summarize and organize assessment findings across sectors and geographies so they can be clearly and succinctly communicated. The process of articulating Regional Key Planning Issues also helps the Regional Working Group confirm shared priorities and serves as the starting point for identifying collective action necessary to resolve the challenges as a region.

ART Bay Area identified eight Regional Key Planning Issues that arose from hundreds of qualitative vulnerability and consequence statements cutting across the four asset categories as well as all 13 OLUs and 32 Focus Areas and Areas of Impact. These key issues highlight:

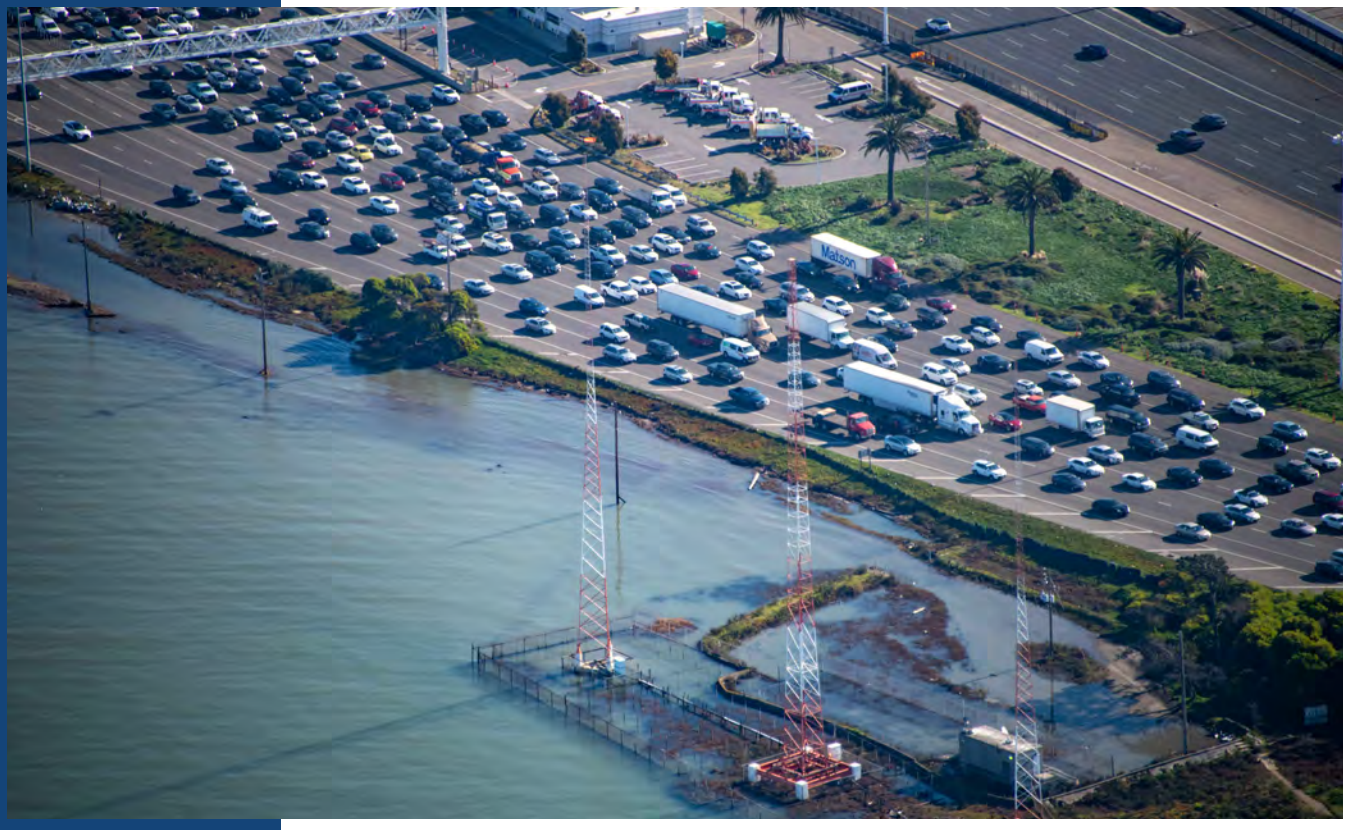
1. **Local and Regional Transportation Hubs Come Together and Flood Together**
2. **Sea Level Rise Decision-Making is Complicated by Ownership, Governance, Management and Regulatory Issues**
3. **Interconnected Local and Regional Emergency and Critical Services Are at Risk**
4. **Contamination Complicated and Exacerbates Flooding Issues**
5. **Rising Sea Level Will Amplify Existing Housing and Displacement Concerns**
6. **Future Development Areas Can Be Critical Tools for Resilience**
7. **Rising Sea Level Will Put Pressure on the Relationship Between Regional Recreation and Habitat**
8. **Nearshore Habitats and the Ecosystem Services they Provide are Sensitive to Sea Level Rise Early On**

REGIONAL KEY PLANNING ISSUE

#1

Local and Regional Transportation Hubs Come Together and Flood Together

Many shoreline areas contain clusters of multiple vulnerable transportation assets that serve as critical nodes and links for regional and local transportation systems. In many cases, these assets lack redundancy and are networked such that loss of function of an asset or portion of a system due to sea level rise would cause significant regional impacts to commuters, access to recreation and services, and movement of goods. This could include region-wide extended transportation times and strain on other transportation systems, loss of economic value from inability to access jobs, services, and goods, as well as disproportionate impacts to service sector workers (unable to telecommute) and people with access to fewer transportation resources (i.e. no car, or transportation cost burdened).



I-80 San Francisco-Oakland Bay Bridge Touchdown during King Tides in January 2020. Photo by SF Baykeeper, Robb Most, and LightHawk.

The region hosts a robust system of local and regional transportation systems, many of which are centered around the bay shoreline. These systems interconnect and users often utilize multiple modes and systems to access work, home, shopping, and services. Local users rely on regional systems, and regional systems are fed by local systems, creating complex interdependencies. The following issues emerged as major regional vulnerabilities:

Interconnection of local and regional systems

In the Bay Area, many commuters rely on multiple modes of transportation to get to work, access services, take their kids to school, and access recreation opportunities. Residents may utilize local roads, highways and freeways, buses, BART, ferries, and pedestrian and bike trails on any given day. Throughout the region, there are many nodes where multiple transportation systems interconnect, allowing users to transfer easily between systems. While these nodes are convenient for seamless transportation, they represent critical shared vulnerabilities, as flooding in a single location would impact the functionality of multiple transportation system.

Some nodes, like San Francisco International Airport, obviously have significant criticality not only to the region, but also to the world, and have very clear economic benefits, if their function is protected, that far outweigh the costs of protection. Other nodes, such as the San Rafael Transit Center, which connects regional buses to local buses, local roads, the SMART train, and the Larkspur Ferry Terminal, may be extremely critical to their immediate community but not to the region as a whole. In these cases, their benefit vs. cost may not be obvious using an economic model.

Goods movement

The region also serves as a hub for goods movement, both within the region as well as into and out of the rest of the state and the world. The region is home to multiple cargo marine ports and airports and depends on local roads, highways, freeways, and rail lines to move goods. Because much of the cargo moves through transportation assets focused along the shoreline such as rail, highways, and ports, and because transportation corridors for cargo are much less flexible and redundant than transportation corridors for people, this sector of transportation is particularly vulnerable.

Richmond provides a prime example of co-located vulnerable systems critical for goods movement – Richmond contains both a Marine Port and Oil Tanker Terminals, which connect to rails owned and utilized by the Union Pacific Railroad, Burlington Northern Santa Fe, and Richmond Pacific Railroad, as well as serves as a key access point via highway to Marin County via I-580, Solano and Sacramento as well as Oakland and points south via I-80.

Networked systems and redundancy

Transportation systems with fixed assets such as rail and roads function as a networked system, such that disruption of a node (i.e., a BART station or highway interchange) or link (section of freeway or train track) has cascading impacts throughout part or all of the rest of the system. Because transportation functions are spatially fixed (the function of a section of a BART line cannot easily be moved) and investment in transportation assets are significant in terms of time and money, there is often little redundancy within a given system. Additionally, while some redundancy between systems may exist (for example, if a portion of a freeway is flooded, a user may take a ferry to get to work instead), redundant systems are often unable to accommodate enough additional users to ensure uninterrupted functions. This is exacerbated by the fact that many of the region's transportation systems are operating at or near capacity and lack of ability for many transportation systems to add capacity quickly.

At its worst, lack of redundancy can sever connections and isolate communities. An example of this is Marin City, which has only one access road in and out of the community and floods starting at 48" TWL. In areas where redundancy is insufficient to meet added demand from a severed link, consequences could include significantly extended travel times, decreased economic output due to inability to access jobs, services, and goods within the region and beyond the region, and impacts to emergency services such as fire trucks and ambulances. Consequences will disproportionately impact vulnerable populations who may not live in more expensive urban areas with more transit options, may not have a car and therefore be dependent on vulnerable transit systems, may lose their jobs if they are unable to be physically present (such as service workers who cannot perform their job remotely like many white collar workers can), or may not be able to afford alternative transportation options that are more expensive (for example, ferries are typically more expensive than buses).

Transportation as flood protection

In some cases, linear transportation assets along the shoreline such as freeways and rail lines serve as de-facto flood protection, so flooding will affect not only the asset, but the communities behind it that depend on it for flood protection. A prime example of this is SR-37 and the adjacent railroad north of Bel Marin Keys, which are elevated on a low berm, as well as the west Contra Costa shoreline, where the railroad tracks along the shoreline are elevated on berms. How these assets are protected will have ripple effects far beyond the asset itself. For example, if a portion of rail that is vulnerable is elevated off the ground to protect its function, but the rail line has been creating an ad-hoc levee for the community behind it, elevating the rail solves one problem (the function of the rail line) but creates another (the community behind the rail line is now exposed to flooding). This same situation also creates the opportunity for multi-benefit adaptation strategies, if

transportation assets are evaluated holistically. Some assets are so critically important that they will be protected at all costs (see discussion in previous paragraph). In these cases, investment in protection of these assets may also provide protection for nearby communities and assets as well, but this will require greater analysis and coordination and may require transportation projects to extend above and beyond current typical project scopes and require new forms of financing, especially if benefits are more diffuse.

Railroad tracks along Contra Costa shoreline near Point Pinole demonstrate how transportation assets can also serve as ad-hoc flood protection. Photo by SF Baykeeper photographer, Cole Burchiel, and LightHawk.

REGIONAL KEY PLANNING ISSUE

#2

Sea Level Rise Decision-Making is Complicated by Ownership, Governance, Management, and Regulatory Issues

Solving many of the local and regional sea level rise vulnerabilities identified in ART Bay Area and in local planning processes will need to involve a large number of stakeholders that own, manage, regulate, or govern the location, existing assets, or new assets that may be needed. All parties need to fully understand the role they play in the vulnerability of the area, as well as their role in establishing common goals and developing and implementing solutions.

Existing structures, decision-making processes, and funding processes may be insufficient to pay for the types or extent of adaptation projects required. Addressing resilience will require innovative forms of planning and decision-making. Of critical importance is the involvement of the local community in this process, as they are the largest stakeholder in many projects, and the one most likely to be overlooked.

The south bay shoreline contains a variety of managed ponds and wetlands, with many different private and public interests. Photo by SF Baykeeper photographer, Robb Most, and LightHawk.

Unlike many other types of problems that local and regional governments solve on a daily basis, sea level rise is a problem of the commons, and decisions made in one location can have implications for other locations. The best way to ensure that future planning and projects provide region-wide benefits and avoid localized negative consequences is to create coordinated, region-wide processes for setting goals, making decisions, funding solutions, and empowering local communities to be able to navigate these complexities. Below are the barriers identified that contribute to this Key Planning Issue.

Local Capacity

Local capacity to plan for sea level rise and carry out projects is highly variable around the region. Some highly resourced cities and counties have done extensive analysis and planning, while other communities lack staff to do daily planning, much less long-term, speculative planning. This can create highly variable abilities to act proactively, including gathering or analyzing information to inform decision-making about sea level rise solutions, finding and developing funding and financing for planning and projects, and ability to coordinate through community engagement or with other stakeholders throughout the region. Additionally, if lower-resourced communities also contain vulnerable community members at risk from flooding, this may impact the ability of the community to provide support, protection, or advocacy to these communities.

Lack of Consensus

While there is a lot of guidance for cities on how to conduct local planning processes for sea level rise, there is a lack of consensus regarding the sea level rise projections and scenarios, and a lack of common goals and desired outcomes for sea level rise planning. This means that each community needs to set their own parameters for planning and projects, which can result in highly variable solutions that reflect an individual community's risk tolerance. Lack of region-wide goals may also mean that solutions benefit only the local community while causing unwanted effects on neighboring communities or regional systems, and that residents throughout the region may feel variable impacts depending on the decisions made by their local community. Lack of consensus also exacerbates lack of local capacity, as there is no regional incentive or mandate to help lower-capacity communities.

Challenging Funding/Financing

Existing funding and financing tools are typically not designed to be applied to sea level rise planning and projects. Local governments are extremely limited in their ability to raise money locally through property taxes and other local measures. Existing funding streams from the state or federal government may be tightly aligned with existing processes or mandates, such as federal transportation dollars

There are often many different interests and owners along the San Francisco Bay shoreline. Photo by BCDC.

that must fit tight criteria for transportation projects. Many of the criteria for existing funding and financing tools may underestimate the value of resilience projects, such as financial cost-benefit, because of the challenge of quantifying the benefits of avoided loss over the long term. Additionally, the magnitude of costs for sea level rise solutions may not be adequately addressed by existing funding sources. Lastly, because it will be difficult to measure quantifiable benefits from investment in adaptation, it can be challenging to identify who is responsible for paying for solutions to sea level rise. These problems point to the need for new, large, flexible funding sources and financing tools, as well as a collective funding approach to recognize the varying capacity throughout the region as well as the interconnected impacts and consequences of projects.

Complex Regulatory Landscape

Many of the responses to sea level rise will include building new structures, demolishing old ones, changing land uses, or other activities that may require a variety of local, regional, and state permits or be governed by various regulations. The regulatory landscape along the shoreline is already complex for projects today; sea level rise will likely require innovative or new types of projects that are not addressed or permitted by current regulation. Additionally, regulatory mandates already often conflict with one another, and this could worsen in the future if certain agencies make changes quicker than others, or if they disagree on the goals, science, or planning horizon of sea level rise. If the permitting process is not able to keep up with current and future needs and projects are denied permits, or if the sheer number or expense of, or timeline for acquiring permits is too onerous, projects may stall completely or may not be in place by the time they are needed.

Lack of Ownership and Leadership

While there are many individuals, organizations, and agencies working on components of sea level rise in the region, there is no clear agency charged with coordinating or "solving" sea level rise. The existing agencies that work within the region have limited jurisdictions or tools necessary for coordinated plans, policies, or financing tools. In addition to institutional limitations, there has been a lack of emergence of a single strong, consistent, and capable regional political champion for others to follow. On one hand, the diverse ownership and leadership in the region has created a number of tools, processes, and local leaders who are making progress on sea level rise; on the other hand, this has led to a fractured, uncoordinated process that is likely to create unintended consequences. Solving this part of the problem may require new authorities or structures with clear mandates to ensure that ownership and leadership roles are clear, though the process of deciding who creates and authorizes these new structures and mandates is currently unclear.

Complex Ownership, Management, and Dependencies

Private property rights are strong in the Bay Area, and much of the shoreline is in private ownership by individuals, businesses, and agencies. The land, and assets on the land, may also be managed, operated, and maintained by a diverse set of stakeholders, and in many cases the owner and manager may be different. Shoreline solutions to sea level rise are likely to be larger in scale than any individually owned parcel or asset, meaning that multiple stakeholders will need to coordinate about decision-making and solution implementation. This may require changes in ownership, tools such as easements, or changes to individual management approaches. In addition, owners of land and assets may be dependent on neighboring owners to make decisions that directly impact their assets, for example if a landowner is dependent upon a levee or wetland that sits between their land and the shoreline for flood protection.

Multi-Scale Decision-Making

Sea level rise solutions will need to be executed at multiple scales, from an individual parcel to larger portion of shoreline or linear assets that span single or multiple jurisdictions. While it is thought that many projects will need to be executed at a local scale, local projects have regional implications, either due to the fact that they are nodes in a regional system or a shoreline solution changes the hydrodynamics elsewhere in the bay and changes flooding patterns elsewhere. Additionally, many of the planning and policy tools that will help create more resilient solutions may be more effective, efficient, or coordinated if they occur at a sub-regional, regional or even statewide scale, rather than on a city-by-city basis. There are no current tools to help understand which decisions should be made at which scales, to assess how local projects will impact the region, or to identify local projects that are regionally critical due to the magnitude and scale of impacts.

Community Awareness and Engagement

For too long, community members who are impacted by local, regional, and state decision-making have not had an adequate role in influencing how decisions are made. Community member involvement can lead to better identification of vulnerabilities and better solutions, as well as create buy-in and trust, leading to political support for community changes or taxes that might otherwise prove unpopular. Public awareness and civic engagement can also help push changes from the ground up, as residents advocate for their protection and safety and ask their elected officials to meet their needs. Local community groups may also have high existing capacity for problem solving and project and service delivery that can help create resilient solutions. Local private landowners also need to understand their role in advancing local and regional adaptation by understanding their own risk, dependencies on the assets they own, and their rights and responsibilities in developing and implementing solutions.

REGIONAL KEY PLANNING ISSUE

#3

Interconnected Local and Regional Emergency and Critical Service Functions are at Risk

In the event of a significant emergency event such as an earthquake, major flood, or wildfire, many critical services are required to move people and goods within the region as well as in and out of the region. Many locally and regionally critical emergency management assets, such as lifeline routes or redundant routes (for example, ferries provide redundancy if bridges are unusable), and police or fire stations are located in flood areas, putting their functions at risk.

Additionally, critical services such as water, wastewater, electricity, and communications may also be at risk, which can exacerbate the impacts of a disaster event or cause cascading emergency situations. Lastly, many community-serving centers like schools, places of worship, and libraries that serve critical functions in emergency events may be inundated and unable to serve both local and regional populations, exacerbating impacts, especially to community members who lack private resources to prepare for, respond to, or recover from a disaster.

Emergency crews pump water from flooded streets at South Bay Mobile Park Monday, Feb. 20, 2017, in San Jose, Calif. Photo by Jim Gensheimer/Bay Area News Group.

The Bay Area is not only at risk from sea level rise, but many other natural disasters such as wildfire, earthquakes, and storm-induced flooding. The region depends on many functions to respond to emergencies and provide services to residents in and after a disaster event. The following sectors are especially critical during emergencies and disasters:

Transportation

Before or during a disaster event, evacuation of at-risk locations may be necessary to relocate people from harm's way. Effective evacuation depends on the functionality of transportation systems, and redundancy is especially critical if the disaster renders certain routes or modes of transportation unusable due to flooding. In addition to evacuation, transportation is critical during the disaster for emergency vehicles like fire trucks or ambulances, and for moving goods and supplies into place. Following a disaster, there will likely be an increased need to move goods, such as food, medical supplies, and building material, and people into and out of impacted areas.

Emergency Response Facilities

First responders are critical to managing a disaster or emergency situation and need to be able to function quickly and effectively. Fire stations and law enforcement facilities are vulnerable to flooding because their buildings often have at-grade openings that are not built to withstand flooding, and if these facilities are unusable, or if equipment stored at these locations is flooded and becomes unusable, emergency response will be severely limited. Additionally, first responders depend on several other services and functions for their own function, such as power, water, communications, and transportation (getting first responders to stations and equipment and getting them and their equipment to the disaster location). However, emergency facilities are often likely to have an inherent capacity to adapt to impacts, having access to emergency water pumps and power as well as strong emergency protocols and plans.

Community-serving facilities

Many facilities that the community uses on a regular basis in non-emergency times serve special functions during and after emergency events. These types of facilities can include schools, places of worship, libraries, or community centers. These facilities may serve as temporary shelters and bases of operations for relief efforts or may serve as a hub for residents to access services like food, financial assistance, or even emergency medical care. In addition, these facilities serve an important role in maintaining social networks and a sense of community, serving as a place for neighbors to find each other, get information, and give and receive support. Places of worship in particular may provide additional social and psychological support in times of disaster or emergency.

Healthcare Facilities

In a disaster event that results in injuries, emergency healthcare facilities such as hospitals are of critical importance. But day-to-day community-serving facilities are also critical, especially when residents rely on them for the management of chronic diseases, such as dialysis centers, chemotherapy centers, and community clinics that serve traditionally underserved populations such as undocumented immigrants and the homeless population. Hospitals and residential care facilities are especially difficult to evacuate due to the specialized needs of their occupants, including limited mobility, dependence on machines such as respirators, and need for supplies such as medication. Healthcare facilities are also highly dependent upon other sectors, including power, water, wastewater, and transportation. However, some facilities like hospitals may include redundant supplies or power sources that can assist with their functioning for a limited amount of time.

Inter-jurisdictional Dependencies

Many communities throughout the Bay Area have mutual aid or interoperability agreements with nearby communities to retain access to functions and services even if their own facilities are non-functioning. These agreements inherently make local facilities regional in nature, as impacts to a local facility will not only impact the community it is in but reduces redundant capacity for nearby communities. Additionally, certain institutions such as hospitals serve a regional (or larger) population base, especially those that perform specialized functions. Supplies may also be stored in a limited number of locations but need to be distributed regionally after a disaster or emergency, such as food stored in food banks, materials to repair roadways or utilities, or other specialty supplies.

One example of an area where interconnected services are at risk is in Downtown Redwood City. This area contains Kaiser Permanente Hospital facilities, Stanford medical facilities, City and County facilities including a Police Station and the Redwood City Woman's Correctional Facility and begins to flood by 36" TWL. This area also contains electrical substations, putting functions at risk due to cascading impacts. US-101 just south of downtown also floods, limiting access into and out of this area.

View of Redwood City looking out from the Kaiser Permanente Hospital. Photo by bgwashburn licensed CC BY 2.0.


REDWOOD

REGIONAL KEY PLANNING ISSUE

#4

Contamination Complicates and Exacerbates Flooding Issues

Many areas at risk of flooding are on or near former industrial sites that have been designated as contaminated areas. Exacerbating this issue is the fact that many vulnerable communities have been pushed to marginal lands adjacent or even on contaminated sites. Development pressure in the Bay Area due to lack of housing is also pushing some of the more centrally located former industrial sites towards new housing and jobs.

There is significant uncertainty about how flooding and rising groundwater will exacerbate contamination and increase public health concerns if contaminants are mobilized, or how dry land cleanup standards will perform if lands become submerged. New development, flood control projects, and considerations for existing vulnerable communities must take into account the risks and uncertainty around shoreline contamination.

Below are some major vulnerabilities around contamination and sea level rise that are present throughout the region.

Former naval shipyard at Hunters Point. Photo by Paul Chinn, The Chronicle.

Contamination and Vulnerable Populations

It is not uncommon for vulnerable populations to occupy land that is less desirable due to its proximity to industrial uses, solid or wastewater treatment facilities, or other land uses that can create soil, water, or air contaminants that can cause health impacts to nearby populations. In the Bay Area, many contaminant-producing uses and nearby vulnerable communities are also along the shoreline and subject to flooding from sea level rise. Increased pressure to create new housing and job centers, especially in dense urban areas, is also increasing the exposure of communities to contaminated sites, as many of the available redevelopment sites are on or near former industrial lands or landfills.

Contamination and Flooding

Contaminants in the soil and groundwater, especially those that have not been properly treated, could become mobilized during flood events or as the water table rises. Contaminants could move from location to location through floodwaters or contaminated soils, leading to new contaminated sites or groundwater. As this occurs on a more frequent or permanent basis, the impacts of mobilized contaminants are unknown, but could be widespread. These impacts could expand to more communities as well as potentially impact ecosystems, including wetlands created as part of a flood control strategy, and access to recreation. Additionally, rising water tables will also mean more salinity in the groundwater, which itself could be seen as a contaminant, rendering drinking water undrinkable and impacting ecosystems that cannot accommodate brackish water.

Cleanup of Contaminated Sites

It is unknown to what degree current and past cleanup requirements will be sufficient in protecting communities and the environment from contaminants, especially as flooding and rising groundwater occurs. More research is needed to fully model the potential consequences of contaminant mobilization or how sea level rise and new shoreline development or flood control projects will alter exposure to contamination. Additionally, sites that have already been remediated may need to be revisited given changing conditions, and future cleanup and review requirements may need to be rethought in flood-prone areas based on best management practices. Additional education or information may be needed for land owners and managers as well as nearby populations who may be impacted.

Transporting Fuels

The transportation of contaminants also poses a potential issue in the face of sea level rise. The Bay Area is a hub for fuel refinement and transportation and relies on heavy rail, pipelines, and freeways to transport hazardous materials. If these systems are damaged or their functions compromised, this could create hazardous materials spills or significantly change the way goods are transported, leading to greater risks of spills from trucks moving through neighborhoods (as opposed to rail or pipeline, which are less likely to be within neighborhoods) and increased air pollution in these neighborhoods.

Federal or Military Ownership of Contaminated Sites

Throughout the Bay Area, many of the sites with contamination are former military sites, including Hunters Point and Mare Island (former Naval Shipyards), Alameda and Moffett Field (former Naval Air Stations). Since the military is subject to federal, not state or local standards, these sites may have been remediated to different standards than other nearby sites and, depending on current military involvement, may be more complicated to adapt due to a more complex ownership and management structure.

REGIONAL KEY PLANNING ISSUE

#5

Rising Sea Level will Amplify Existing Housing and Displacement Concerns

Throughout the Bay Area, a severe housing affordability crisis is exacerbating the social vulnerability of populations throughout the Bay Area to a degree that displacement risk is at an unprecedented high. This pressure is felt most acutely by communities subject to historic and ongoing marginalization, in particular low income and communities of color, but any combination of social vulnerability factors, such as transit dependence, contamination and environmental justice burdens, language barriers, status as renters, or disability, among other factors, can compound vulnerability.

Additionally, many vulnerable communities are disproportionately exposed to sea level rise and, in many cases, live in poor quality, older housing that is especially sensitive to flooding, while being least prepared to adapt to sea level rise. This creates another factor for displacement. Displacement, in turn, contributes to loss of community cohesion and social networks, which further adds to vulnerability to hazards like flooding.

A street in East Palo Alto, a city with increasing housing affordability concerns. Photo by BCDC.

The Bay Area has experienced steady growth in population coupled with a significant growth in jobs and economic output over the past decade. While this has led to an extremely strong regional economy, the additional population coupled with an influx of high-salary jobs has put extreme pressure on a slow-to-expand housing market. Rising housing costs, combined with lack of tenant protections, can result in families having to relocate to distant, more affordable communities. This displacement disproportionately impacts lower income renters who are less likely to be able to find affordable alternative housing and can lead to loss of community, loss of access to jobs and services, and increased commute times and costs if people have to move far from their jobs to find alternative housing.

Below are some considerations for housing, people, and displacement when planning for sea level rise.

Rising Sea Level will Exacerbate Housing Displacement Risks

Social vulnerability factors, especially being low income and housing cost burdened, increase the likelihood that a resident will experience displacement due to gentrification. Sea level rise will also increase displacement, forcing residents to move if their neighborhoods are temporarily or permanently flooded. Vulnerable populations, including renters, low income, and people of color, are often disproportionately likely to experience displacement due to rising sea levels due to the fact that many of these populations live along the bay shoreline in historically less desirable areas (areas of the shoreline that were filled in the mid-19th century by developers seeking to expand developable areas, or shoreline areas where industrial uses had historically been present). Much of the housing occupied by vulnerable populations is also likely to be older and in poor quality[1], which makes it less able to withstand or recover from flood events. Additionally, the populations themselves are less resilient to flooding, due to having fewer resources to prepare themselves, such as floodproofing their homes, moving to less flood-prone areas, or carrying flood insurance. This means that certain populations may experience more factors that increase their likelihood for displacement, and also many of the same factors that put them at risk for displacement from gentrification are the same factors that increase their risk of displacement due to rising sea levels.

Housing Displacement Reduces Social Resilience

In contrast to measurable indicators of vulnerability such as income and ethnicity, existential factors such as community cohesion and social networks increase the resilience of community members[2]. People depend on their religious communities, neighbors, nearby family members, and community groups to meet their needs during disaster events and in disaster recovery. Strong community bonds can

also advocate for better local decision-making within the community by enabling residents to have a stronger collective voice. Displacement breaks up existing communities and networks, reducing community cohesion and social capital and increasing social and disaster vulnerability.

Without Adaptation Measures, Sea Level Rise will Increase Housing Pressures

Loss of housing due to sea level rise will amplify existing housing pressures by removing existing units from the market and limiting locations where new housing can go. Limiting new housing to locations outside the flood areas will increase housing development pressure elsewhere, increasing densification in existing development areas and possibly pushing new development into greenfield areas. These pressures may also increase traffic and job commute times, create the need for new supportive infrastructure such as utilities, transportation, services, and shopping, and place additional climate burdens on new communities, such as risk for extreme heat and wildfire.

Property Values Will Influence Adaptation Decisions

The housing shortage has also driven property values to unprecedented heights. This provides significant financial challenges for many adaptation strategies, as costs for acquisition of private property may be prohibitive, and homeowners have strong incentive to retain or enhance property values and right to private property (since private property is currently an extremely powerful tool for wealth-building). Homeowners may not be likely to support actions like downzoning or buyouts that threaten the value of their asset, and instead prefer protective actions that maintain the status quo. However, over time, rising insurance costs and erosion of property values due to increased flooding will devalue certain properties naturally, which may prompt homeowners to demand restitutive or compensatory action from the government to help them cope with the consequences.

Housing and Adaptation Need to be Balanced

There is currently mounting pressure on cities and developers to build new housing to help ease the shortage. There are significant hurdles to this, including high cost of land, construction materials, and labor; pressure to build near transit and existing density, and pushback from long-term residents who are not comfortable with the increased traffic and visual and socio-economic changes in their community. Because of these many conflicting pressures, there may be inadequate or inconsistent consideration of how new housing will perform in the face of sea level rise. Without stronger policies, housing is likely to be built within current and future flood zones and not built to be adaptive to flooding. However, proposing use limitations and/or increased building standards may be seen as adding increased pressure to a building economy that cannot bear any more pressures. And, despite

the fact that flooding will increase displacement and loss of housing, since sea level rise is a long-term threat, the immediate challenge of housing affordability may take precedence over another, more uncertain and distant challenge. Solutions will have to be highly localized and balance long-term considerations, such as impacts to people and long-term protection costs shorter-term considerations, like managing the housing crisis.

RVs parked on Bay Road in East Palo Alto in March 2018. Photo by BCDC.

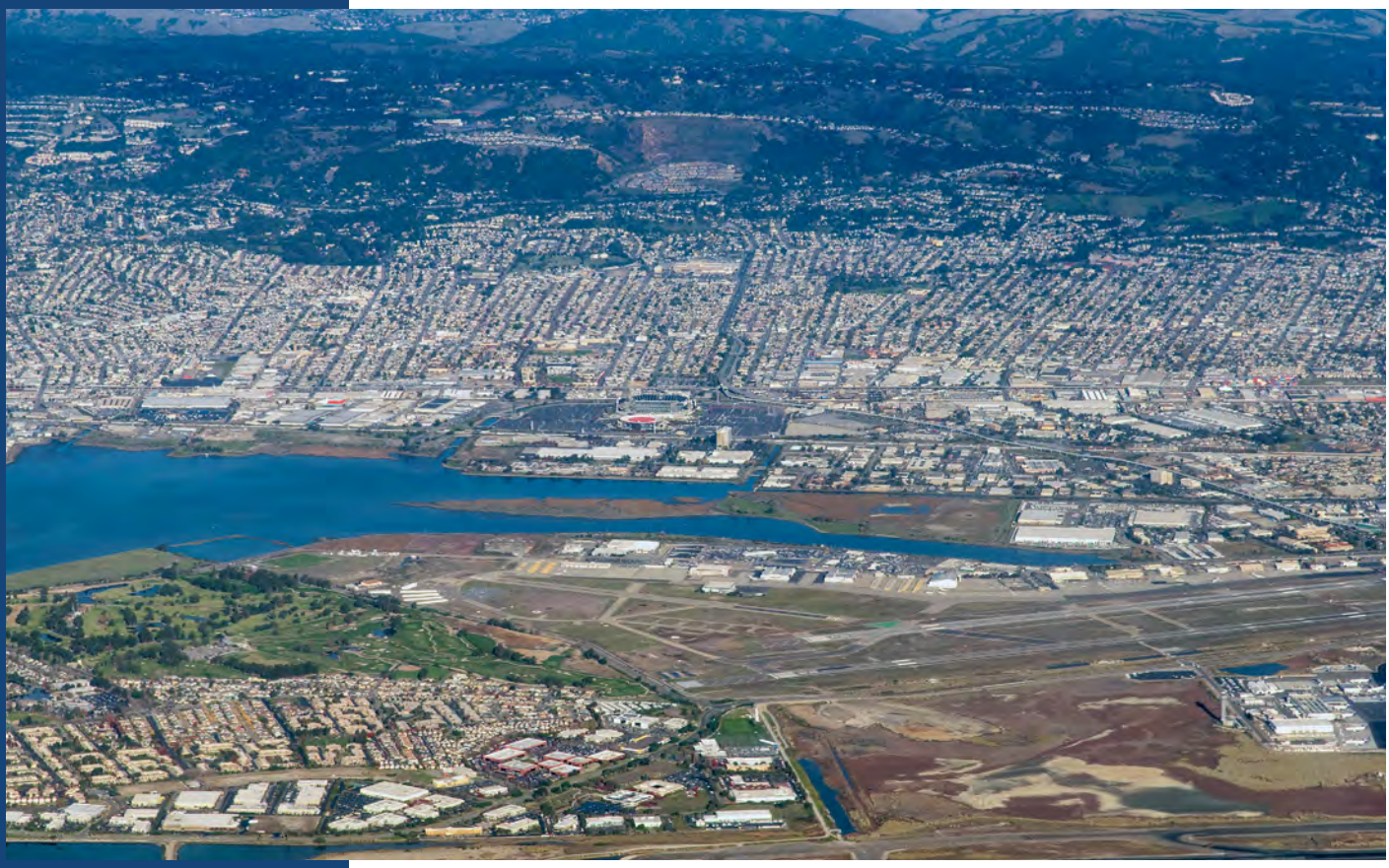
REGIONAL KEY PLANNING ISSUE

#6

Future Development Areas can be Critical Tools for Resilience

A strong economy has added a large number of jobs and people to the region in recent years. There is significant region-wide pressure to add new development to accommodate these jobs as well as provide much-needed affordable housing to ease pressure in a limited housing market. SB 375 and the RHNA process are designed to facilitate new development.

New development presents an opportunity to make smart choices about how much new vulnerability we create for future generations, as well as how safe, desirable, connected, and affordable our region will be, but without adequate and timely consideration of long-term pressures such as sea level rise, development decisions may place even more people and jobs at risk down the line.



Coliseum BART Area is planning for future growth. Photo by Al Case licensed under CC BY 2.0.

Land use planning can be a powerful tool for ensuring that high value land uses are not slated for areas that will experience significant exposure in the future, or that appropriate considerations are given to new development that accounts for long-term sea level rise trends. While it can be difficult and expensive to accommodate sea level rise in areas that are historically developed, more opportunities for resilience may exist in areas that do not yet accommodate extensive development.

However, development pressures in the region are at an all-time high due to decades of underbuilding to meet growing demand. New development is a much needed and overdue tool to help alleviate prohibitively expensive housing costs and a lack of enough new development over the last few decades is creating a sense of urgency. This is coupled with SB 375 requirements from the state, which mandate that the region reduce greenhouse gas emissions from auto sources by focusing housing and job growth near existing development or near transit. These pressures can create development patterns that prioritize immediate needs – providing housing and reducing greenhouse gas emissions – over long-term threats, especially in areas that are currently desirable due to housing value, proximity to transit, or both. If historical development patterns continue and without adaptation, by 24" TWL (high risk scenario for 2040, which is the time horizon for Plan Bay Area 2040), over 38,000 new homes could be added in areas at risk of flooding within currently-designated PDAs. However, smart choices such as those described in this report and Plan Bay Area could significantly reduce exposure for new development.

Smart Planning for New Growth

Careful planning for new development in the highest-risk areas ensures that future residents avoid or reduce vulnerability from the get-go. This could mean reducing density, planning for flood control from the start, or avoiding new growth altogether, depending on what other factors are influencing the location's suitability for growth (such as greenhouse gas reduction potential, affordability, or equity). It also ensures that new investments in housing are smart ones, and housing won't be lost due to flooding, or unnecessary flood control structures won't need to be built to protect this new housing. The region already has significant challenges ahead to protect existing housing from flooding, so making smart choices about where and how to build in high hazard areas can ensure that funding for adaptation is used efficiently and effectively. In addition to protecting housing, smart building in areas that will be flooded in the future should also consider the flooding of associated investments in transportation, utilities, and other services that could be impacted alongside housing. People may not just be impacted by their homes flooding, but by loss of access to and from their homes or loss of other services. Plan Bay Area 2050, in particular Priority Development Areas, can be a powerful tool for incentivizing safe, smart growth if they are sited and planned smartly.

Additionally, Priority Conservation Areas can take remove the most vulnerable shoreline locations from development potential as well as help prioritize key lands for early adaptation efforts such as wetlands restoration or living levees.

Balancing Adaptation with Smart Growth

Limiting or constraining new development in flood-vulnerable areas while also conforming to SB 375 may prove challenging, as many less vulnerable locations are greenfield areas outside the existing urban core. Development in these areas and could potentially increase job commute times, create the need for new infrastructure such as utilities, transportation, schools, services, and shopping, and place additional climate burdens on these new communities such as risk for extreme heat and wildfire. There will need to be a balance between the future protection of development and the demands of the housing market and SB 375. For vulnerable areas already designated for growth, or otherwise desirable for future growth, there are many planning tools that can ensure this growth occurs safely. In addition to large-scale measures such as conservation easements, parcel-level zoning tools can create buffers within flood zones, incentivize new construction to be flood-resistant, and identify other creative ways to avoid flooded neighborhoods. PDAs such as the North San Jose PDA, Bayview/Hunters Point Shipyard/Candlestick Point PDA, Coliseum BART Station Area PDA, Downtown Jack London Square PDA, and Naval Air Station PDA can serve as case studies for accommodating significant growth in potentially flooded areas, as they are the PDAs with the largest projected future residential household growth, but also in cities that are either already planning for rising sea levels or have enough resources to be proactive. These case studies will be especially critical for PDAs that may have fewer vulnerable households but also fewer resources, which represent a different kind of risk.

Suisun City shoreline. Photo by Sharon Hahn Darlin, licensed under CC BY 2.0.

Development as an Adaptation Tool

New development may be a critical key to help finance adaptation measures. In areas with high land values, developers may pay an impact fee or other financing tool to fund adaptation within their own neighborhood or elsewhere, and if new development in flood areas is required to be protected or adaptable, it may be able to replace or serve as a flood control buffer for older, less resilient development behind it. Additional households can also contribute to property tax and sales taxes within a community that could be leveraged to fund adaptation measures, even if these new homes do not directly benefit. The success of such tools depends on the capacity of the local government to identify and develop, a high enough return on investment for developers that they are willing to pay in order to develop, and high property values for utilizing property taxes. However, these tools, which may slow or disincentivize new development or new homeowners, can be challenging to implement in a very tight housing market that is depending on new development for relief.

Limiting Displacement and Gentrification

Lastly, many of these challenges have the possibility of causing or exacerbating gentrification, displacement, and disproportionate impacts to vulnerable communities. Limiting building in certain areas may depress nearby property values, leading to loss of wealth to those homeowners. Any limits to new development may keep housing costs higher than desirable, extending or exacerbating the housing crisis and leading to more displacement from the region. And limiting the availability of new, cheap land for housing may yield more gentrification in existing neighborhoods as potential homebuyers face fewer options.

REGIONAL KEY PLANNING ISSUE

#7

Rising Sea Level Will Put Pressure on the Relationship Between Regional Recreation and Habitat

Many of the region's vulnerable recreation areas are co-located with sensitive habitat areas that are also at risk. Additionally, many of these areas of co- location could play critical roles in flood management through nature-based solutions. Different stakeholders may have differing priorities for the management of natural shoreline areas that prioritize people, natural systems, or flood control, amongst other things, over one another.

Shoreline adaptation approaches should balance recreational uses such as required public access, access to recreation, and nature-based education with the protection of essential ecosystem functions, especially preservation of habitat for threatened and endangered species, carbon sequestration, sediment management, biodiversity preservation, and flood control.

King Tides impact the Lucy Evans Baylands Nature Interpretive Center, Palo Alto. Photo courtesy of California Bay King Tides Project.

The shoreline of the San Francisco Bay is unique in the degree of natural habitat and recreation it provides for the region. There is a long history of stakeholders advocating for the preservation and enhancement of these uses, even as commercial or residential interests have sometimes been in conflict with shoreline recreation or habitat.

Smart Planning for New Growth

Careful planning for new development in the highest-risk areas ensures that future residents avoid or reduce vulnerability from the get-go. This could mean reducing density, planning for flood control from the start, or avoiding new growth altogether, depending on what other factors are influencing the location's suitability for growth (such as greenhouse gas reduction potential, affordability, or equity). It also ensures that new investments in housing are smart ones, and housing won't be lost due to flooding, or unnecessary flood control structures won't need to be built to protect this new housing. The region already has significant challenges ahead to protect existing housing from flooding, so making smart choices about where and how to build in high hazard areas can ensure that funding for adaptation is used efficiently and effectively. In addition to protecting housing, smart building in areas that will be flooded in the future should also consider the flooding of associated investments in transportation, utilities, and other services that could be impacted alongside housing. People may not just be impacted by their homes flooding, but by loss of access to and from their homes or loss of other services. Plan Bay Area 2050, in particular Priority Development Areas, can be a powerful tool for incentivizing safe, smart growth if they are sited and planned smartly. Additionally, Priority Conservation Areas can take remove the most vulnerable shoreline locations from development potential as well as help prioritize key lands for early adaptation efforts such as wetlands restoration or living levees.

Access to Recreation

Open space and recreational trails along the shoreline provide residents and visitors throughout the region opportunities to learn about and explore the natural environment at low to no cost. Many local and regional parks seek to balance recreation with natural resource management. The Bay Trail and Water Trail work to expand access to, and recreation opportunities along, the shoreline and into the bay. The San Francisco Bay Plan also calls for preservation and creation of public access to the bay when considering shoreline permits. Many Priority Conservation Areas feature recreation and shoreline access as one of their major features, such as Oakland Urban Greening, Bothin Waterfront, Central Marin Bayfront, and Napa Valley – Napa River Corridor.

Ecosystem Services

In addition to recreation, the shoreline offers diverse natural habitats and ecosystems, which offer a variety of ecosystem services such as flood protection, improved water quality and supply, and carbon sequestration in addition to habitats for native and endangered species. Many stakeholders seek to protect, restore, and expand these habitats. Some of the most critical areas within the region are the Suisun Marsh, Eden Landing Ecological Reserve, Don Edwards San Francisco Bay National Wildlife Refuge, San Pablo Bay National Wildlife Refuge, and many smaller baylands along the San Pablo and San Francisco Bay.

Competing Spaces: Where Tensions Arise

In some areas, human uses and natural systems may be in tension due to limited space or impacts on ecosystems due to human use. This tension may be exacerbated as sea levels rise, altering shoreline habitats and forcing wetlands and public access areas to migrate into limited upland locations or limiting the ability to expand or connect habitats. The function of shoreline recreational infrastructure such as trails and parks may be compromised. Shared space will become more limited in the future as the buffer of open space between the shoreline and inland development decreases, such as at the South Bay Salt Ponds Restoration Project area in San Jose, which is limited by Moffett Field, SR-237, and residential and commercial development inland. Many of these locations also contain infrastructure, including roads, railways, pipelines, flood control infrastructure, and power lines, adding further competing uses and stakeholders.

Decision-Making as Seas Rise

The tension between people and natural systems will also increase as decisions are made about what to protect from sea level rise and how. While ideally nature-based flood control strategies can help balance the needs of both habitats and people, some hard decisions will likely need to be made that introduce tradeoffs between the protection of homes and infrastructure with preservation of habitats, especially at higher total water levels. For example, a levee or sea wall that protects the built environment degrades or eliminates shoreline habitats and may cut off access or viewsheds to the shoreline once it reaches a certain height. Additionally, purely nature-based solutions may not offer enough flood protection to adequately protect the built environment that lies behind it when certain TWLs are reached.

Ideally, decisions about prioritizing nature-based solutions will be done in collaboration with multiple stakeholders that represent the varying interests along the shoreline. These decisions may provide multiple benefits including flood control, preservation of ecosystem services, carbon sequestration, recreation, and environmental education while preserving critical infrastructure and ecosystem functions alike.

The South Bay baylands is an ongoing area of habitat restoration and currently has many trails used for recreation along its levee system. Map data ©2019 by Google Earth Pro.

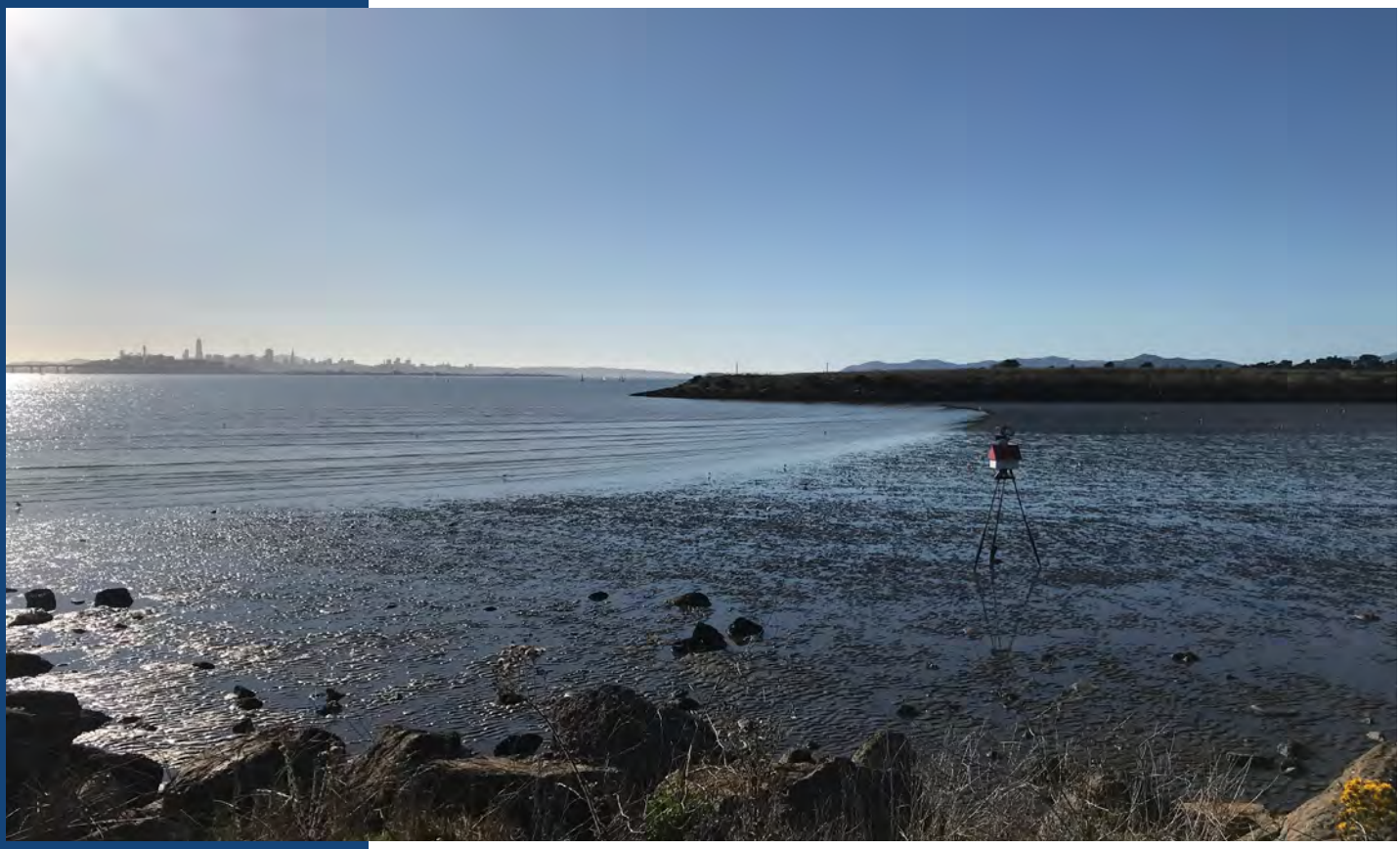
REGIONAL KEY PLANNING ISSUE

#8

Nearshore Habitats and the Ecosystem Services they Provide are Sensitive to Sea Level Rise Early On

Nearshore habitats provide significant natural and ecosystem services, such as habitats for endangered species, carbon sequestration, wave attenuation, and contribution to recreation and regional character. However, in many locations, natural ecosystems will be the first locations to be impacted by sea level rise. Protecting, restoring, and enhancing nearshore habitats can provide many benefits.

However, to maintain these benefits early action must be taken and careful consideration should be given to several key factors, such as protection of migration space, changes in management of endangered species habitats or fisheries, increasing linkages among different habitats and upland areas, and an understanding of how habitat restoration can or should integrate into longer-term shoreline protection plans.



Mudflats at low tide provide critical habitat for shorebird species and other wildlife. Photo by BCDC.

In many locations, nearshore habitats will be the first locations to experience flooding from sea level rise. Rising waters will impact habitats and the ecosystem services they provide in many ways, and early decisions about habitat protection and restoration will have longer-term impacts on both ecosystem services and inland communities. The following concepts will be critical to consider as adaptation decisions are made.

Migration of Habitats

As sea level rises and inundates nearshore habitats, these habitats will either shift to other habitat types or migrate up in elevation. For example, permanent flooding from sea level rise will cause wetlands to either downgrade to unvegetated mudflats or migrate up in elevation if there is adequate sediment supply and space. If habitats are to migrate, it is critically important to identify and protect upland migration space, if it is available. These spaces should be identified and protected quickly to avoid development that would compromise migration space. In some locations, no migration space is available because habitats abut built environments, such as rail lines, roadways, or neighborhoods. Some of these barriers to migration may be removed, if feasible. In addition, migrating or changing habitats may require regulations around the protection of endangered species habitats to change – protected areas may no longer be suitable to support a particular species, or protections for endangered species habitats may need to migrate up in elevation with habitats.

Restoration of Habitats

Around the Bay, restoration of habitats has been a huge priority since the 1970's. Large areas of Bayland habitat were previously diked and drained to create land for agriculture, salt ponds, or other human shoreline uses. Breaching existing flood control structures to allow wetlands to return to their natural state has been ongoing in both the north bay, such as the Sears Point Restoration Project, Cullinan Ranch Tidal Marsh Restoration Project, and the Napa River Salt Marsh Restoration Project, and south bay, such as the South San Francisco Bay Shoreline Project and South Bay Salt Pond Restoration Project. Restoration projects may also include importing sediment, aquatic vegetation, or other materials to accelerate habitat establishment. Additionally, any restoration that occurs today should take into account future habitat changes from sea level rise and take steps to ensure that restored habitats continue to offer the benefits they are envisioned to offer. This may require allowing for migration space or supplementing habitats with additional sediment. One challenge in the bay is the lack of availability of sediment for restoration projects and the lack of natural sediment supply from the watershed. This challenge will continue to grow as sediment demand increases due to sea level rise.

Expansion of Habitats

To truly expand the existing network of habitats and restore some of the historical richness of habitats along the bay shoreline, nearshore habitats need to be connected to one another across the landscape, and connections to upland locations that provide sediment, corridors for wildlife, and potential migration space should be prioritized. This will require the consideration of habitat restoration and preservation at the regional scale to ensure that decisions made to protect or not protect existing habitats from sea level rise do not have unintended consequences for adjacent habitats.

Ecosystem Services

In addition to the benefits ecosystems provide to support wildlife, nearshore habitats also provide a number of ecosystem services that benefit nearby human communities. Wetlands provide flood control for communities behind them, through wave attenuation, slowing the movement of water and allowing it to replenish the groundwater supply rather than bombard the shoreline, and reducing erosion along the shoreline. In this way, nearshore habitats can be used for flood protection in the early stages of sea level rise, and to supplement grey infrastructure at higher total water levels.

Wetlands sequester carbon in their soils, thus, protecting and enhancing these habitats also contributes to the storage of blue carbon, the term for the carbon captured by coastal ecosystems. These carbon sinks also offer a potential opportunity to sell carbon offsets in carbon markets. Additionally, these habitats serve as stormwater retention and filtration basins, potentially reducing flooding from stormwater and contributing to greater water quality. Lastly, nearshore habitats may offer commercial benefits such as fishery nursery grounds.

In many locations, nearshore habitats will be the first locations to experience flooding from sea level rise. Rising waters will impact habitats and the ecosystem services they provide in many ways, and early decisions about habitat protection and restoration will have longer-term impacts on both ecosystem services and inland communities. The following concepts will be critical to consider as adaptation decisions are made.

View of Suisun Marsh, one of the largest wetland habitats in the San Francisco Bay Area. Map data ©2019 by Google Earth Pro.

2.4 Guide to Using the Regional Systems Assessment Sections

ORGANIZATION AND STRUCTURE OF SECTIONS

These next four sections present the analysis of the four regional systems assessed in ART Bay Area: 2.5 Transportation Networks, 2.6 Vulnerable Communities, 2.7 Future Growth Areas and 2.8 Natural Lands. These following sections communicate the results of analyses from two different methodologies (Figure 2-8).

TWO APPROACHES TO ANALYSIS

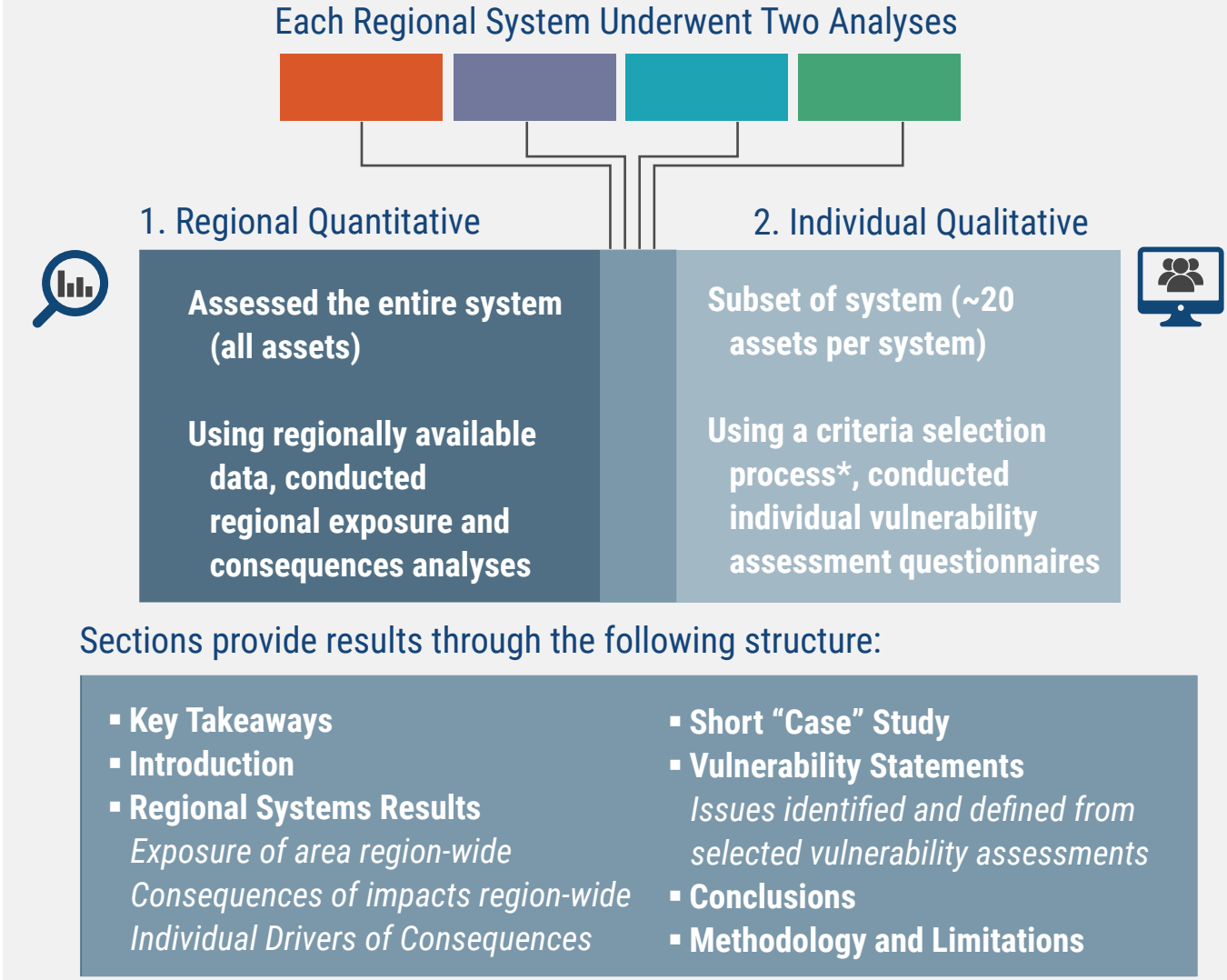


Figure 2-8. Overview of the two analyses conducted for Regional Systems Assessment sections 2.5 to 2.8, including the general structure of each section. *Selection criteria for qualitative assessments can be found in Chapter 3. Local Assessments, which details the process taken for selecting and assessing local vulnerability.

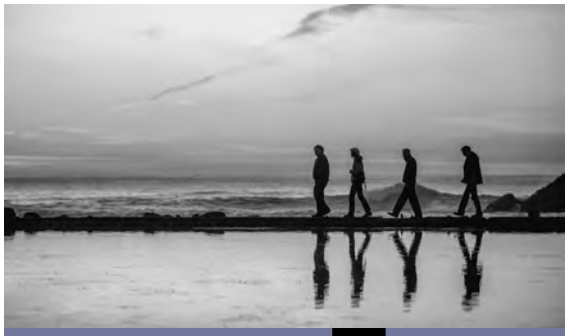
INDIVIDUAL REGIONAL SYSTEM SECTIONS ARE AVAILABLE IN SEPARATE PDF FILES FOR DOWNLOAD

Due to the large size of each of the following sections, they are available individually for download. ***Click the boxes below to download the following sections***.

d o w n l o a d

2.5 TRANSPORTATION NETWORKS

d o w n l o a d



2.6 VULNERABLE COMMUNITIES

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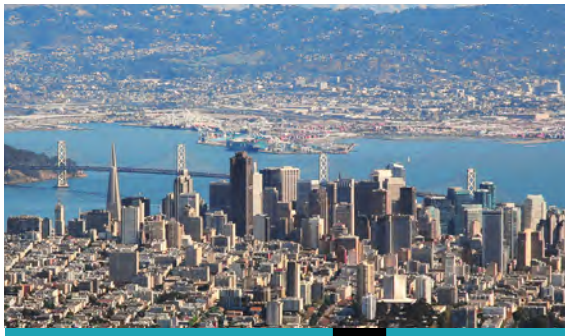


2.7 FUTURE GROWTH AREAS

d o w n l o a d

2.8 NATURAL LANDS

Endnotes

1 Dana Brechwald et al., "Stronger Housing, Safer Communities: Strategies for Seismic and Flood Risks" (Association of Bay Area Governments, March 2015), http://resilience.abag.ca.gov/projects/stronger_housing_safer_communities_2015/.

2 Rohaizat M Ludin SM and Arbon P, "The Association between Social Cohesion and Community Disaster Resilience: A Cross-Sectional Study.," Health Soc Care Community 27, no. 3 (May 2019): 621–31, https://doi.org/10.1111/hsc.12674

People walking along a flooded trail in East Palo Alto during King Tides in December 2019. Photo courtesy of California Bay King Tides Project.

Chapter 3.0

LOCAL ASSESSMENT

3.1 Local Vulnerability, Regional Impacts

HOW LOCAL ASSESSMENT INFORMS REGIONAL VULNERABILITY

ART Bay Area focused on understanding the vulnerabilities to current and future flood risk of four interconnected systems across the region: Transportation, Vulnerable Communities, Future Growth Areas (current and potential Priority Development Areas[1], or PDAs), and Natural Lands (including Priority Conservation Area[2]s, or PCAs). In addition to assessing the vulnerabilities and consequences for each of these systems region-wide (see Section 2.0, Regional Systems Assessment Chapter), ART Bay Area assessed the nuances of vulnerabilities and consequences of *individual* assets as well as *shared* vulnerabilities and consequences across these four systems in specific locations using place-based, deep-dive analyses.

ART Bay Area completed 13 Local Assessments covering 32 Focus Areas and Areas of Impact that analyzed shared vulnerabilities throughout the region. Conducting local assessments achieved three outcomes:

1. **They described specifically how and where regional systems were vulnerable to flooding by gathering site-specific vulnerability details about individual assets;**
2. **They explored how regional systems were spatially and functionally interconnected and interdependent in specific locations; and**
3. **They connected vulnerabilities identified locally to consequences felt regionally to shed light on some of the region's potential shared priorities.**

This chapter includes a description of the approach taken to identify and conduct the local vulnerability assessments, the use of Operational Landscape Units (OLUs)[3] as an organizing principle for communicating risk and consequence, and the importance of shared vulnerabilities and consequences within and across regional systems.

A DEEP DIVE INTO THE VULNERABILITIES OF THE REGIONAL SYSTEMS

Local assessments provide a snapshot not only of what individual assets are at risk of exposure to current or future flooding, but also describe why and how individual assets are vulnerable.

Across the nine-county Bay Area, there are hundreds of individual system components within each of the four regional systems. The networks of transportation systems alone are comprised of many different segments of highways, rail, local roads, ports, airports, and ferry terminals. Many vulnerable populations live throughout the entire region, and the PDA and PCA systems collectively contain over three hundred unique and individually defined areas. The individual components making up these interconnected regional systems is vast.

The regional analysis in Chapter 2, Regional Systems Assessment Findings, identified big-picture systems vulnerabilities and consequences at ten different total water levels (TWLs). The results of this data-driven, region-wide, quantitative analysis included information on each of the four systems' exposure to flooding, including when exposure first starts, region-wide impacts from flooding through consequence indicators, and high-consequence hot spots. While this information is critical for understanding large-scale trends and impacts to the region, it does not capture the specific, smaller-scale functional, informational, governance, or physical vulnerabilities that can exist within and across these systems. Local assessments provide a snapshot not only of what individual assets are at risk of exposure to current or future flooding, but also describe why and how individual assets are vulnerable. This helps deepen the understanding of the characteristics that drive the vulnerabilities of the regional systems as a whole.

Local assessments resulted in detailed descriptions of vulnerabilities specific to a certain location. This information was incorporated into Chapter 2, Regional Systems Assessment Findings, to support a description of the drivers of vulnerabilities within each regional system grounded in specific, real-world, local examples. In addition, this information helped develop shared stories, or narratives of flooding exposure, risks, and consequences within specific geographic areas where clusters of regional systems exist.

At Coyote Point in San Mateo, two people take measurements of the shoreline as King Tides approach in January 2020. Photo courtesy of California Bay King Tides Project.

SHARED STORIES, SHARED SOLUTIONS

Much of the ART Program's past work on vulnerabilities in the region has been focused on describing vulnerabilities *within* asset classes and sectors. While this information has been important in illuminating and describing risks unique to different asset classes, limiting vulnerability findings to individual asset classes alone may miss, and potentially underestimate, the interrelated vulnerabilities associated with nearby, overlapping, or interconnected systems.

Components of a region-wide system are often connected, either physically or functionally, to other regional systems nearby. For example, a major transportation highway or rail station connects people to job centers and places where they live, which might also be an area slated for future housing and job growth. Many future growth areas are also home to vulnerable populations today, amplifying the risk of displacement on existing community members. Additionally, many shoreline areas also provide residents and visitors access to natural lands for recreation or commuting via the San Francisco Bay Trail or other trail systems where people may enjoy the benefits provided by the Bay and its wealth of natural habitats. This interconnection means that individual components at risk are often shared, and that solutions could also be shared and provide multiple benefits.

Local assessments can also help to provide a link between local vulnerabilities and shared regional impacts. While decisions about and implementation of adaptation solutions are often made at the local level where land use authority lies, understanding shared consequences highlights the importance of responding cross-jurisdictionally to critical vulnerabilities that will impact the well-being of the region's people, economy, and environment.

Shifting the focus and communication of vulnerability towards *shared* stories elevates common stories throughout the region and highlights the interdependency amongst networks of regionally critical systems. Communicating shared stories increases the opportunity for shared solutions and helps move the region forward on more effectively tackling large problems through encouraging broader coordination and shared or collective funding.

ORGANIZING SHARED VULNERABILITIES USING OPERATIONAL LANDSCAPE UNITS

One way to highlight shared vulnerabilities and the potential for shared solutions in the Bay Area is to organize and communicate vulnerability assessment results by geographically defined sub-regional landscape-scale areas called Operational Landscape Units. This concept was developed by the San Francisco Estuary Institute (SFEI) in partnership with the San Francisco Bay Area Planning and Urban Research Association (SPUR)[3] and incorporates delineating features such as watersheds, rivers, floodplains, and other characteristics along the Bay Area shoreline to define OLU boundaries. As described in the *San Francisco Bay Adaptation Atlas* (2019), the Operational Landscape Unit, or "nature's jurisdiction," provides a scientific basis for identifying suitable, locally appropriate, nature-based sea level rise adaptation measures.

To align ART Bay Area with the best available science on nature-based adaptation actions, we utilized OLU boundaries to geographically organize the vulnerability assessments.

To align ART Bay Area with the best available science on nature-based adaptation actions, we utilized OLU boundaries to geographically organize the vulnerability assessments. OLUs provided a useful intermediate scale larger than an individual city, but smaller than a county. They also cross existing jurisdictional boundaries, which is useful to help communicate shared cross-jurisdictional risks and highlight needed coordination. The nature-based strategies identified in the *San Francisco Bay Adaptation Atlas* (2019) that could be implemented within each OLU to address flooding risks helps advance thinking about adaptation solutions. Lastly, OLUs as an organizational concept encourage a standard planning scale to facilitate coordinated adaptation planning within the region.

3.2 Focus Areas: Determining What to Assess Locally and Where

Local assessment areas were selected through identifying OLUs that met certain criteria (described below), then additional refinement led to the identification of Focus Areas within each OLU. Identifying OLUs and Focus Areas first required a region-wide analysis of assets within the four regional systems. Local assessments were selected in areas where exposed, significant assets were geographically co-located. This selection methodology is described in the following sections.

IDENTIFYING WHAT TO ASSESS: LOCAL ASSETS, REGIONAL IMPORTANCE

Within the region, only certain assets and geographic areas were assessed, both to limit the scope of the assessment as well as prioritize the assessment of assets most critical to the region. Identification of these assets pointed to 13 OLUs and 32 Focus Areas for local assessments. Areas were flagged that met the following criteria:

- ***(A)*** **Flooding exposure of assets by 66" TWL or earlier;**
- ***(B)*** **Regionally significant consequences from flooding of these assets (described below); and**
- ***(C)*** **Geographically co-located assets.**

The next few sections provide details of each of the three criteria listed above, and a visual overview of these criterion can be seen in Figure 3-1.

(A) Flooding Exposure

ART Bay Area selected 66" TWL as a primary threshold of flooding because it reflects the Ocean Protection Council's 2050 estimate of 22.8" of sea level rise (closest to 24" in ART flooding scenarios) in the medium-high risk aversion (1 in 200 chance) category plus a 100-year storm surge. This water level was chosen to reflect an emphasis on medium to longer term planning.

(B) Selecting Regionally Significant Assets Within Each of the Four Regional Systems

In general, assets were selected that were: regionally significant based on a set of criteria described below; representative of each regional system as a whole; and/or geographically distributed across the region. The following section provides details on individual assets identified.

SELECTING INDIVIDUAL ASSETS FOR LOCAL ASSESSMENTS

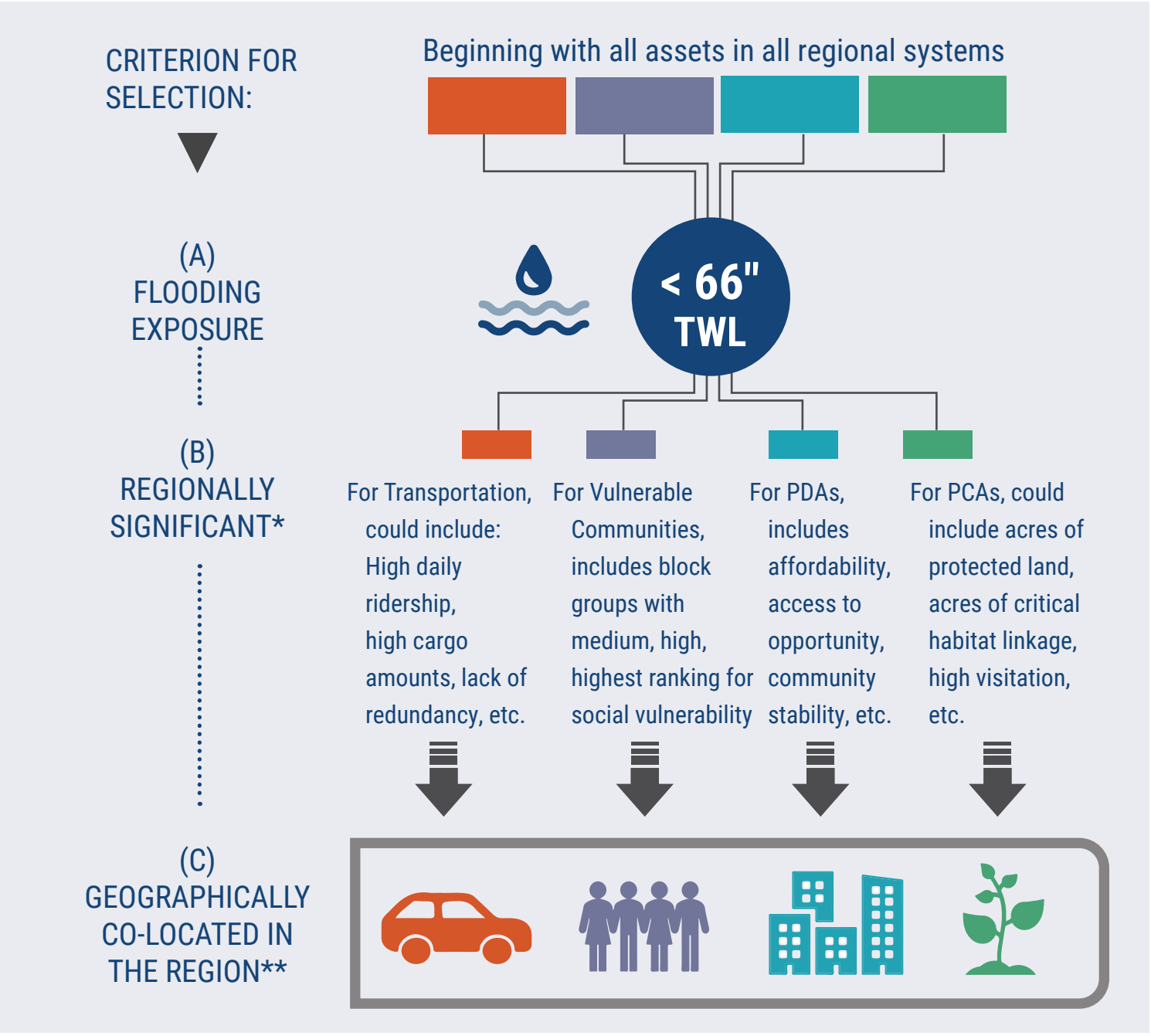


Figure 3-1. Overview of the three criterion used to identify which individual assets would be eligible for qualitative vulnerability assessments. The colors represent Transportation Infrastructure (orange), Vulnerable Communities (purple), Priority Development Areas (blue) and Priority Conservation Areas (PCAs). *Regionally significance was evaluated differently for each regional system. Details on what was used to evaluate regional significance can be found on pages 3-8 to 3-15. **Geographically co-lated refers to assets that met criteria A and B, and were also within the same Operational Landscape Unit (OLU).

Transportation

The transportation networks contain numerous modes of transportation infrastructure and services. ART Bay Area further classifies transportation assets into transportation "classes," including highways and bridges, commuter rail, freight rail, ferry systems, bus networks, airports, seaports, local roads, and active transportation such as the San Francisco Bay Trail.

Regional significance is based on the following metrics. Transportation assets within each transportation class that scored highly across these categories were flagged for consideration for local assessment.

- High daily ridership
- High cargo volumes
- Transit connections
- Service to disadvantages communities
- Lack of redundancy or sole transit access
- Co-location with other transportation services
- Representative of assets with physical characteristics similar to other assets within the system
- Providing ad-hoc shoreline protection
- Contribution of co-benefits such as greenhouse gas reductions or congestion reduction

Waters rising in San Rafael during King Tides in January 2002. Photo by SF Baykeeper, Robb Most, and LightHawk.

In total, over 88 individual transportation assets or segments were assessed across the region and integrated into the local assessments.

This number does not include the fact that in some cases, different segments of the same highways and rail lines were assessed in different locations around the nine-county region Additionally, local roads were included as they pertained to vulnerability of nearby assets beign assessed.

List of Transportation Infrastructure Assessed:

Highways and Bridges

US-101
SR-92
SR-84
SR-61
SR-37
SR-260
SR-237
SR-12
SR-1
I-880
I-80
I-680
I-580
I-280
Various Local Roads*

Commuter Rail Lines & Stations

San Rafael Downtown SMART Station and Line
Amtrak/Capital Corridor and Emeryville Station
Coliseum Station Complex (Coliseum BART, Amtrak, Oakland Airport Connector BART)
West Oakland BART Station
Santa Clara Valley Transportation Authority Light Rail and Facilities
Caltrain line and Redwood Caltrain Station
4th and King Caltrain Station
BART/Muni Embarcadero Station
Muni T Third Line, Muni Historic E and F lines and Muni Portal

Freight Rail

Northwestern Pacific Railroad
California Northern Railroad
Union Pacific Railroad
Burlington/Northern Santa Fe Railroad
Richmond Pacific Railroad
San Francisco Bay Railroad

Airports

Napa County Airport
Oakland International Airport
Palo Alto Airport
San Carlos Airport

Ferries

Sausalito Ferry Terminal
Mare Island/Vallejo Ferry Terminals
Alameda Gateway Landing Ferry Terminal
San Francisco Ferry Terminal
South San Francisco Ferry Terminal

Seaports

Port of Richmond
Port of Oakland
Port of Redwood City
Port of San Francisco

Buses

Manzanita Park and Ride Golden Gate Transit
Golden Gate Bridge Highway and Transit Maintenance Yard (Anderson Drive)
San Rafael Transit Center
Vallejo Transit Center
Sereno Transit Center
SamTrans South Base Maintenance Facility
MTA Facilities

**Local roads were included as they related to shared stories of vulnerability in local assessments.*

Vulnerable Communities

In ART Bay Area, vulnerable communities were identified by three components – social vulnerability characteristics, presence of contamination, and comparison to other, complementary social vulnerability screening tools. Block groups for vulnerable communities that exhibited 'highest,' 'high,' and/or 'moderate' social vulnerability characteristics, in addition to high levels of land contamination and with a consideration for their relative scoring from other agencies and entities screening tools were elevated for analysis. Detailed explanations of these components can be found in Chapter 2.6 Vulnerable Communities section.

Social vulnerability characteristics represent socio-economic characteristics that may impact a community member's ability to plan for, withstand, or recover from a flood event. The twelve social vulnerability characteristics include[4]:

- **Very Low Income**
- **Non-US Citizen**
- **Without a Vehicle**
- **People with a Disability**
- **Single Parent Households**
- **Communities of Color**
- **Limited English Proficiency**
- **Without a High School Diploma**
- **Young Children Under 5**
- **Severely Housing Cost Burdened**
- **Older Adults Living Alone**
- **Renters**

Land contamination burden indicators represent threats to communities and the natural environment from pollution. The presence of contaminated lands and water raises health and environmental justice concerns, which could worsen with flooding and rising sea level due to contaminant mobilization. Block groups where both the CalEnviroScreen 3.0 total score and contamination score are in the 80th percentile were identified.

Social vulnerability characteristics represent socio-economic characteristics that may impact a community member's ability to plan for, withstand, or recover from a flood event.

UC Berkeley's Displacement and Gentrification Typologies from the Urban Displacement Project[5] were used to analyze all communities. This is not a definitive measure of whether or not displacement is occurring or may occur, but it can help illuminate areas of particular concern.

Another layer of review included understanding the vulnerability of populations using complementary community vulnerability screening tools. These tools include:

- Metropolitan Transportation Commission (MTC) **Communities of Concern**[6]
- Californiaa Environmental Protection Agency (CalEPA) **CalEnviroScreen 3.0**[7]
- Department of Water Resources (DWR) **Disadvantaged Communities**[8]

ART Bay Area also established groupings of socially vulnerable block groups to serve as a proxy for 'functional communities.' These groupings are aimed at describing a more planning-relevant scale than individual block groups with vulnerable characteristics. This methodology acknowledges that any external definition of community boundaries has the potential to be incorrect or to run counter to community interests. Similarly, boundaries of communities are fluid, and can be defined differently by different entities. The boundaries of each block group should not be considered a hard boundary of where households with the characteristics described are located. The ART Bay Area approach to defining functional communities is as follows:

- Within a grouping of three contiguous block groups with moderate, high or highest social vulnerability, and containing at least one high or highest vulnerability block group.
- Block groups with moderate social vulnerability were only considered if they were adjacent to block groups with high or highest social vulnerability.
- Where a grouping spanned two OLUs, and one of those OLUs was not assessed in the Local Assessments, the grouping was roughly limited to the assessed OLU boundary.
- In some cases, conversations with local communities expanded the functional community different than the above criteria due to demonstrated community cohesion in that area.

In total, 22 areas were considered 'communities' for the purposes of the analysis and assessed around the region. The results are integrated into the local assessments.

List of 'Communities':

Block groups with social and/ or contamination vulnerability considered 'communities' for the purpose of analysis:

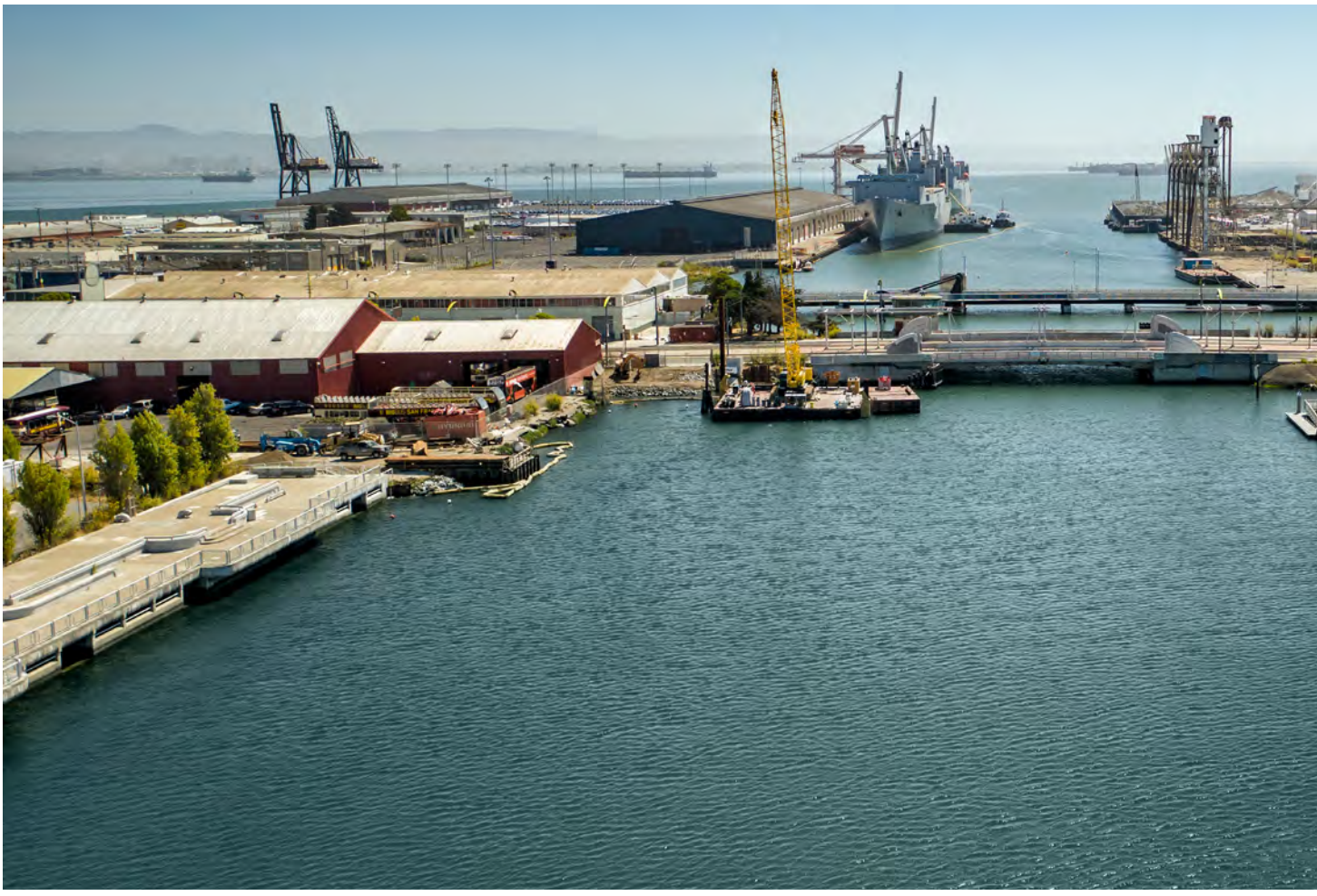
Marin City
San Rafael Canal District
Napa
Vallejo and American Canyon
Fairfield and Suisun City
Rodeo
North Richmond
Iron Triangle / Central Richmond
Richmond Annex / El Cerrito
Berkeley
Emeryville
West Oakland
Downtown Oakland
East Oakland
Alameda
Alviso
Redwood City / North Fair Oaks
Foster City
Belle Haven
East Palo Alto
Bayview / Hunters Point
Mission Creek, Chinatown and Embarcadero

**This methodology acknowledges that any external definition of community boundaries has the potential to be incorrect or to run counter to community interests. Our intent in identifying 'communities' was to elevate areas around the region at risk of flooding and who may require increased resources to plan for, withstand, or recover from flooding or other events.*

Future Growth Areas

Future growth areas were identified using the presence of PDAs. There are currently a total of 188 PDAs in the Bay Area (as of late 2019) designated in *Plan Bay Area 2040*. The selection of PDAs considered for local assessments utilizes analysis metrics developed by MTC/ABAG as part of the *Regional Growth Strategies* paper published in 2019[9], which identifies how PDAs and potential future PDAs would align with certain regional goals. ART Bay Area utilized four of the five metrics, with the exclusion of Hazard Risk, as this was already accounted for in the first selection criteria (exposed at 66" TWL). The four metrics used to guide the selection of PDAs include the following:

- **Affordability:** Combined housing and transportation costs[10]
- **Access to Opportunity:** Resources available to residents, such as quality schools and a variety of jobs[11]
- **Community Stability:** Displacement risk[12]
- **Potential Vehicle Miles Traveled Reduction:** Greenhouse gas reduction potential[13]



Islais Creek in 2019, which is part of the Port of San Francisco PDA and located near many other PDAs. Photo by Port of San Francisco is licensed under CC BY 2.0

PDAs that ranked the highest across these four metrics were flagged. Additionally, to maintain fair representation across the region, a number of top scoring PDAs were chosen to reflect the geographic distribution of the entire region-wide PDA network.

Based on this criteria, 20 individual PDAs were identified for individual evaluation, and 2 additional PDAs that were included due to their proximity to other assets being evaluated during vulnerability assessments, for a total of 22 PDAs identified for local assessment.

List of PDAs Assessed:

Unincorporated Marin County
- Marin City
- California Park

Downtown San Rafael (San Rafael)*

Vallejo Waterfront and Downtown (Vallejo)

Downtown South Jefferson Street (Fairfield)

Western Contra Costa Transportation Authority Committee San Pablo Corridor (Contra Costa)

Waterfront District (Hercules)

North Richmond (Unincorporated Contra Costa County)

South Richmond (Richmond)

Mixed-Use Core (Emeryville)

Coliseum BART Station Area (Oakland)

Downtown and Jack London Square (Oakland)*

Naval Air Station (Alameda)

Northern Waterfront (Alameda)

North San Jose (San Jose)

Ravenswood (East Palo Alto)

Downtown Redwood City (Redwood City)

Broadway/Veterans Boulevard Corridor (Redwood City)

Bayview / Hunters Point Shipyard / Candlestick Point (San Francisco)

San Francisco/San Mateo Bi-County Area (San Francisco, South San Francisco)

Port of San Francisco (San Francisco)

Mission Bay (San Francisco)

**Two PDAs that did not meet criteria were included due to proximity to other assets being evaliuated during the vulnerability assessment.*

Natural Lands

Natural lands were identified using the presence of PCAs. There are currently a total of 165 PCAs in the Bay Area as of *Plan Bay Area 2040*. The selection of PCAs considered for the local vulnerability assessments were based on a ranking analysis of 21 characteristics for each of the exposed PCAs. The metrics used to guide the selection of PCAs include the following:

- Conservation Lands Network (Acres)
- Bay Area Critical Linkages - Large Landscape Blocks (Acres)
- Bay Area Critical Linkages - Linkage link (Acres)
- Baylands (Acres)
- Important habitat for threatened and endangered vertebrates
- Key riparian corridor (Miles)
- Suitable grazing land (Acres)
- Farmland of local importance (Acres)
- Prime Farmland (Acres)
- Hydrogeologically vulnerable areas (Acres)
- Water Quality Index
- Groundwater recharge (Acre-feet per year)
- Reservoir catchment areas
- Aboveground live carbon storage (Tons)
- Soil carbon storage (Tons)
- Regional trails – existing (Miles)
- Regional trails – proposed (Miles)
- Conservation easement (Acres)
- Publicly accessible recreational lands (Acres)
- Protected lands by fee (Acres)
- Visitation (Photo User Days)

Sonoma Baylands is located in Sonoma County. Photo by BCDC.

PCAs that ranked the highest across these characteristics were flagged. To maintain fair representation of each designation, a number of top scoring PCAs per designation were chosen, proportionally reflecting the designation distribution across the entire regional PCA network.

Based on this criteria, 16 individual PCAs were identified, with an additional 3 PCAs that crossed multi-county jurisdictions, and 1 PCA that was included due to proximity to other assets during vulnerability assessment. In total, 20 PCAs were identified for local assessment.

This number does not include the fact that for the San Francisco Bay Trail, San Francisco Water Trail, and Regional Trail Systems Gap, different segments of the same system were assessed in different locations around the nine-county region.

List of PCAs Assessed:

Bothin Waterfront (Marin)**
Central Marin Bayfront, Canalways (Marin County)
Napa Valley - Napa River Corridor (Napa)
Napa County Agricultural Lands and Watersheds (Napa)
Sonoma Baylands (Sonoma County)
Pinole Creek Watershed (Pinole)
Cerrito Creek (El Cerrito/Albany)
Oakland Priority Creeks (Oakland)
Oakland Priority Creek Tails (Oakland)
Oakland Priority Estuaries (Oakland)
Oakland Recreational Trails (Oakland)
Potential Oakland Gateway Area (Oakland)
Baylands (Santa Clara County)
Riparian Corridor (Santa Clara County)
Proposed Menlo Park/East Palo Alto Baylands (Menlo Park/East Palo Alto)
San Bruno Mountain and Surrounding Area (San Bruno)
Bayview Hill Natural Area (San Francisco)
San Francisco Bay Trail (various locations around the Bay)*
Regional Trail Systems Gaps (various locations in the East Bay)*
San Francisco Bay Water Trail Sites (various locations around the Bay)*

**Three PCAs that did not meet criteria were included due to their multi-jurisdictional nature and size.*

***One PCA was included due to proximity to other assets being evaluated during the vulnerability asssessment.*

(C) Identifying Where Individual Assets are Geographically Connected

Following each regional system's individual selection process that included both an initial 66" TWL exposure and a second set of criteria for each regional system, a third criterion was applied across all assets identified in the regional systems – the presence of clustered or co-located assets, as organized by OLU boundary. These criteria identified OLUs with high concentrations of critical assets as well as a variety of asset types.

In order for an OLU to be selected, it had to contain all of the following:

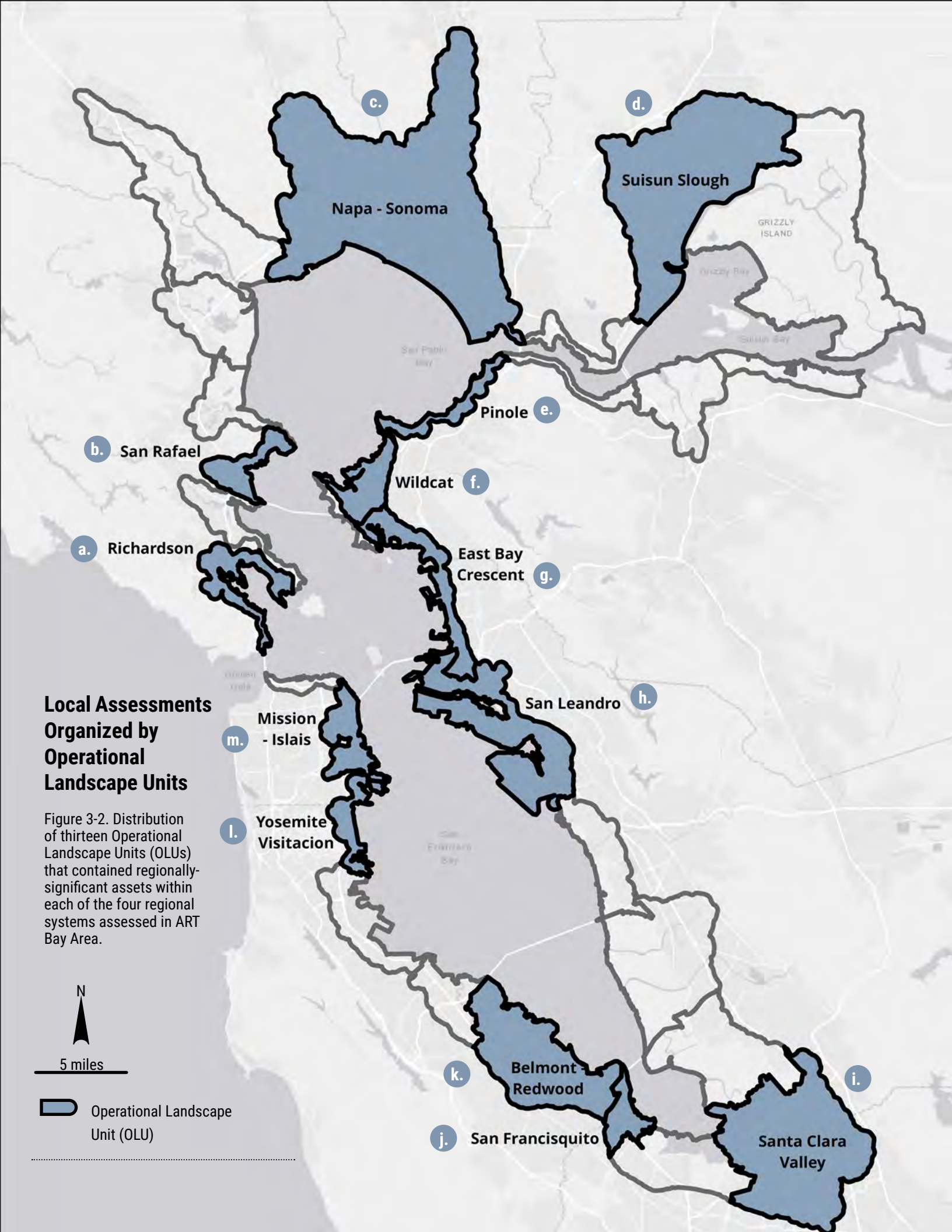
1. **Previously identified assets that exposed to flooding impacts at 66" TWL or earlier;**
2. **Previously identified assets identified as regionally significant through selection criterion; and**
3. **At least one asset of each of the four ART Bay Area asset classes.**

Thirteen OLUs were identified in the region (Figure 3-2) to serve as the organizing geographies for the final assets identified for in-depth vulnerability assessments.

These thirteen OLUs include:

a. Richardson
b. San Rafael
c. Napa Sonoma
d. Suisun Slough
e. Pinole
f. Wildcat
g. East Bay Crescent
h. San Leandro
i. Santa Clara Valley
j. San Francisquito
k. Belmont-Redwood
l. Yosemite-Visitacion
m. Mission-Islais

Within each of the thirteen geographies, the analysis was refined even further to capture stories of shared vulnerabilities and consequences. The following page provides details on specific Focus Areas and Areas of Impact within each of the thirteen OLUs. Each OLU identified has its own Local Assessment available for individual download, and are labeled by both the name of the OLU and a corresponding letter.



Local Assessments Organized by Operational Landscape Units

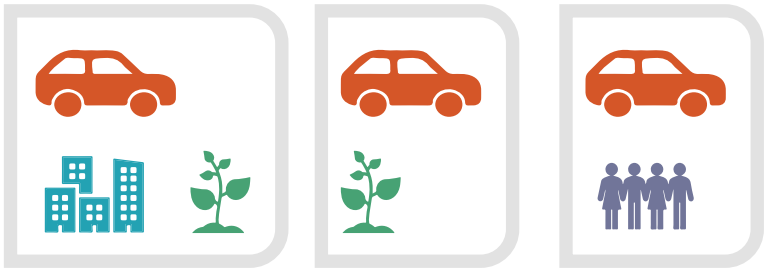
Figure 3-2. Distribution of thirteen Operational Landscape Units (OLUs) that contained regionally-significant assets within each of the four regional systems assessed in ART Bay Area.

REFINING ANALYSIS TO COMMUNICATE SHARED STORIES: FOCUS AREAS AND AREAS OF IMPACT

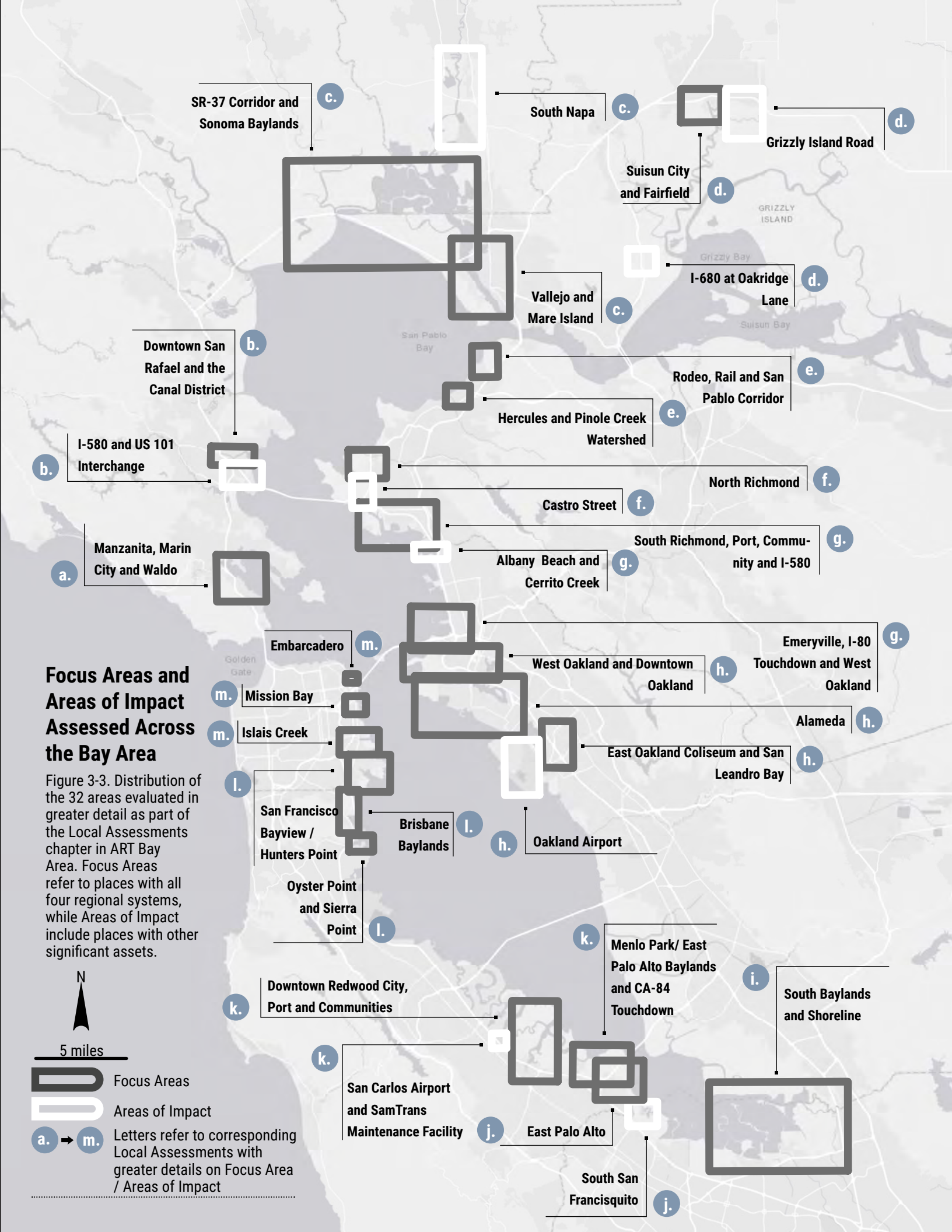
Once the thirteen OLUs were selected, one additional layer of geographical refinement was used. While the OLU scale provides a series of benefits for considering large-scale, nature-based features for sea level rise adaptation planning, localizing the communication of vulnerabilities into more specific geographic locations within OLUs (Figure 3-3) proved helpful for identifying specific vulnerable assets. Two further scales helped to organize and communicate results:

1. **Focus Areas:** Areas (neighborhood or community-scale) within the OLU that contained a cluster of least one regionally significant asset in all four of the regional systems; and

2. **Area of Impact:** Areas (neighborhood or community-scale) within the OLU that contained a cluster of regionally significant assets within at least two regional systems, but not containing assets from all four regional systems.



Refining the scale of communication of results to Focus Areas and Areas of Impact allows the creation of narratives of shared shoreline features and known large-scale developments along the shoreline, flooding exposure and overtopping, and shared vulnerabilities and consequences to current and future flooding.


SR-37 Corridor and Sonoma Baylands
c.
South Napa
c.
Grizzly Island Road
d.
Suisun City and Fairfield
d.
GRIZZLY ISLAND
Grizzly Bay
I-680 at Oakridge Lane
d.
Vallejo and Mare Island
c.
Suisun Bay
San Pablo Bay
Downtown San Rafael and the Canal District
b.
Rodeo, Rail and San Pablo Corridor
e.
Hercules and Pinole Creek Watershed
e.
I-580 and US 101 Interchange
b.
North Richmond
f.
Castro Street
f.
Manzanita, Marin City and Waldo
a.
South Richmond, Port, Community and I-580
g.
Albany Beach and Cerrito Creek
g.
Golden Gate
Embarcadero
m.
Emeryville, I-80 Touchdown and West Oakland
g.
West Oakland and Downtown Oakland
h.
Mission Bay
m.
Alameda
h.
Islais Creek
m.
East Oakland Coliseum and San Leandro Bay
h.
San Francisco Bayview / Hunters Point
l.
Brisbane Baylands
l.
Oakland Airport
h.
Oyster Point and Sierra Point
l.
Menlo Park/ East Palo Alto Baylands and CA-84 Touchdown
k.
South Baylands and Shoreline
i.
Downtown Redwood City, Port and Communities
k.
San Carlos Airport and SamTrans Maintenance Facility
k.
East Palo Alto
j.
South San Francisquito
j.
Focus Areas and Areas of Impact Assessed Across the Bay Area
Figure 3-3. Distribution of the 32 areas evaluated in greater detail as part of the Local Assessments chapter in ART Bay Area. Focus Areas refer to places with all four regional systems, while Areas of Impact include places with other significant assets.
N
5 miles
Focus Areas
Areas of Impact
a. → m. Letters refer to corresponding Local Assessments with greater details on Focus Area / Areas of Impact

3.3 Local Assessment Methodology

Individual assets were identified to undergo a local vulnerability assessment. This was done through an exposure analysis and a detailed vulnerability questionnaire to collect data and characterize vulnerability and consequence of the assets.

Exposure analysis included the following (with terminology described in greater detail in Figure 3-4, i-iv):

- **Description of the existing shoreline**, including natural and flood control features (i);
- **Description of known shoreline development** that could change the function of the shoreline (ii);
- **Overtopping analysis** that identifies where water is coming in over the shoreline (iii); and
- **Exposure analysis** that identifies where flooding occurs and what assets get wet at what total water level (iv).

The assessment questionnaire includes questions to identify:

- **Existing conditions** of the asset such as location, land-use, ownership, and function;
- **Physical conditions** of an asset such as presence of salt-water sensitive components, design aspects that might make an asset particularly vulnerable, or location at or below grade;
- **Informational or knowledge-based characteristics** such as types of information publicly accessible, quality of information available, data gaps, or mechanisms to share information;
- **Governance conditions** such as the presence or lack of plans to address flood risk, challenges with multiple owners or managers, or permitting and regulatory challenges;
- **Functional and dependency characteristics** such as resilience on other assets, connections to other systems, and dependencies of shared flood risk along the shoreline or across flood pathways; and
- **Consequence** to society and equity, environment and economy if the asset were to fail or no longer be able to provide its current functions and services.

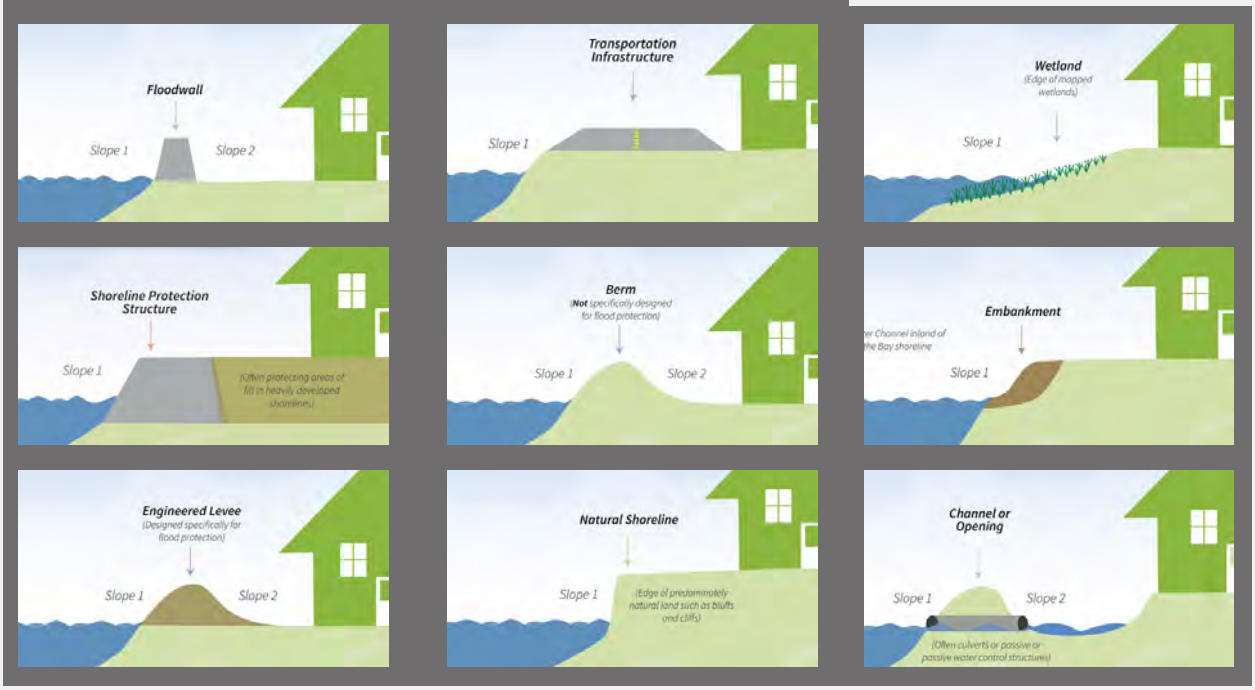
After individual vulnerability assessments were conducted, the results were synthesized to communicate how multiple assets within a Focus Area or Area of Impact share vulnerabilities from flooding. Questionnaire results were organized into Local Assessments that provide details of shared flooding impacts, including shared vulnerability and consequence statements.

i. Existing Shoreline Type

The San Francisco Bay Shore Inventory was classified into ten primary categories to capture the diversity of today's Bay shore. The categories reflect both features which were built for flood risk management (e.g., floodwalls) and natural features (e.g., wetlands) which could indirectly provide coastal protection but were not specifically designed for this purpose. Detailed descriptions of mapping methodologies can be found in the SFEI 2016 report: San Francisco Bay Shore Inventory: Mapping for Sea Level Rise Planning.

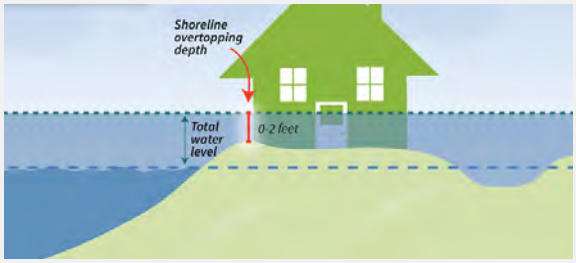
ii. Future Development

To the extent feasible, Focus Areas/Areas of Impact include a list known large-scale shoreline development projects that are either in significant planning phases or have been permitted by BCDC.



iii. Shoreline Overtopping

Shoreline overtopping refers to the condition where the total water level associated with a particular flood scenario exceeds the elevation of the shoreline, allowing water to flow inland. The overtopping mapping shows which segments of the shoreline are impacted.



iv. Depth of Flooding

The depth of flooding indicates how deep the water is over land. In these maps, the darker the blue the deeper the flooding. The depth of flooding can be greater than the total water level if the elevation of the flooded area is below Mean Higher High Water.

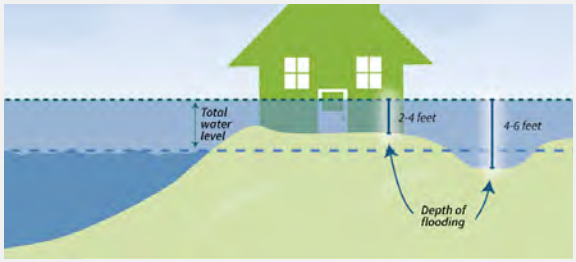


Figure 3-4. Visual representations of the different components of the exposure analysis, including: i) shoreline type, ii) future development story, iii) shoreline overtopping, and iv) depth of flooding.

LOCAL ASSESSMENTS INCLUDE THREE SCALES OF COMMUNICATING FLOODING VULNERABILITY ANALYSIS

Local Assessment sections include three main scales of communicating the results of the qualitative assessment analysis: Operational Landscape Unit (OLU), Focus Area or Area of Impact, and Individual Asset. Each scale provides a different level of detail and purpose in communicating findings of the qualitative vulnerability assessment. See Figure 3-5 to see a visual of the three scales.

1. **Operational Landscape Units (OLU):** Local Assessements are organized (and named) after OLU boundaries. This was one of the three criteria used to identify which individual assets would recieve a vulnerability assessment. Due to the interdependency among regional systems, OLUs were identified as an important geographic boundary to understand how flooding vulnerability could be shared in specific locations around the region, particularly because OLUs provide guidance on suitability of nature-based sea level rise adaptation solutions.

2. **Individual Asset:** Being exposed to flooding by at least 66” TWL and geographically co-located to other exposed and regionally significant assets was a criteria for selecting individual assets for evaluation. Assets identified by the criterion process recieved individual qualitative vulnerability assessments. The methodology used for vulnerability assessments can be seen in more detail in Section 3.3 Local Assessment Methodology.

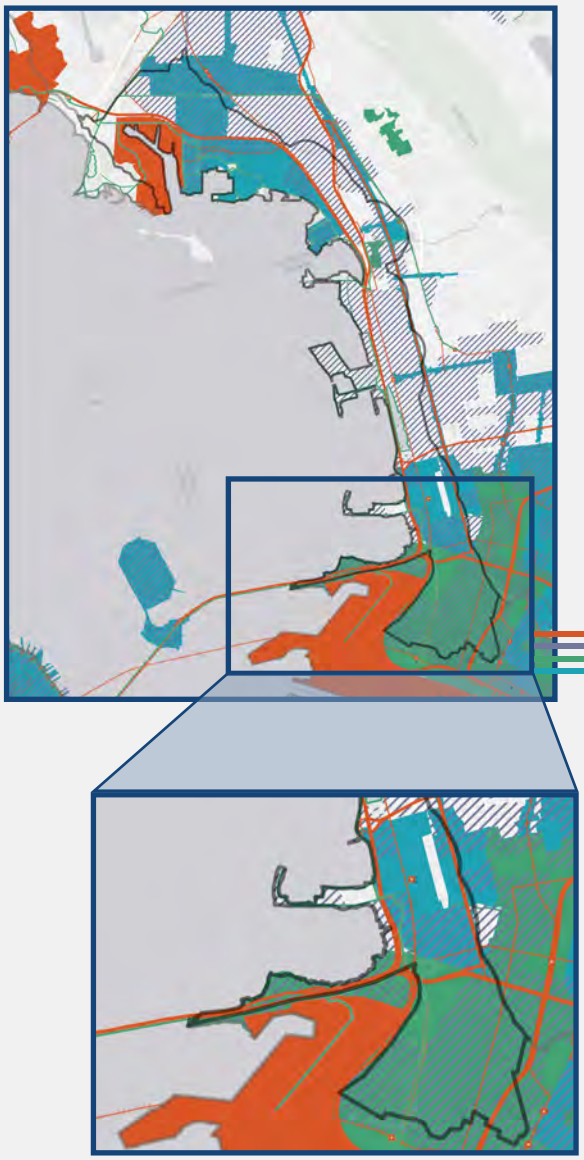
3. **Focus Area/Area of Impact:** Following individual vulnerability assessments, the ART team went through a process of synthesizing vulnerability assessment results to communicate shared stories of vulnerability across multiple assets. Focus Areas and Areas of Impact were identified as places that contained a cluster of assets. Focus Areas and Areas of Impact in the Local Assessment include details of shared vulnerability to multiple assets, including when and where shoreline overtopping occurs, where flooding becomes more severe, vulnerabilities to multiple assets that cross sectors, and shared consequences of flooding. Section 3.4 Guide to Using Local Assessments provides further details on how Local Assessments are structured.

The following sections provides guidance on how to use the local assessment section and provide links to access individual Local Assessments for download.

SCALES OF LOCAL ASSESSMENT SECTIONS

1. Operational Landscape Unit (OLU)

OLUs were used as geographic boundaries for identifying case studies of individual assets for assessment



2. Individual Asset

Individual assessment questionnaires, online research and interviews were used to gather data to understand asset-scale vulnerabilities to flooding

- I-80 San Francisco-Oakland Bay Bridge Touchdown
- West Oakland Community
- Mixed-Use Core (Emeryville) PDA
- Potential Oakland Gateway Area PCA

3. Focus Areas/Areas of Impact

Focus Areas/Areas of Impact within OLUs were identified to communicate shared vulnerabilities and consequences to flooding

Figure 3-5. Diagram reflecting the different scales of analysis used in the Local Assessment sections, from Operational Landscape Unit (OLU) as an organizing principle, to Focus Areas/Areas of Impact to communicate shared stories, and Individual asset details on flooding vulnerability.

3.4 Guide to Using the Local Assessments Section

LOCAL ASSESSMENTS CONDUCTED THROUGH THE LENS OF REGIONAL SYSTEMS

The following sections of this chapter communicate the results of the local assessments organized by the thirteen OLUs and their Focus Areas and Areas of Impact. Local assessments in this section do not reflect a comprehensive assessment of vulnerability to sea level rise and flooding across the entire OLU; instead they represent the results of vulnerabilities and consequences for assets identified through the criteria outlined previously.

The Local Assessments are organized by the main components shown on the following pages. (Figure 3-6).

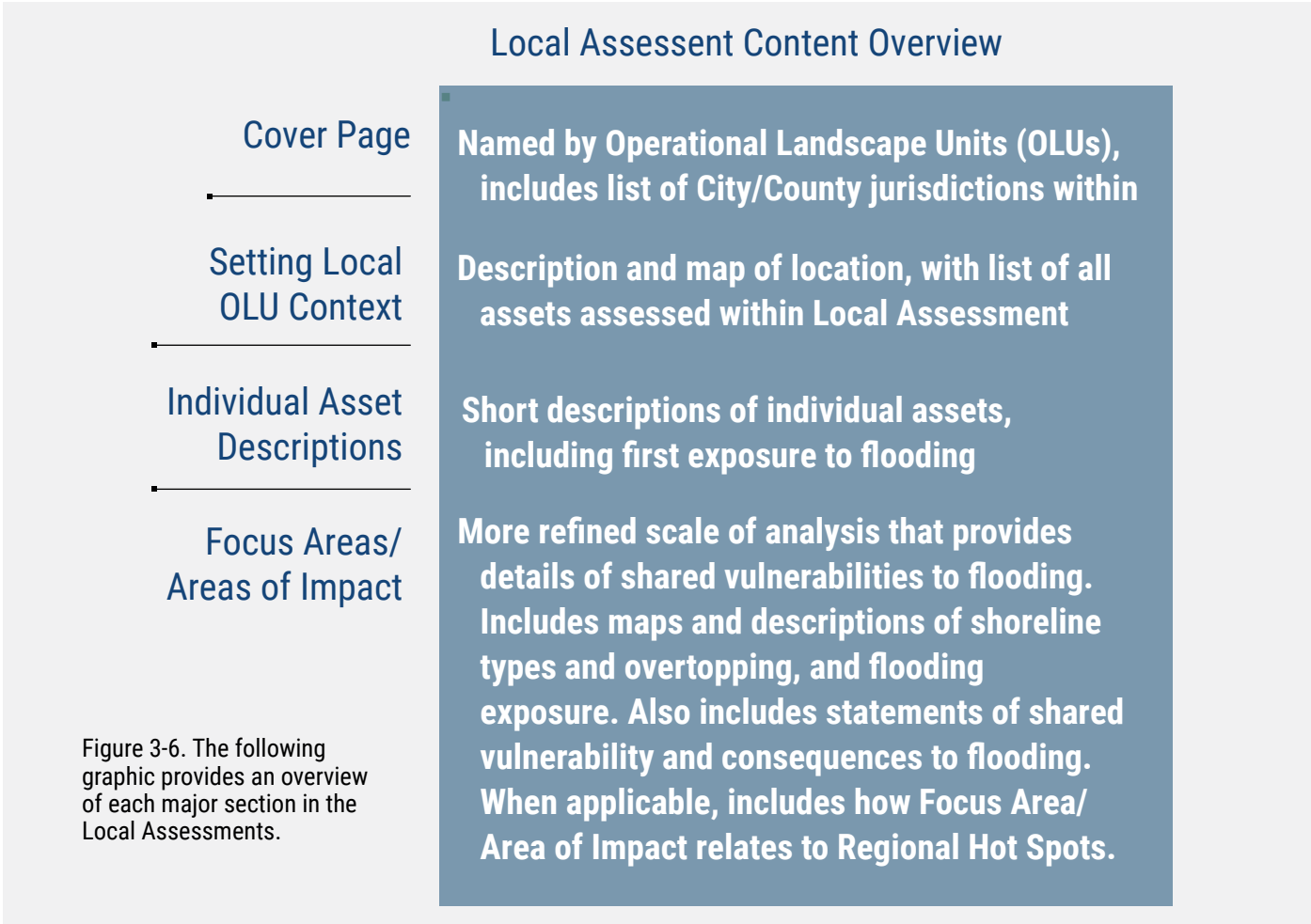
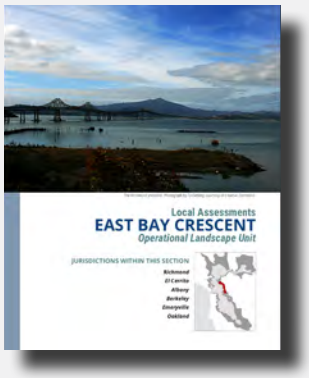


Figure 3-6. The following graphic provides an overview of each major section in the Local Assessments.

COVER



Cities and Counties

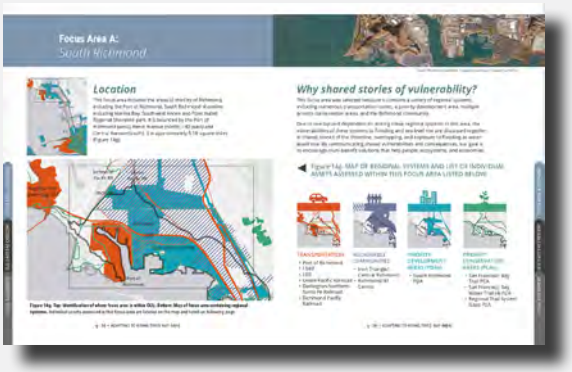
SETTING LOCAL OLU CONTEXT

Where are we and what regional systems are here?

INDIVIDUAL ASSET DESCRIPTIONS

Descriptions of each asset assessed, organized by regional system

FOCUS AREAS / AREA OF IMPACT



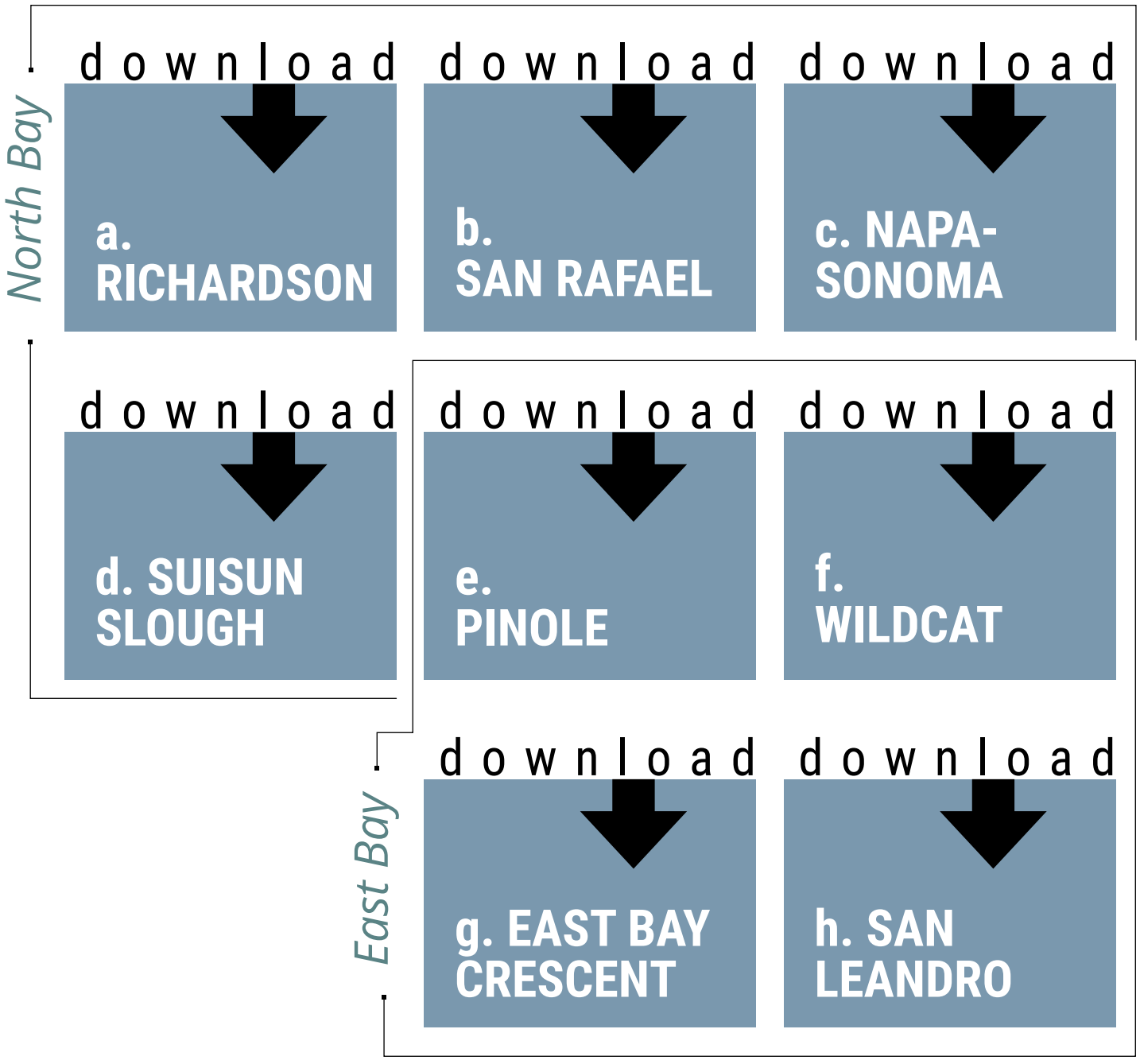
Map and list of assets within

Shared stories of vulnerability and consequence to flooding

3.5 Local Assessment Results

INDIVIDUAL LOCAL ASSESSMENTS ARE AVAILABLE IN SEPARATE PDF FILES FOR DOWNLOAD

Due to the size of each local assessment, detailed results can be viewed within individual local assessments. Local Assessments are organized by letters a to m (which can be reviewed in Figure 3-3). ***Click the boxes below to download individual Local Assessments.***



Tidal marshes in Ravenswood Preserve in the San Francisquito OLU provide important habitat for species, recreational opportunities for people, and numerous other benefits. Photo by Jaclyn Mandoske, BCDC.

South Bay and Peninsula

download

i. SANTA CLARA VALLEY

download

j. SAN FRANCISQUITO

download

k. BELMONT-REDWOOD

download

l. YOSEMITE-VISITACION

download

m. MISSION-ISLAIS

IDENTIFYING ASSETS IN LOCAL ASSESSMENTS

The following pages provide additional resources on how to identify where assets are located within Local Assessments. Table 3-1 provides the details of assets within each Local Assessment.

Search for Assets by Geography

North Bay

Letter	Local Assessment	*Focus Area / Area of Impact*	Transportation Infrastructure	Vulnerable Communities	Priority Development Areas (PDAs)	Priority Conservation Areas (PCAs)
a.	**Richardon**	***Manzanita, Marin City and Waldo***	US-101 SR-1 Sausalito Ferry Terminal Manzanita Park & Ride Golden Gate Transit Local Roads	Marin City	Unincorporated Marin County (Marin City)	Bothin Waterfront San Francisco Bay Trail and Water Trail
b.	**San Rafael**	***Downtown San Rafael and the Canal District*** *I-580 and US-101 Interchange*	I-580 US-101 San Rafael Downtown SMART Station San Rafael Transit Center Golden Gate Bridge Highway and Transit District Maintenance Yard (Anderson Drive) Local Roads	San Rafael Canal District	Downtown San Rafael Unincorporated Marin County (California Park)	Central Marin Bayfront, Madera Bay Park San Francisco Bay Trail and Water Trail
c.	**Napa-Sonoma**	***SR-37 Corridor and Sonoma Baylands*** ***Vallejo and Mare Island*** *South Napa*	SR-37 Mare Island/Vallejo Ferry Terminals Vallejo Transit Center Sereno Transit Center Northwestern Pacific Railroad California Northern Railroad Napa County Airport Local Roads	Napa Vallejo and American Canyon	Vallejo Waterfront and Downtown	Napa-Valley Napa River Corridor Napa Agricultural Lands and Watersheds Sonoma Baylands San Francisco Bay Trail and Water Trail
d.	**Suisun Slough**	***Suisun City and Fairfield;*** *Grizzly Island Road;* *I-680 at Oakridge Lane*	I-680 SR-12 Union Pacific Railroad Amtrak/Capital Corridor Grizzly Island Road Local Roads	Fairfield and Suisun City	Downtown South Jefferson Street	San Francisco Bay Water Trail

Table 3-1. Local Assessments are named by Operational Landscape Units (OLUs) and organized geographically around the nine-county region. Use the table to find Local Assessments and identify Focus Areas/Areas of Impacts and individual assets within.

East Bay

e.	**Pinole**	***Rodeo, Rail and San Pablo Corridor*** ***Hercules and Pinole Creek Watershed***	Union Pacific Railroad Local Roads	Rodeo	Contra Costa Transportation Authority Committee San Pablo Corridor (Contra Costa) Waterfront District (Hercules)	Pinole Creek Watershed San Francisco Bay Trail and Water Trail
f.	**Wildcat**	***North Richmond*** *Castro Street*	Union Pacific Railroad Burlington-Northern Santa Fe railroad Richmond Pacific Railroad I-580 Chevron Richmond Refinery Local Roads	North Richmond	North Richmond	San Francisco Bay Trail
g.	**East Bay Crescent**	***South Richmond, Port, Community and I-580*** ***Emeryville, I-80 Touchdown and West Oakland*** *Albany Beach and Cerrito Creek*	I-580 I-80 I-880 Port of Richmond Port of Oakland Union Pacific Rail Burlington-Northern Santa Fe railroad Richmond Pacific Railroad Amtrak/Capital Corridor Emeryville Station Local Roads	Iron Triangle/ Central Richmond Richmond Annex / El Cerrito West Oakland Berkeley Emeryville	South Richmond Mixed-Use Core (Emeryville)	Cerrito Creek Oakland Priority Creeks Potential Oakland Gateway Regional Trail System Gap San Francisco Bay Trail and Water Trail
h.	**San Leandro**	***West Oakland and Downtown Oakland*** ***East Oakland Coliseum and San Leandro Bay*** ***Alameda*** *Oakland Airport*	Oakland International Airport Coliseum Station Complex (Coliseum BART, Amtrak, Oakland Airport Connector BART) Alameda Gateway Landing Ferry Terminal Union Pacific Railroad I-880 Port of Oakland Doolittle Drive (SR-61) Webster/Posey Tubes (SR-260) Local Roads	West Oakland Downtown Oakland East Oakland Alameda	Coliseum BART Station Area Downtown and Jack London Square Naval Air Station Northern Waterfront	Oakland Priority Creeks Oakland Priority Estuaries Oakland Recreational Trails Oakland Priority Creek Trails Potential Oakland Gateway PCA Regional Trail System Gaps San Francisco Bay Trail and Water Trail

Table 3-1 (cont.). Local Assessments organized geographically around the nine-county region. Use the table to find Local Assessments and identify Focus Areas/Areas of Impacts and individual assets within.

Search for Assets by Geography

South Bay

i.	**Santa Clara Valley**	***South Baylands and Shoreline***	Union Pacific Railroad US-101 SR-237 Amtrak/Capitol Corridor Santa Clara Valley Transportation Authority Light Rail and Facilities	Alviso	North San Jose	Baylands Riparian Corridor Regional Trail System Gaps San Francisco Bay Trail
j.	**San Francisquito**	***East Palo Alto*** *South San Francisquito*	SR-84 US-101 Palo Alto Airport Local Roads	East Palo Alto	Ravenswood	Proposed Menlo Park/East Palo Alto Baylands San Francisco Bay Trail and Water Trail
k.	**Belmont-Redwood**	***Menlo Park/ East Palo Alto Baylands and CA-84 Touchdown*** ***Downtown Redwood City, Port and Communities*** *San Carlos Airport and SamTrans Maintenance Facility*	Union Pacific Railroad US-101 SR-84 SR-92 Redwood Caltrain Station Port of Redwood City SamTrans South Base Maintenance Facility San Carlos Airport Local Roads	Redwood City/ North Fair Oaks Belle Haven East Palo Alto Foster City	Downtown (Redwood City) Broadway/ Veterans Boulevard Ravenswood	Menlo Park/East Palo Alto Baylands San Francisco Bay Trail and Water Trail

Table 3-1 (cont). Local Assessments are named by Operational Landscape Units (OLUs) and organized geographically around the nine-county region. Use the table to find Local Assessments and identify Focus Areas/Areas of Impacts and individual assets within.

Boats docked at the Port of Redwood City Public Fishing Pier Redwood Creek. Photo by Jaclyn Mandoske, BCDC.

Search for Assets by Geography

Peninsula

l.	**Yosemite-Visitacion**	***Oyster Point and Sierra Point*** ***Brisbane Baylands***	US-101 South San Francisco Ferry Terminal Caltrain UPRR Local Roads	Bayview / Hunters Point	Bayview / Hunters Point / Candlestick Point San Francisco/ San Mateo Bi-County	San Bruno Mountain and Surrounding Area Bayview Hill Natural Area San Francisco Bay Trail and Water Trail
m.	**Mission-Islais**	***Oyster Point and Sierra Point*** ***Brisbane Baylands***	US-101 I-80 I-280 Embarcadero Roadway and Promenade San Francisco Ferry Terminal Port of San Francisco Muni T Third Street Line Muni Historic E/F Lines Muni Portal MTA Facilities BART /Muni Embarcadero Station 4th and King Caltrain Station Union Pacific Railroad San Francisco Bay Railroad	Bayview / Hunters Point Mission Creek, Chinatown and Embarcadero	Bayview / Hunters Point / Candlestick Point	San Francisco Bay Trail and Water Trail

Table 3-1 (cont.). Local Assessments are named by Operational Landscape Units (OLUs) and organized geographically around the nine-county region. Use the table to find Local Assessments and identify Focus Areas/Areas of Impacts and individual assets within.

Search by Asset

The following graphic (Figure 3-7) provides the same information as Table 3-1 but in a different visual format. Use the graphic to find the asset you are interested in, and then identify which Local Assessment that asset has been assessed in. Some assets (particulary in transportation) appear in numerous Local Assessments.

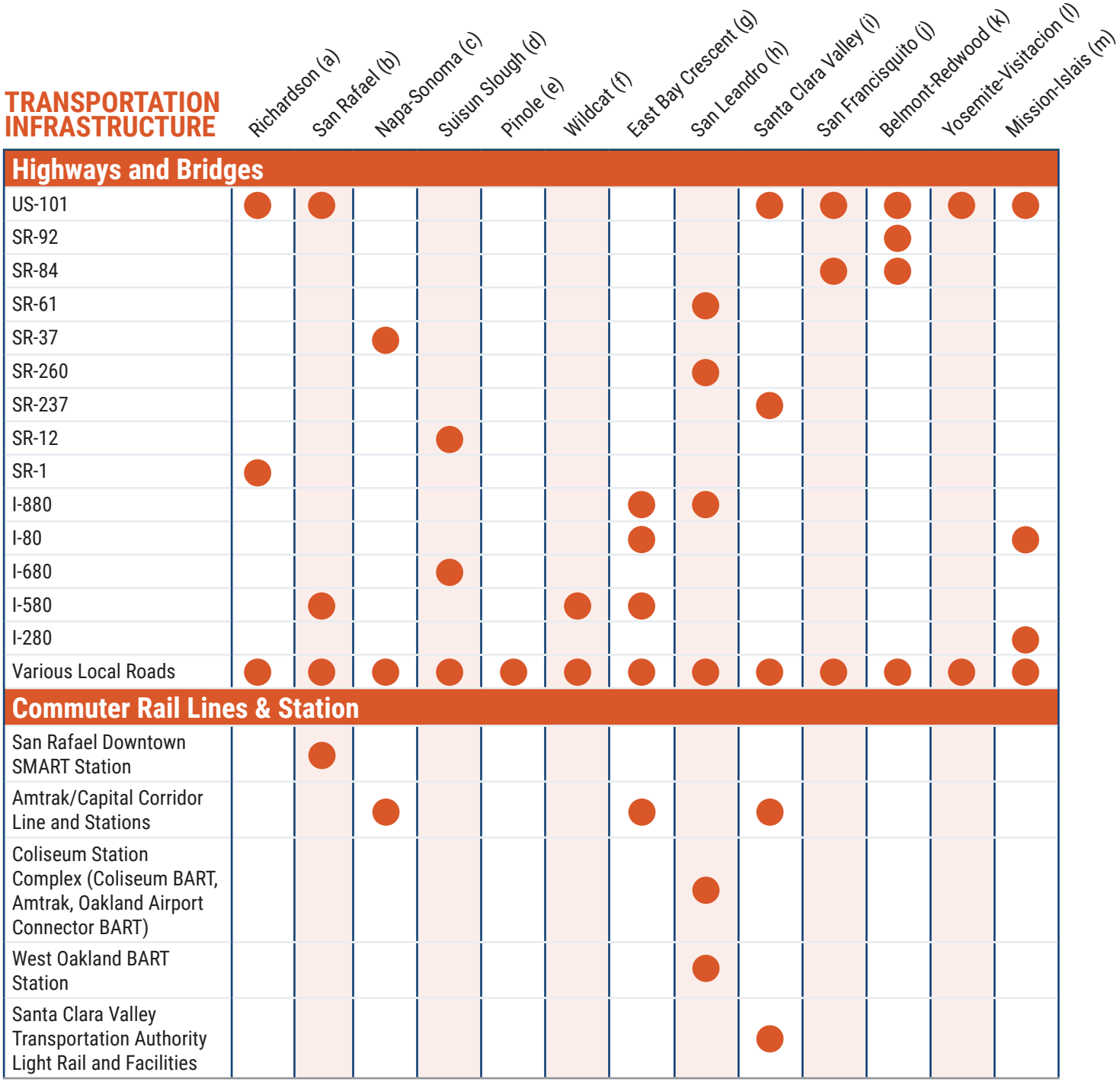


Figure 3-7. Visual representation of individual assets assessed and the Local Assessments in which they can be found. Individual assets are listed and organized by: Transportation, Vulnerable Communities, Priority Development Areas (PDas) and Priority Conservation Areas (PCA). The colored dots identify the Local Assessment in which the asset can be found.

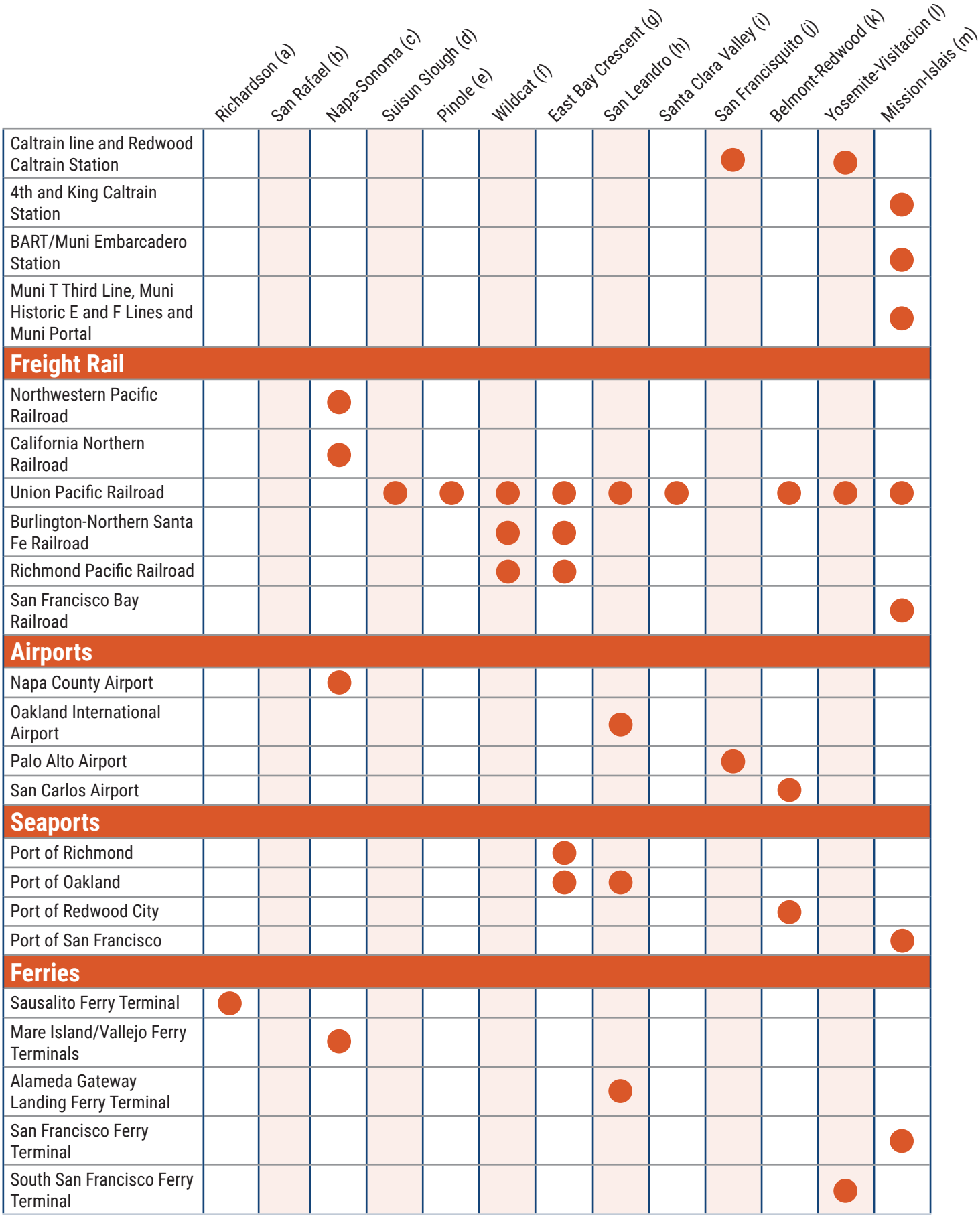


Figure 3-7 (cont). Visual representation of individual assets assessed and the Local Assessments in which they can be found.

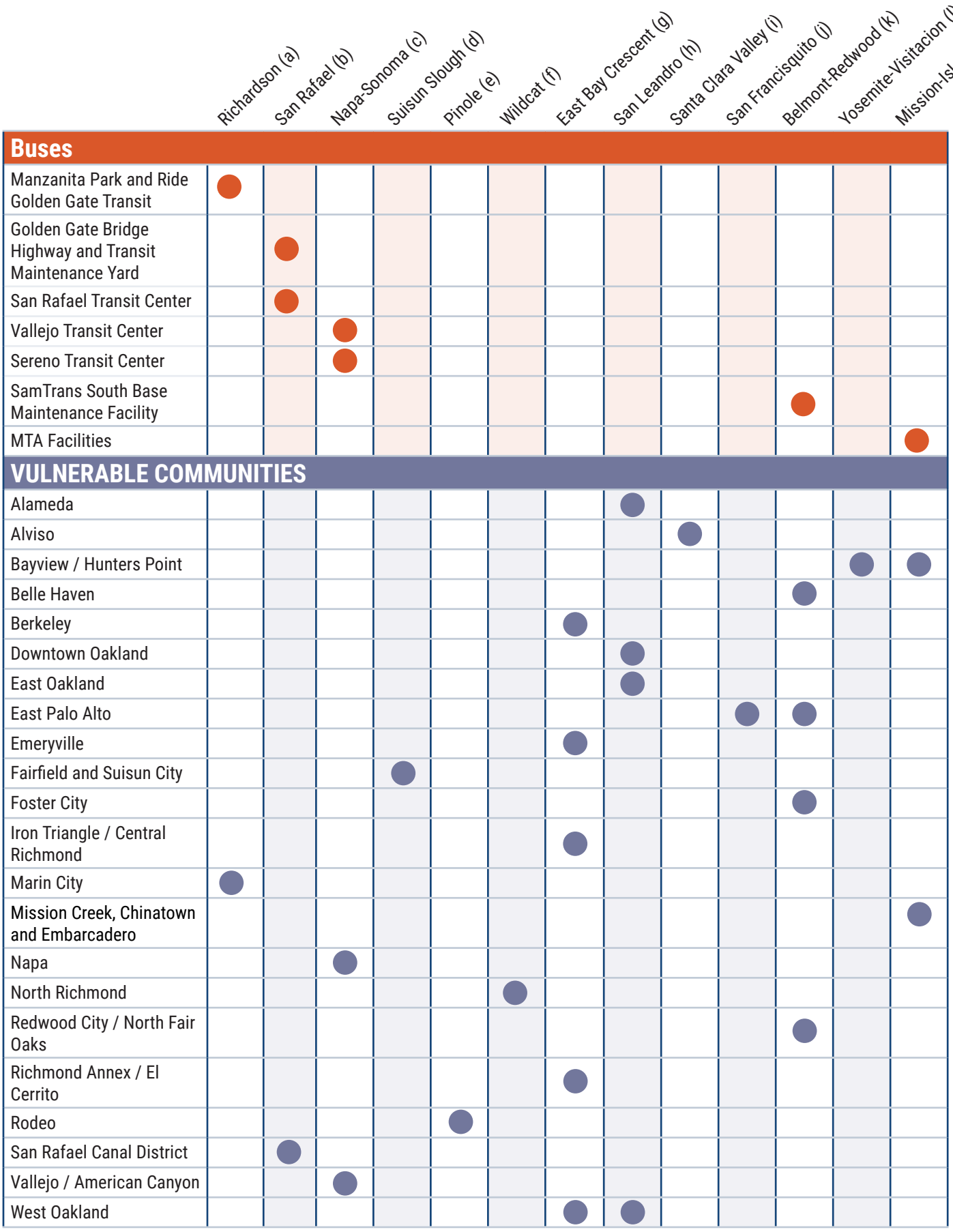


Figure 3-7 (cont). Visual representation of individual assets assessed and the Local Assessments in which they can be found.

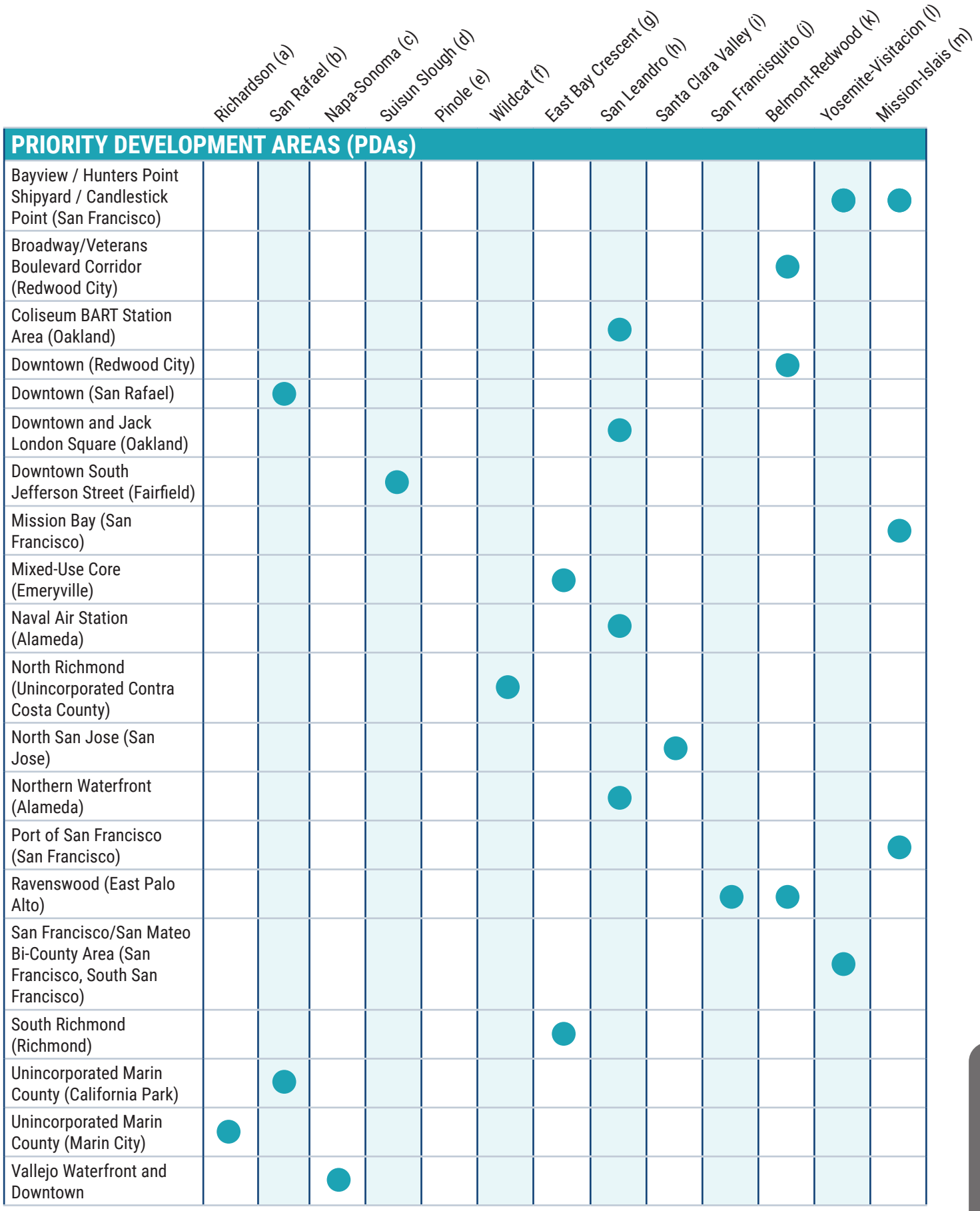


Figure 3-7 (cont). Visual representation of individual assets assessed and the Local Assessments in which they can be found.

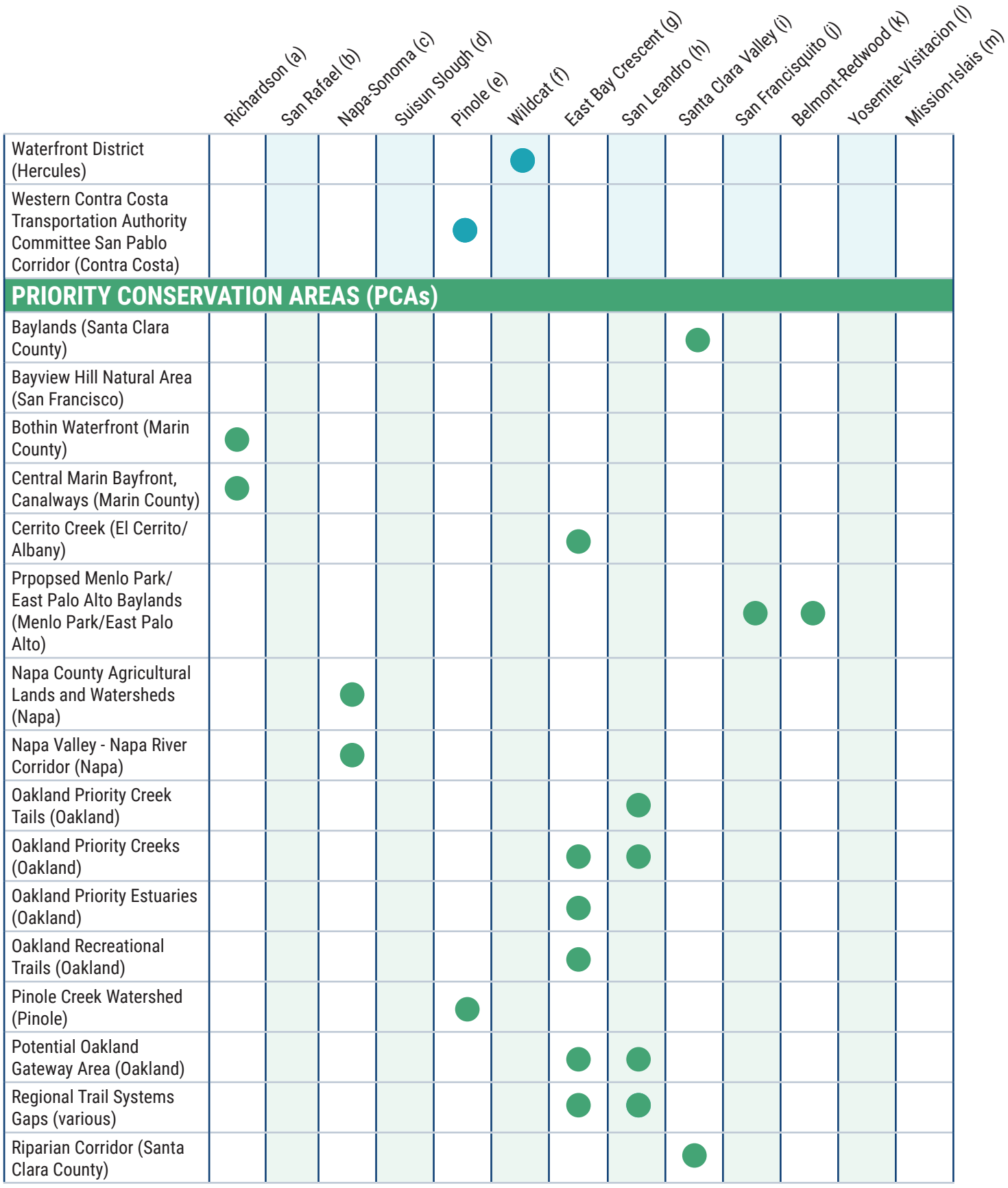


Figure 3-7 (cont). Visual representation of individual assets assessed and the Local Assessments in which they can be found.

	Richardson (a)	San Rafael (b)	Napa-Sonoma (c)	Suisun Slough (d)	Pinole (e)	Wildcat (f)	East Bay Crescent (g)	San Leandro (h)	Santa Clara Valley (i)	San Francisquito (j)	Belmont-Redwood (k)	Yosemite-Visitacion (l)	Mission-Islais (m)
San Bruno Mountain and Surrounding Area (San Bruno)												●	
San Francisco Bay Trail (various)	●	●	●	●	●	●	●	●	●	●	●	●	●
San Francisco Bay Trail - Bay Area Ridge Trail (Marin County)	●												
San Francisco Bay Water Trail Sites (various)	●	●	●	●	●	●	●	●		●	●	●	●
Sonoma Baylands (Sonoma County)			●										

Figure 3-7 (cont). Visual representation of individual assets assessed and the Local Assessments in which they can be found.

Menlo Park/East Palo Alto Baylands PCA is an example of an area that crosses two Local Assessments. Photo by Jaclyn Mandoske, BCDC.

Endnotes

1 Association of Bay Area Governments, "Priority Development Areas," Priority Development Areas, 2019, https://abag.ca.gov/our-work/land-use/pda-priority-development-areas

2 Association of Bay Area Governments, "Priority Conservation Areas," Priority Conservation Areas, 2019, https://abag.ca.gov/our-work/land-use/pca-priority-conservation-areas

3 SFEI and SPUR, "San Francisco Bay Shoreline Adaptation Atlas: Working with Nature to Plan for Sea Level Rise Using Operational Landscape Units" (Richmond, CA: San Francisco Estuary Institute, SPUR, April 2019), https://www.sfei.org/sites/default/files/biblio_files/SFEI%20SF%20Bay%20Shoreline%20Adaptation%20Atlas%20April%202019_highres.pdf.

4 ART Bay Area Regional Community Vulnerability Indicators, BCDC (2018).

5 Zuk, M., & Chapple, K. (2015). Urban Displacement Project. https://www.urbandisplacement.org/map/sf

6 Metropolitan Transportation Commission. (2018), "Equity Analysis- Communities of Concern". Accessed online at https://www.planbayarea.org/2040-plan/plan-details/equity-analysis.

7 California Office of Environmental Health Hazard Assessment (OEHHA). (June 2018). "CalEnviroScreen 3.0." Accessed online at https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

8 California Department of Water Resources. "DAC Mapping Tool." Accessed online at https://gis.water.ca.gov/app/dacs/.

9 Metropolitan Transportation Commission, Association of Bay Area Governments (2019) "Regional Growth Strategies Perspective Paper". https://mtc.ca.gov/sites/default/files/Horz_Perspective3_022719.pdf.

10 American Community Survey (ACS), 2012-2016. 5-year estimate

11 California Department of Housing and Community Development/Department of Finance Opportunity Maps, 2018, Composite Index based upon factors demonstrated to increase upward mobility amongst low-income families

12 Metropolitan Transportation Commission (MTC). "Displacement Risk | Vital Signs," February 2019, http://www.vitalsigns.mtc.ca.gov/displacement-risk.

13 Metropolitan Transportation Commission (MTC). Travel Model 1.0, 2015, 2018.

The Bay shoreline contains a variety of land uses, from homes and businesses to natural habitats and recreation opportunities. Photo SF Baykeeper, Robb Most, and LightHawk.

Chapter 4.0

REGIONAL ADAPTATION

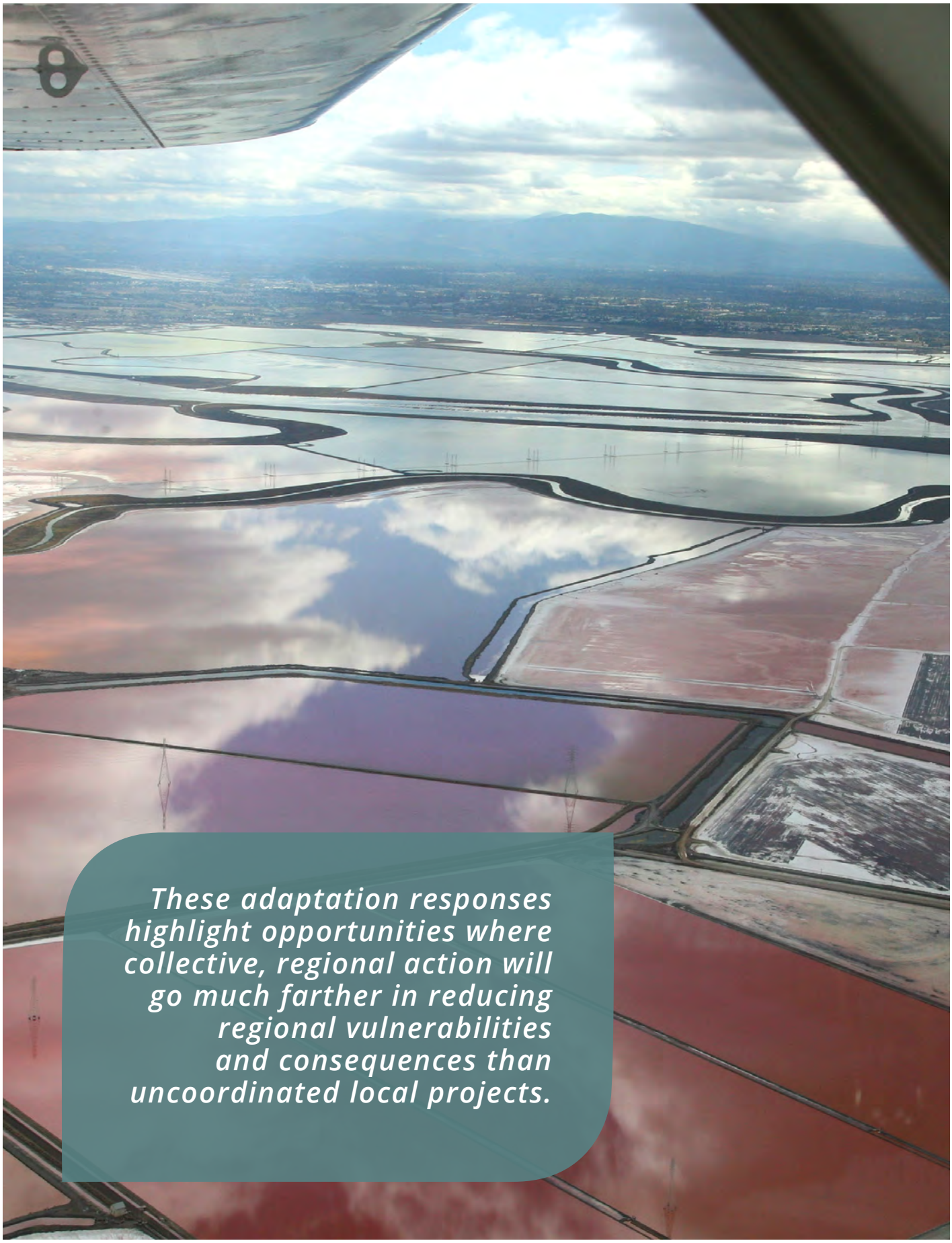
IN THIS CHAPTER

4.1 Adaptation - Bridging the Gap

Adapting to sea level rise in the Bay Area will require a multi-scale effort consisting of planning and policy changes, capacity-building, built projects, and financing within individual jurisdictions and across jurisdictional boundaries, county, or region-wide. Many efforts are already underway locally that will reduce sea level rise impacts through restoring wetlands, improving shoreline protection, enhancing flood control, or identifying specific responses to sea level rise.

Adaptation responses were developed for the project's eight Regional Key Planning Issues. The ART Bay Area adaptation approach varies from past ART projects because the adaptation responses developed respond to regional issues and focus on regional actions. These adaptation responses highlight opportunities where collective, regional action will go much farther in reducing regional vulnerabilities and consequences than uncoordinated local projects. Special consideration should also be given to applying adaptation responses in the previously-defined "Regional Hot Spots" (see Chapter 2.2) which represent locations where adaptation solutions could be multi-benefit by addressing similar vulnerabilities and consequences across a range of assets, geographies, and communities, and where benefits may cross jurisdictional boundaries.

Local projects are also of critical significance to reducing future risk; however, identifying local adaptation responses was not done as part of this project because of the criticality of deep local engagement and decision-making. However, the ART Program provides tools to support local adaptation planning, and an updated, integrated adaptation approach is under development, to be published in early 2020. ART Bay Area focuses on regional adaptation, as such, this adaptation approach is designed as a tool to help support local adaptation planning, which is a critical companion to regional actions. The adaptation approach provides a more robust support tool that can be picked up by users in locations where vulnerabilities are understood and where the community is ready to explore options for adaptation.



View of the South Bay Salt Ponds, where a large-scale restoration and flood protection project has been developed through a collaborative multi-jurisdictional effort. Photo by Jitze Couperus, licensed CC BY 2.0.

These adaptation responses highlight opportunities where collective, regional action will go much farther in reducing regional vulnerabilities and consequences than uncoordinated local projects.

APPROACH AND METHODOLOGY

ART Bay Area's eight Regional Key Planning Issues were identified through analysis of 32 local scale Focus Areas around the region (for more information on Regional Key Planning Issues, see Chapter 2, Regional Systems. For more information on local vulnerability assessments, see Chapter 3, Local Assessments).

Regional adaptation responses were created that start to resolve the issues identified in the eight Regional Key Planning Issues. These adaptation responses represent actions that require coordination by local and regional stakeholders, should be initiated by regional stakeholders or through a regional process, or consist of best practices for local jurisdictions to help address the common, regionally significant vulnerabilities identified in the Regional Key Planning Issues. These responses require collective implementation effort from stakeholders region-wide, because they cannot (or should not) be solved by individual agencies, organizations, asset managers, or communities. These strategies do not represent every detailed action that could be taken to solve regional or local vulnerabilities but provide a guide for how the region could work together to solve some critical cross-cutting issues.

These strategies have been reviewed by the Regional Working Group and should be advanced regionally through *Bay Adapt: Regional Strategy for a Rising Bay* (led by BCDC) and *Plan Bay Area 2050* (MTC/ABAG) as well as through local planning efforts. Strategies are categorized in the following ways:

- **Short-, Medium-, or Long-Term (Timing):** Actions within the short-term category focus on: possible early wins, having a single owner/manager, achievable under existing governance and regulatory conditions, are closely aligned with existing processes, entail additional study, or consist of foundational capacity building, such as education or the formation of new partnerships. Medium-term actions focus on more complex coordination or partnerships, initiating policy changes, larger-scale planning projects, or changes to existing processes. Long-term strategies are only those actions that are extremely complex or require significant preliminary steps.
- **Partner(s):** This identifies potential planning and implementation stakeholders. Regional, state, or federal stakeholders are called out by name; local stakeholders are identified by category as they will vary based on the specific location where actions are being implemented.
- **Strategy Category:** These categories describe the basic type of action that the response involves. These categories include Capacity Building, Plans and Policies, Programs and Operations, Funding and Financing, and Build a Project (Table 4-1: Strategy Category Descriptions). Some actions fit into multiple categories, but only one is described here.
- **Easy Win:** These strategies were identified by the Regional Working Group as low hanging fruit or "easy wins" - strategies that have existing support,

organizational capacity, or momentum. These strategies can identify some early implementation priorities that the Regional Working Group may help advance.

Adaptation responses to the Regional Key Planning Issues are achieved through a combination of different actions. Actions may include the development of built projects on the shoreline; changes in policies, procedures, operations or structures; increasing capacity for decision-making or action; the formation of new entities, programs, or collaboratives that bring people together to find shared multi-benefit solutions.

Adaptation Strategy Categories in ART Program

Strategy Category	Description
CAPACITY BUILDING	Includes actions that increase the ability to problem solve and implement actions, such as education, community engagement, formal or informal partnerships, relationship-building, or creating new organizational structures.
PLANS AND POLICIES	Includes actions to update, revise, or develop new plans, policies, and guidelines to address sea level rise. These plans and policies may alter how governance, zoning, ordinances, building codes, design, or permitting decisions are made within a jurisdiction.
PROGRAMS AND OPERATIONS	These actions include new or ongoing programs to improve procedures or management activities within a jurisdiction to address climate change, such as tax incentive programs, financial programs, land acquisition or banking, adaptive management procedures, or disincentive programs.
FUNDING AND FINANCING MECHANISMS	These actions identify funding mechanisms that may be used for planning and implementing strategies, including regional resources, state, federal, or local grants, and financial tools such as taxes, assessments, private funding, or fees.
BUILD A PROJECT	These actions utilize best available science to identify large-scale shoreline adaptation solutions that may be appropriate in different locations around the San Francisco Bay, including nature-based solutions, grey infrastructure, retrofits, or adaptive designs.

Table 4-1. Categories of adaptation strategies are divided into capacity building, policies and plans, programs and operations, funding and financing mechanisms, and build a project.

4.2 Adaptation Responses for Regional Key Planning Issues

Some common adaptation responses emerged across the Regional Adaptation Responses. These included:

- **Work closely with MTC/ABAG and *Plan Bay Area*** to ensure that regional goals for adaptation are included in transportation, land use, housing, future growth, and conservation area assessments, program incentives, and funding;
- **Leverage the upcoming *Bay Adapt: Regional Strategy for a Rising Bay*** to advance coordinated action around financing and supporting local adaptation planning;
- **Support local community engagement and education;**
- **Support capacity-building for local and regional government decision-makers** to incorporate sea level rise into daily decision-making and existing plans and processes;
- **Support and expand accelerated shoreline permitting** through the Bay Restoration Regulatory Integration Team (BRRIT) or a similar team;
- **Establish regional priorities and guiding principles;**
- **Encourage protection of vulnerable populations;**
- **Encourage local land use policies** that ensure that new development is resilient; and
- **Protect areas critical to the region** due to ecosystem value and/or flood protection benefits from future development.

Adaptation responses for each Regional Key Planning Issue that were identified by the Regional Working Group as "easy wins" are identified in the tables on the following pages (Tables 4-2 to 4-9). For a full list of regional adaptation responses addressing the Regional Key Planning Issues, see the Appendix.

The adaptation responses in the following tables address issues identified in the eight Regional Key Planning Issues described in greater detail in Chapter 2.3 Common Vulnerability Themes: Regional Key Planning issues. For a reminder on what the eight Regional Key Planning Issue are, see Figure 4-1. A list of acronyms used throughout the tables can be found in the beginning of the report.

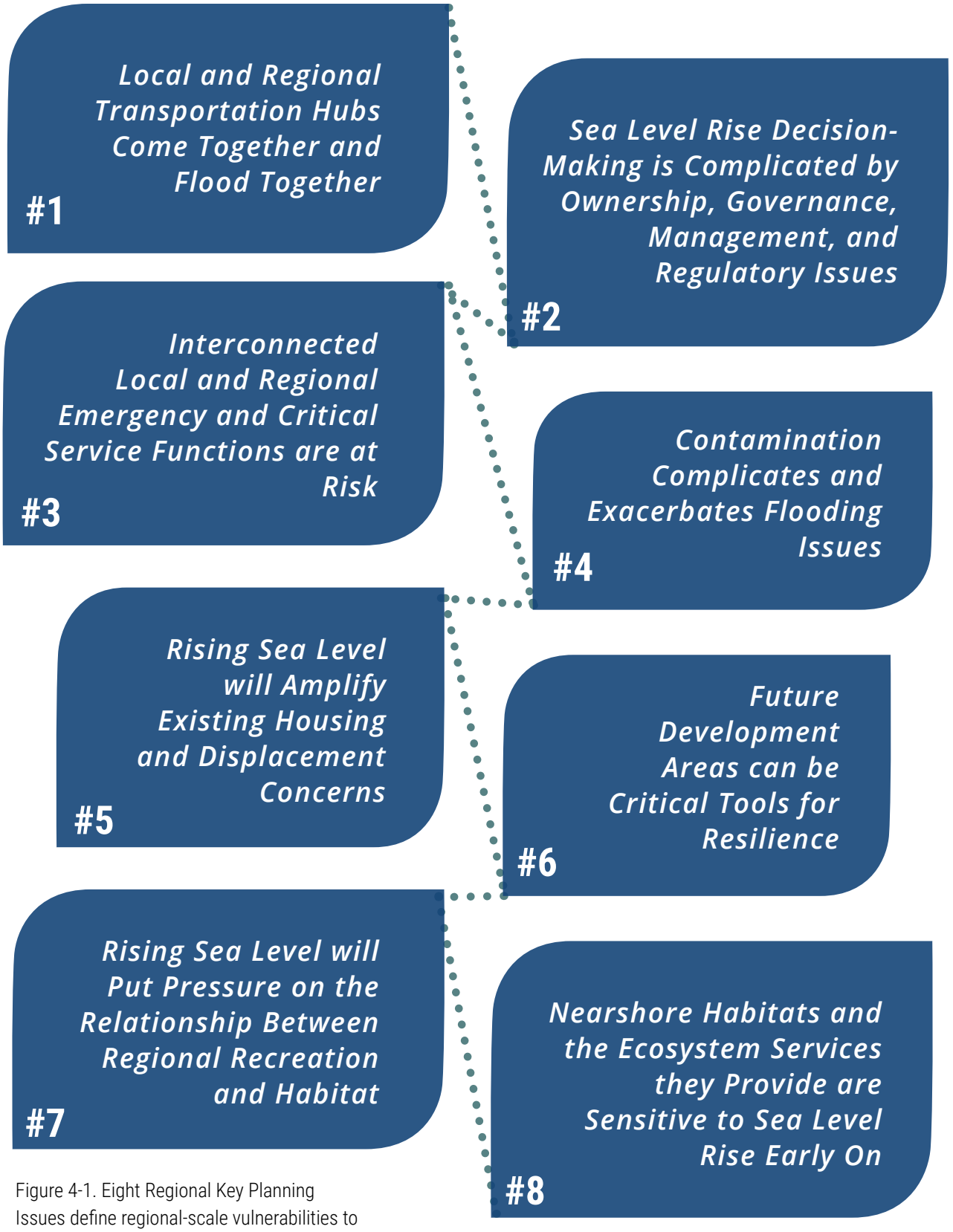


Figure 4-1. Eight Regional Key Planning Issues define regional-scale vulnerabilities to flooding that emerged in the local assessments conducted in ART Bay Area across the region.

REGIONAL ADAPTATION RESPONSES

#1

Local and Regional Transportation Hubs Come Together and Flood Together

Regional Vulnerability: *Many shoreline areas contain clusters of multiple transportation assets vulnerable to flooding that are critical to a functioning transportation system. In many cases, these assets lack redundancy and are networked such that loss of function of an asset or segment of the system would cause significant regional impacts to commuters, access to recreation and services, and movement of goods. See Chapter 2.3 for more details on vulnerability.*

Strategic Responses: *Table 4-2 identifies "easy win" adaptation responses. A full list of responses are in the Appendix.*

Adaptation Responses for Transportation Hubs

	Strategy Description	Partner(s)	Category
Short	Establish regional priorities for high consequence transportation clusters ("critical nodes") that connect multiple transportation types (e.g. roadways, rail, and other forms of transit), scales of service (local, sub-regional, or regional system), types of service (e.g. moving people or goods), and service to vulnerable communities, and use regional funding mechanisms to plan and implement protection measures in these locations.	MTC/ABAG, Caltrans, CTAs, BART, US DOT, Local Transit Authorities, Private Transit Providers, Railroad Companies	Programs and Operations 
Short	Adapt existing transportation funding and financing mechanisms to ensure that resilience measures are eligible for existing funding programs.	FHA, BATA, Caltrans, MTC/ABAG, Coastal Conservancy	Financing Mechanisms 

Table 4-2. "Easy win" adaptation responses for Transportation Hubs Regional Key Planning Issue.

Adaptation Responses for Transportation Hubs (Cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Collaborate on *Plan Bay Area 2050* Transportation Element to maximize integration of resilient transportation infrastructure and seek to integrate sea level rise resilience into existing programs, incentives, funding, or new planning tools and funding source(s).	MTC/ABAG, Caltrans	Plans and Policies
Short	Convene working groups across local, regional, and state transportation agencies and departments, as well as key local stakeholders and communities, to coordinate planning, funding, and implementation of protection measures around critical regional transportation vulnerabilities.	MTC/ABAG, Caltrans, CTAs, Local Transit Authorities, Private Transit Providers, rail	Capacity Building
Short	Proactively protect and prioritize funding to improve vulnerable public transportation assets that serve transit-dependent populations or prioritize development of alternative transit options to serve these populations.	MTC/ABAG, BATA, CTAs	Programs and Operations
Short	Adopt data management and sharing agreements, such as Memorandum of Understanding (MOUs), among local, state and regional transportation agencies, as well as utility agencies with co-located assets, to ensure that complete and high-quality transportation and utility asset information is available and accessible across systems to support adaptation planning and implementation.	MTC/ABAG, BARC, Caltrans, CTAs, Local Transit Authorities, Private Transit Providers, rail	Programs and Operations

Table 4-2 (cont.). "Easy win" adaptation responses for Transportation Hubs Regional Key Planning Issue.

REGIONAL ADAPTATION RESPONSES

#2

Sea Level Rise Decision-Making is Complicated by Ownership, Governance, Management, and Regulatory Issues

Regional Vulnerability: *Addressing local and regional seal level rise vulnerability will require multi-disciplinary planning among the many stakeholders that need to work together to identify shared goals and priorities, assign value to different assets, and agree on the types of strategies needed to reduce flooding and sea level rise risks. Of critical importance is the involvement of the local community in this process, as they are the largest stakeholder in many projects, and the one most likely to be overlooked. See Chapter 2.3 for more details on vulnerability.*

Strategic Responses: *Table 4-3 identifies "easy win" adaptation responses. A full list of responses are in the Appendix.*

Adaptation Responses for Complex Governance Issue

Timing	Strategy Description	Partner(s)	Category
Short	Develop *Bay Adapt: Regional Strategy for a Rising Bay* that accelerates implementation and coordination for adaptation, based on a shared set of guiding principles.	BCDC, MTC/ ABAG, BARC, SCC, Cities and Counties, CBOs, Private Sector, BayCAN, CHARG	Capacity Building
Short	Collaborate on *Plan Bay Area 2050* Implementation Plan to identify next steps for regional governance of sea level rise resilience.	MTC/ABAG, BARC, BCDC, Cities and Counties	Plans and Policies

Table 4-3. "Easy win" adaptation responses for Complex Governance Regional Key Planning Issue.

Bay waters rising during King Tides in December 2019 in San Pablo Bay at the Pinole shoreline. Photo by SF Baykeeper, Cole Burchiel, and LightHawk.

Adaptation Responses for Complex Governance Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Develop a regional technical assistance program that provides training, education, and tools for the development of local adaptation projects, including support for vulnerability assessments, identifying and evaluating adaptation strategies and improving governance, community engagement, and coordination with partners.	MTC/ABAG, BCDC, CCC, BayCAN, CHARG, Cities and Counties, CBOs, NGOs	Capacity Building
Short	Using ART Bay Area evaluation criteria and other existing criteria as the basis, and *Bay Adapt: Regional Strategy for a Rising Bay* as the platform, facilitate conversations and the development of decision-making criteria or models that allow local jurisdictions to assess the consequences and impacts of local decisions on the rest of the region.	BCDC, MTC/ABAG, BARC, SCC, Universities, Cities and Counties, CBOs, Private Sector Partners, CCC, BayCAN, CHARG, NGOs	Capacity Building
Short	Provide support for local and regional community engagement in adaptation planning and implementation through small participation grants, existing engagement resources, sharing of best practices, and region-wide recognition of successes.	MTC/ABAG, BARC, BCDC, Private Sector Partners, CBOs, Cities and Counties, NGOs	Capacity Building

Table 4-3 (cont.). "Easy win" adaptation responses for Complex Governance Regional Key Planning Issue.

Adaptation Responses for Complex Governance Issue (cont.)

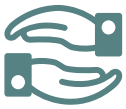
Timing	Strategy Description	Partner(s)	Category
Short	Improve and expand communication campaigns to increase public awareness and capacity to participate in local and regional sea level rise decision-making, with a focus on basic understanding of concepts, consequences, relationship to other critical issues such as jobs and housing, and how to get involved with local, regional, and state governance.	Cities and Counties, Community Groups, NGOs, BCDC, BARC, MTC/ ABAG, Private Entities, Public Heath Agencies, Universities and Other Public Educators	Programs and Operations 
Medium	Using *Bay Adapt: Regional Strategy for a Rising Bay* as the platform, and guiding principles as the basis, develop a regional funding source, and/or expand existing statewide funding sources, through a coordinated proposal to the California legislation to help incentivize collaborative Bay Area adaptation projects that meet regional priorities.	BCDC, MTC/ ABAG, BARC, SCC, Cities, CBOs, NGOs, Private Sector Partners, CCC, BayCAN, CHARG	Financing Mechanisms 
Medium	Support and expand the Bay Restoration Regulatory Integration Team (BRRIT) to ensure consistent regulatory and planning approaches to sea level rise adaptation across all project types, and to reduce regulatory, programmatic, or legislative barriers to assessing and addressing future risks.	BRRIT, BCDC, USACE, FEMA, RWQCB, CDFW, USFWS, NOAA, Cities and Counties	Capacity Building 

Table 4-3 (cont). "Easy win" adaptation responses for Complex Governance Regional Key Planning Issue.

The Bay shoreline is owned or managed by various entities and is home to wetlands and natural habitats, utilities, businesses and other uses. Photo by SF Baykeeper, Cole Burchiel, and LightHawk.

REGIONAL ADAPTATION RESPONSES

#3

Interconnected Local and Regional Emergency and Critical Service Functions are at Risk

Regional Vulnerability: *In the event of a significant emergency, many critical services are required to move people and goods within as well as in and out of the region. Many emergency management assets are located in flood areas, putting their functions at risk. Critical services such as water, wastewater, electricity, and communications also may be at risk, and community-serving centers like schools, places of worship, and libraries that serve critical functions in emergencies may be inundated and unable to serve residents. See Chapter 2.3 for more details on vulnerability.*

Strategic Responses: *Table 4-4 identifies "easy win" adaptation responses. A full list of responses are in the Appendix.*

Adaptation Responses for Emergency Response Issue

Timing	Strategy Description	Partner(s)	Category
Short	Require critical community facilities, including those providing emergency response and public health services, to update or expand operations and contingency plans to ensure they are protected from flooding and have water, power, food and other supplies necessary to maintain key functions during a flood event.	Cities and Counties, Special Districts, Public Health Departments, CalOES, FEMA	Programs and Operations
Short	Establish/update/strengthen mutual aid agreements and initiate or strengthen joint protocols with adjoining jurisdictions for cooperative disaster response.	Cities and Counties, Special Districts	Plans and Policies

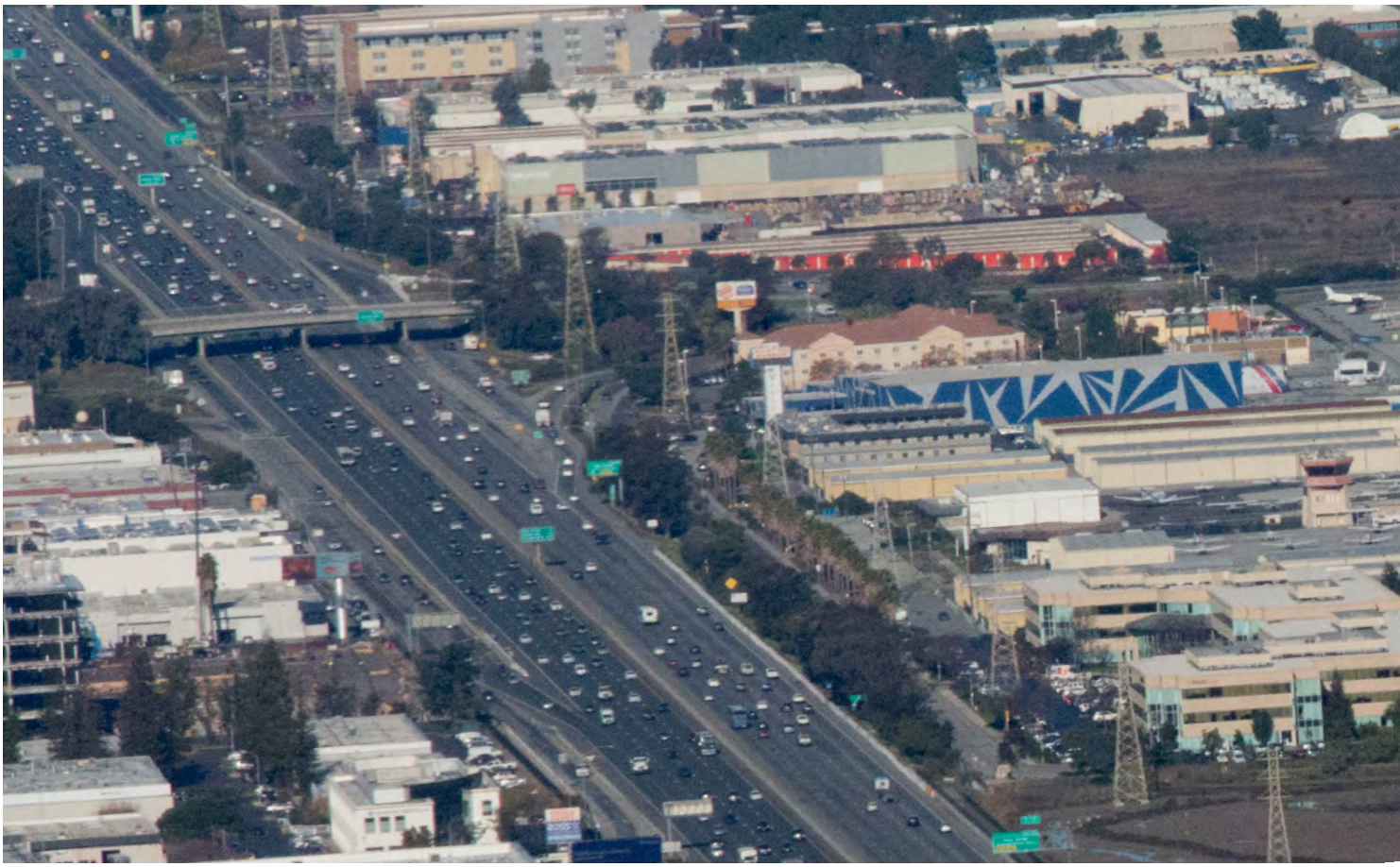
Table 4-4. "Easy win" adaptation responses for Emergency Response Regional Key Planning Issue.

The San Francisco waterfront is a critical place for emergency services, ranging from ferries to the I-80 Bay Bridge. Photo by SF Baykeeper, Cole Burchiel, and LightHawk.

Adaptation Responses for Emergency Response Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Encourage and support the ongoing development and timely updating of Local Hazard Mitigation Plans at the city and county level that include future hazards such as rising sea level, and are coordinated with other local plans, such as the General Plan Safety Element.	FEMA, CalOES, MTC/ABAG, Cities and Counties	Plans and Policies
Short	Ensure that transportation adaptation projects prioritize lifeline routes, emergency evacuation routes, and goods movement corridors and support the continued function of co-located critical utilities.	MTC/ ABAG, CTAs, Caltrans, Cities and Counties, Special Districts, Private Sector Partners	Plans and Policies
Short	Foster community-based emergency response networks, such as CERT programs, that build community capacity and increase a community's ability to prepare for, respond to, and recover from a disaster event.	Cities and Counties, CBOs, NGOs	Capacity Building

Table 4-3 (cont.). "Easy win" adaptation responses for Emergency Response Regional Key Planning Issue.



The CA-92 San Mateo Bridge is only one a few bridges that can transport people across the Bay in the case of an emergency. Photo by SF Baykeeper, Cole Burchiel, and LightHawk.

Adaptation Responses for Emergency Response Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Expand or form multi-agency and cross-jurisdictional partnerships, and fund participation of community-based organizations, to improve the capacity to address the needs of people in the community, particularly those with special mobility, care, or medical needs, during a disaster or emergency.	Cities and Counties, CADPH, CalOES, FEMA, CBOs, NGOs, Private Sector Partners	Capacity Building

Table 4-4 (cont.). "Easy win" adaptation responses for Emergency Response Regional Key Planning Issue.

Adaptation Responses for Emergency Response Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Medium	Review and update region-wide standards, codes, and regulations for new critical public services, including emergency response facilities, schools, childcare centers, community centers, health services, assisted living and nursing homes, power, water, wastewater, and waste transfer stations to avoid or address sea level rise, storm events, and elevated groundwater levels, and exposure to saltwater.	Cities and Counties, CalOES, FEMA, Special Districts, CBOs, NGOs, Private Sector Partners	Plans and Policies

Table 4-3 (cont.). "Easy win" adaptation responses for Emergency Response Regional Key Planning Issue.

REGIONAL ADAPTATION RESPONSES

#4

Contamination Complicates and Exacerbates Flooding Issues

Regional Vulnerability: *Many areas at risk of flooding are on or near former industrial sites that have been designated as contaminated areas. Many vulnerable communities live adjacent to or even on contaminated sites. There is significant uncertainty about how flooding and rising groundwater will exacerbate contamination and increase public health concerns if contaminants are mobilized, or how dry land cleanup standards will perform if lands become submerged. See Chapter 2.3 for more details on vulnerability.*

Strategic Responses: *Table 4-5 identifies "easy win" adaptation responses. A full list of responses are in the Appendix.*

Adaptation Responses for Contamination Issue

Timing	Strategy Description	Partner(s)	Category
Short	Leverage grants and technical assistance funding from US EPA Region 9 to develop and implement an approach for identifying, assessing and prioritizing contaminated cleanup sites in the region, especially those in areas of current and future flooding.	US DOD, US EPA, DTSC, BCDC, RWQCB, Cities and Counties, CBOs	Plans and Policies
Short	Develop and keep current a publicly accessible, centralized information system about contaminated site vulnerability, consequences and adaptation options, or add to existing contaminated sites databases, and flag sites in areas of current and future flooding.	DTSC, RWQCB, US EPA, County Health Departments	Programs and Operations

Table 4-5. "Easy win" adaptation responses for Contamination Regional Key Planning Issue.

Adaptation Responses for Contamination Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Conduct studies of dryland site remediation standards to determine their efficacy if sites are impacted by temporary flooding, permanent flooding, or changes in groundwater or salinity levels.	DTSC, RWQCB, US EPA, County Health Departments, CA EPA, US EPA, US DOD	Programs and Operations 
Short	Compile data that already exists, and conduct studies (if necessary) to determine where contaminated sites that have been cleaned to dryland standards may become flooded as sea levels rise, utilizing existing sea level rise viewers.	DTSC, RWQCB, US EPA, Cities and Counties, CBOs	Programs and Operations 
Medium	If existing standards are deemed insufficient, develop new contaminated site cleanup standards that consider the impact of sea level and groundwater rise on sediment-bound or water-soluble contaminants as well as the efficacy of the remediation practice and cleanup standard selected.	DTSC, RWQCB, US EPA	Plans and Policies 
Medium	Develop regional or local policies that ensure new development that is required to do remediation of contaminated lands in high- hazard areas is performed to the highest standards, including to the adequate standards of submersion to protect people and the environment in the event of future permanent inundation.	US EPA, CalEPA, DTSC, Cities and Counties, Water Boards, Public Health Departments	Plans and Policies 

Table 4-4 (cont.). "Easy win" adaptation responses for Contamination Regional Key Planning Issue.

REGIONAL ADAPTATION RESPONSES

#5

Rising Sea Levels will Amplify Existing Housing and Displacement Concerns

Regional Vulnerability: *Throughout the Bay Area, a severe housing affordability crisis has led to unprecedented displacement risk. This pressure is felt most acutely by communities subject to marginalization. Many vulnerable communities also are more vulnerable to displacement due to rising sea level. Displacement, in turn, contributes to loss of community cohesion and social networks, which further adds to vulnerability to hazards like flooding. See Chapter 2.3 for more details on vulnerability.*

Strategic Responses: *Table 4-6 identifies "easy win" adaptation responses. A full list of responses are in the Appendix.*

Adaptation Responses for Housing and Displacement Issue

Timing	Strategy Description	Partner(s)	Category
Short	Collaborate on *Plan Bay Area 2050* Housing Element to incorporate land use resilience goals, specifically around planning future housing in lower-risk areas or by mitigating risk from sea level rise through shoreline adaptation.	MTC/ABAG, BCDC, BARC, Cities and Counties	Plans and Policies
Short	Improve and expand public communication campaigns to increase public awareness and capacity to participate in local and regional sea level rise decision-making, with a focus on basic understanding of concepts, consequences, relationship to other critical issues such as jobs and housing, and how to get involved with local, regional, and state governance.	Cities and Counties, CBOs, NGOs, BCDC, BARC, MTC/ABAG, Private Entities, Public Heath Agencies, Public Educators	Capacity Building

Table 4-5. "Easy win" adaptation responses for Housing and Displacement Regional Key Planning Issue.

In the North Bay, homes border the many creeks and channels that are influenced by a rising bay. Photo courtesy of California Bay King Tides Project.

Adaptation Responses for Housing and Displacement Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Encourage owners of property and renters in floodplains to purchase flood insurance and educate the public that most homeowner insurance policies do not cover a property with flood damage.	Cities and Counties, NGOs, FEMA	Capacity Building
Short	Provide support for local community engagement in adaptation planning and implementation through small participation grants, existing engagement resources, sharing of best practices, and region-wide recognition of successes.	MTC/ABAG, BARC, BCDC, Private Sector Partners, CBOs, Cities and Counties, NGOs	Capacity Building
Short	Establish regional protection priorities for vulnerable communities identified to be at high risk of displacement, and use regional funding mechanisms to plan and implement protection measures in these locations.	BCDC, MTC/ABAG, BARC, Cities and Counties, CBOs, NGOs	Plans and Policies

Table 4-5 (cont.). "Easy win" adaptation responses for Housing and Displacement Regional Key Planning Issue.

King Tides in December 2019 at the San Jose shoreline. Photo by SF Baykeeper, Cole Burchiel, and LightHawk.

Adaptation Responses for Housing and Displacement Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Advocate that the allocation of future housing growth, such as the Regional Housing Needs Allocation (RHNA) accounts for relocation and/or loss of housing due to flooding to ensure that no net loss of housing occurs.	MTC/ABAG, Cities and Counties, HCD, NGOs, CBOs	Plans and Policies 
Medium	Develop and adopt a regional and local strategy for housing that is at risk of loss due to flooding and has not been identified for protection, and ensure that additional new housing is built to ensure no net loss of housing occurs, and that owners and tenants are adequately compensated and provided assistance for relocation, and that accounts for changes in tax base and/or community costs to local jurisdictions.	MTC/ABAG, BARC, Cities and Counties, HCD, NGOs, CBOs	Plans and Policies 
Medium	Develop and implement residential real estate disclosure requirements for agents and lessors that disclose future flood and groundwater exposure due to sea level rise and ensure that these requirements are updated as risk is better understood over time.	Cities and Counties, CA Department of Insurance, CalOES, FEMA, HCD, NGOs, Private Sector, California Association of Realtors	Plans and Policies 
Medium	Establish partnerships with existing or new housing leadership entities (such as CASA's proposed *Regional Housing Enterprise*) to ensure that sea level rise considerations are incorporated into housing policies implementation.	MTC/ABAG, BCDC, Cities and Counties, NGOs, CBOs	Capacity Building 

Table 4-5 (cont.). "Easy win" adaptation responses for Housing and Displacement Regional Key Planning Issue.

REGIONAL ADAPTATION RESPONSES

#6

Future Development Areas can be Critical Tools for Resilience

Regional Vulnerability: *A strong economy has added a large number of jobs and people to the region in recent years. There is significant region-wide pressure to add new development to accommodate these jobs as well as to provide much-needed affordable housing. New development presents an opportunity to make smart choices about how much new risk we create for future generations. See Chapter 2.3 for more details on vulnerability.*

Strategic Responses: *Table 4-7 identifies "easy win" adaptation responses. A full list of responses are in the Appendix.*

Adaptation Responses for Future Growth Areas Issue

Timing	Strategy Description	Partner(s)	Category
Short	Ensure *Plan Bay Area 2050* incorporates land use resilience strategies, including adaptation strategies for existing and future growth in vulnerable areas. Use existing and future regional funding programs, including the OBAG grant program and PDA planning program, to support local efforts to enhance resiliency.	MTC/ABAG, BCDC, BARC, Cities and Counties, Private Sector, CBOs	Plans and Policies
	Improve and expand public communication campaigns that increase public awareness and capacity to participate in local and regional sea level rise decision-making, with a focus on basic understanding of concepts, consequences, relationship to other critical issues such as jobs and housing, and how to get involved with local, regional, and state governance.	Cities and Counties, CBOs, NGOs, BCDC, BARC, MTC/ABAG, Private Sector, Public Heath Agencies	Capacity Building

Table 4-7. "Easy win" adaptation responses for Future Growth Areas Regional Key Planning Issue.

The former Naval Air Station in the City of Alameda is planned for significant future housing and jobs. Photo by SF Baykeeper, Cole Burchiel, and LightHawk.

Adaptation Responses for Future Growth Areas Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
	Provide support for local community engagement in adaptation planning and implementation through small participation grants, existing engagement resources, sharing of best practices, and region-wide recognition of successes.	MTC/ABAG, BARC, BCDC, Private Sector, CBOs, Cities and Counties, NGOs	Capacity Building
	Identify existing and/or develop a toolkit and guidance, including model ordinances, for local zoning and planning tools that encourage more resilient decision-making around local land use planning, such as downzoning, zoning for wetland migration space, clustering of development, increasing buffers and setbacks, redevelopment restrictions, special districts, or other such tools.	CalOES, OPR, SCC, MTC/ ABAG, BCDC, BARC, NGOs (e.g. APA), CBOs	Plans and Policies

Table 4-7 (cont.). "Easy win" adaptation responses for Future Growth Areas Regional Key Planning Issue.

REGIONAL ADAPTATION RESPONSES

#7

Rising Sea Level will Put Pressure on the Relationship Between Regional Recreation and Habitat

Regional Vulnerability: *Many of the region's vulnerable recreation areas are near sensitive habitat areas that are at risk. Many of these areas also could play critical roles in flood management through nature-based solutions. Different stakeholders may have differing priorities for the management of natural shoreline areas that prioritize people, natural systems, or flood control, amongst other things, over one another. See Chapter 2.3 for more details on vulnerability.*

Strategic Responses: *Table 4-8 identifies "easy win" adaptation responses. A full list of responses are in the Appendix.*

Adaptation Responses for Recreation and Habitats Issue

Timing	Strategy Description	Partner(s)	Category
Short	Expand and support public education about the risks in the Bay Area to shoreline parks and natural areas from sea level rise, the multiple benefits of parks and ecosystem services provided by natural areas (flood protection, wildlife habitat, educational and recreational values) and the opportunities for adaptation to protect these functions and services	NPS, CSP, SCC, SFEP, Bay Trail, BCDC, City and County Parks Districts, NGOs, CBOs, RWQCB	Capacity Building 

Table 4-8. "Easy win" adaptation responses for Recreation and Habitats Regional Key Planning Issue.

Flooding of wetlands and trail during King Tides in January 2020 on a windy but clear day in Bothin Marsh in the North day. Photo by Steve Disenhof, courtesy of California Bay King Tides Project.

Adaptation Responses for Recreation and Habitats Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Develop best practices and guidance to ensure that regional shoreline park planning, and project development activities, consider sea level rise and factor impacts into tidal wetland restoration, habitat enhancement or creation, and park/recreation management activities.	NPS, USACE, USFWS, SCC, CDFW, CA DFW, SFEP, Bay Trail, BCDC, RWQCB, Cities and Counties	Plans and Policies
Short	Expand or form partnerships with local and regional transportation owners and operators to understand transportation pressures (such as pedestrian or bike commuting) on shoreline recreational paths, such as the Bay Trail, and how flooding may impact these functions.	Cities and Counties, Bay Trail, MTC/ ABAG, Caltrans, CTAs, Local Transportation Authorities	Capacity Building

Table 4-8 (cont.). "Easy win" adaptation responses for Recreation and Habitats Regional Key Planning Issue.

Adaptation Responses for Recreation and Habitats Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Develop policies, guidance or incentives to encourage setbacks and buffers adjacent to tidal marshes that protect sensitive species, and/or establish zoning or conservation of upland locations for marsh migration while maintaining appropriate types of public access and recreation uses.	Cities and Counties, SCC, SFEP, Bay Trail, CA DFW, USFWS, NOAA, NGOs	Plans and Policies
Medium	Form or expand existing partnerships among park districts, park and recreation departments, Private Entities, community-based organizations and community members to develop a shared vision and decision-making process for protecting and jointly maintaining the function of parks and open space across the region.	NPS, SCC, SFEP, Bay Trail, BCDC, City and County Parks Districts, Nonprofits and CBOs	Capacity Building
Medium	Develop a region-wide or county-wide park enhancement and protection plan(s) that identifies opportunities for increasing the resilience of parks that are vulnerable to sea level rise and the capacity of parks that are not at risk.	NPS, SCC, SFEP, Bay Trail, BCDC, City and County Parks Districts, Nonprofit and CBOs	Plans and Policies
Medium	Region-wide, identify and preserve or expand high tide refugia for species and transition zones for marshes and identify where these locations are in conflict with existing or planned recreational uses.	NPS, NOAA, USFWS, SCC, CDFW, SFEP, Cities and Counties, NGOs, CBOs	Programs and Operations

Table 4-8 (cont.). "Easy win" adaptation responses for Recreation and Habitats Regional Key Planning Issue.

Bedwell Bayfront Park in Redwood City is a popular recreational area and has many trails surrounding the park located near surrounding natural areas.. Photo of wetlands and trails in the South Bay. Photo by SF Baykeeper, Robb Most, and LightHawk.

REGIONAL ADAPTATION RESPONSES

#8

Nearshore Habitats and the Ecosystem Services they Provide are Sensitive to Sea Level Rise Early On

Regional Vulnerability: *Nearshore habitats provide significant natural and ecosystem services, such as habitats for endangered species, carbon sequestration, wave attenuation, and contribution to recreation and regional character. In many locations, natural ecosystems will be the first locations to be impacted by rising sea level. Protecting, restoring, and enhancing nearshore habitats can provide many benefits. See Chapter 2.3 for more details on vulnerability.*

Strategic Responses: *Table 4-9 identifies "easy win" adaptation responses. A full list of responses are in the Appendix.*

Adaptation Responses for Habitats and Ecosystem Services Issue

Timing	Strategy Description	Partner(s)	Category
Short	Develop policies, guidance or incentives to encourage setbacks and buffers adjacent to tidal marshes that protect sensitive species, and/or establish zoning or conservation of upland locations for marsh migration while maintaining appropriate types of public access and recreation uses.	Cities and Counties, SCC, SFEP, CA DFW, USFWS, NOAA, NGOs	Plans and Policies 

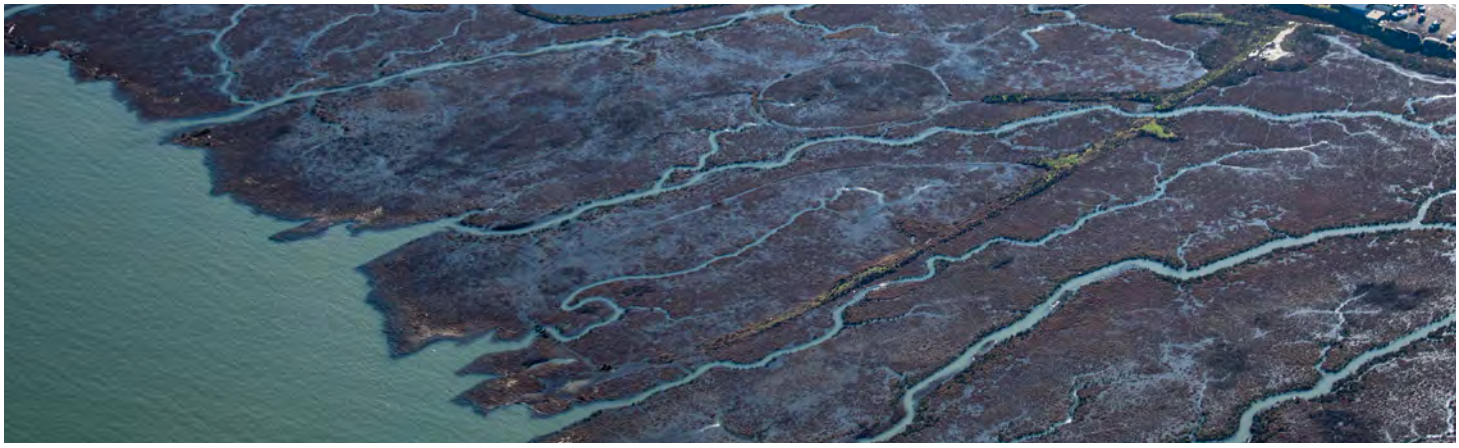
Table 4-9. "Easy win" adaptation responses for Habitats and Ecosystem Services Regional Key Planning Issue.

Low tide in Bothin marsh reveals species that depend on healthy wetlands. Photo by Fabrice Florin licensed under CC BY 2.0.

Adaptation Responses for Habitats and Ecosystem Services Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Support research and development of best practices to monitor tidal marshes as sea level rise occurs (for example, to identify when marshes are approaching key thresholds for management decisions), actions that will improve tidal marsh resilience, and better understanding of how tidal marsh and adjacent ecotone and subtidal habitats will be affected by different shoreline adaptation responses (e.g., structural solutions versus natural solutions).	USFWS, NOAA, DWR, SCC, SF Bay NERR, SFEP, CDFW, Cities and Counties, NGOs, CBOs	Programs and Operations
Short	Organize collaborative regional discussions to explore where legal, policy or regulatory changes are needed to promote nature-based solutions, such as constructing oyster and eelgrass reefs in a living shorelines approach, to address existing and future infrastructure adaptation challenges.	BRRIT, Cities and Counties, SCC, SFEP, CDFW, BCDC, RWQCB, USACE, NOAA, BAFPA, IRWMP	Capacity Building

Table 4-9 (cont.). "Easy win" adaptation responses for Habitats and Ecosystem Services Regional Key Planning Issue.



Natural habitats line the San Francisco Bay and provide critical ecosystem services that support people and wildlife, including wetlands of Giant Marsh. Photo by SF Baykeeper, Robb Most, and LightHawk.

Adaptation Responses for Habitats and Ecosystem Services Issue (cont.)

Timing	Strategy Description	Partner(s)	Category
Short	Develop a decision-making framework for planning and implementing resilient, multi-objective shoreline adaptation projects that clearly weigh the trade-offs among short- and long-term impacts versus benefits to the economy, environment and social equity.	SFBRA, SCC, BCDC	Plans and Policies
Short	Support the development of a comprehensive regional sediment management plan that emphasizes the reuse of suitable sediment for baylands enhancement and restoration.	SCC, CDFW, BCDC, RWQCB, UASCE, USFWS, SFBRA, Cities and Counties	Plans and Policies
Medium	Region-wide, identify and preserve or expand high tide refugia for species and transition zones for marshes and identify where these locations are in conflict with existing or planned recreational uses.	NPS, NOAA, USFWS, SCC, CDFW, SFEP, Cities and Counties, NGOs, CBOs	Capacity Building

Table 4-9. "Easy win" adaptation responses for Habitats and Ecosystem Services Regional Key Planning Issue.

Adaptation Responses for Habitats and Ecosystem Services Issue (cont.)

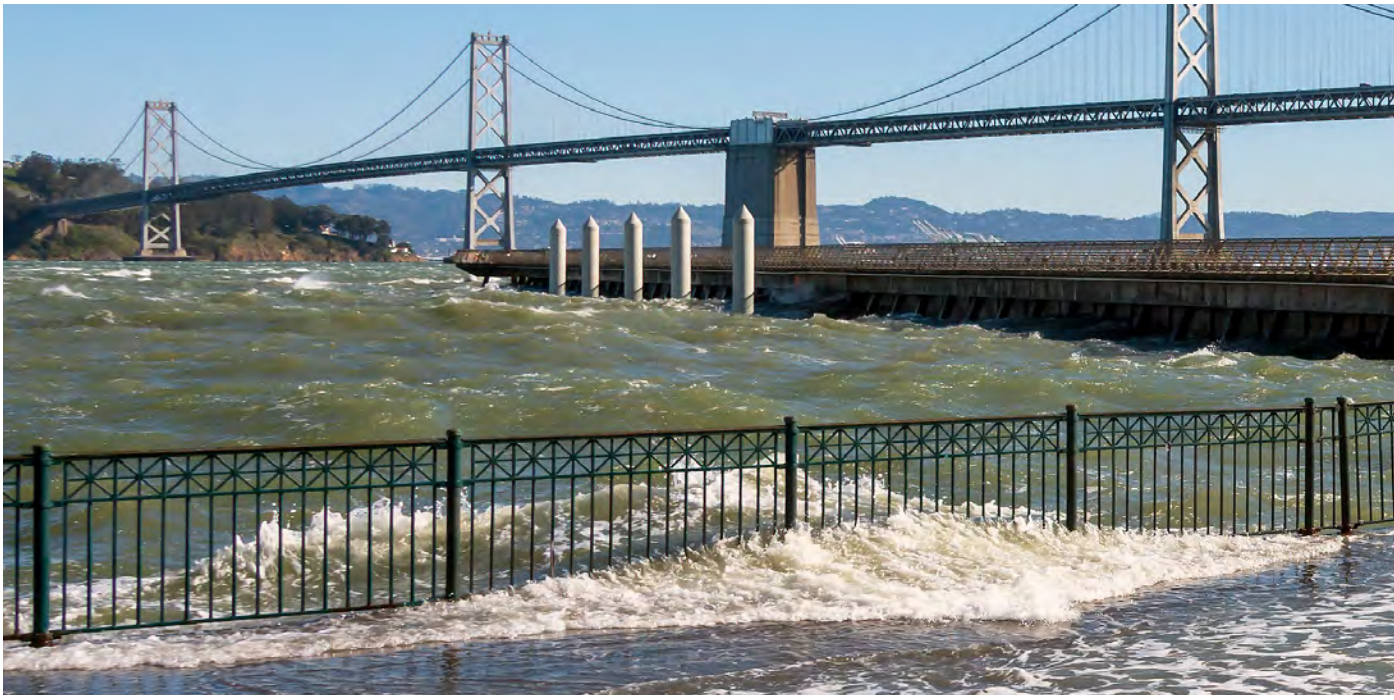
Timing	Strategy Description	Partner(s)	Category
Medium	Using BEHGU as a guide, develop a strategic plan to acquire and conserve upland areas, and reconnect baylands to adjacent open lands, from willing landowners in order to support marsh landward migration.	SCC, CDFW, BCDC, State Parks, USFWS, NGOs	Plans and Policies 
Medium	Establish cooperative agreements with local jurisdictions and agencies along creeks, streams, and/or watersheds to encourage more holistic and integrative management of fluvial flooding, combined fluvial and coastal flooding and sediment flow, including studying and implementing practices to ensure adequate sediment delivery to tidal marshes to a degree that enables these habitats to adapt to rising water levels and migrate upland over time.	USFWS, NOAA, DWR, SCC, SFEP, CDFW, Cities and Counties, NGOs, CBOs	Programs and Operations 
Long	Develop a regional or local program to establish conservation easements that preserve certain high hazard areas as non-development areas that can be maintained as open space or habitat, and/or low-density development areas to discourage/ prohibit new development or densification in high hazard areas.	Cities and Counties, CDC, SCC, MTC/ ABAG, BCDC, BARC, NGOs	Programs and Operations 

Table 4-9 (cont.). "Easy win" adaptation responses for Habitats and Ecosystem Services Regional Key Planning Issue.

4.3 Localizing Adaptation Pathways in Focus Areas

ART Bay Area focuses on regional adaptation responses, but meaningful adaptation throughout the region will require action at a variety of scales. Solving for adaptation region-wide will require a multi-scale, multi-stakeholder approach that incorporates everything from small, local flood control improvements to coordinated statewide legislation. It was not within the scope of this project to identify all local adaptation options in the areas assessed, in large part because of the local engagement required to create meaningful, community-driven solutions, and also because additional detail is likely required in the local analysis areas to provide a comprehensive picture of local vulnerability.

The ART Program provides tools to support local adaptation planning. Previous ART guidance on adaptation responses (the Plan Step) provided a wide-ranging suite of adaptation responses that address vulnerabilities identified in vulnerability statements, resulting in a comprehensive suite of possible stand-alone or sequenced actions, and information on how to begin to flesh out a plan for implementation of specific actions. However, new thinking on scenario planning and sequencing adaptation actions provides a more robust approach to adaptation. An updated, integrated adaptation approach is under development, to be published in early 2020. The following sections provide an overview of this approach.



New thinking on scenario planning and sequencing adaptation actions by the ART Program provides a more robust approach to adaptation. An updated, integrated adaptation approach is under development, to be published in 2020.

ADAPTATION - AN UPDATED APPROACH

The updated Plan Step guidance seeks to provide a step-wise process of utilizing information from the Assess and Define steps to identify a tailored suite of adaptation strategies that take into account local community members and stakeholders, defined planning parameters, a clear vision for the future, guiding principles that reflect resilience goals, opportunities and challenges, and a sequencing of actions in a logical way that accounts for uncertainty and change.

San Francisco Embarcadero flooded during King Tides. Photo courtesy of California Bay King Tides Project.

Advancing Local Adaptation Guidance in Development

The adaptation process is geared towards local users and designed to be led by whichever lead agency has been facilitating the vulnerability assessment process in coordination with a wide range of community members and other local stakeholders. The goals of this process are:

- **Help to guide users towards understanding how to decide what adaptation actions (a "strategy") is most appropriate** for their particular location and why they are appropriate;
- **Help users think about how actions sequence over time,** taking into account uncertainty about when temporary and permanent inundation will occur as well as what future local conditions will be like, to help illuminate what actions (or monitoring) should start occurring today, even though impacts may not be felt until later; and
- **Encourage and illuminate best practices around community engagement** and the need for adaptation planning to be more inclusive of local voices.

This adaptation process encapsulates the ART Plan step and assumes that users have already followed the ART approach and have clearly defined the vulnerabilities, consequences and planning issues present in the community (e.g. completed the ART Assess and Define steps). The following steps guide users through the adaptation process.

1. **Engage with Community and Stakeholders**
2. **Coordinate with the Relevant Partners**
3. **Establish Planning Assumptions,** including physical planning units, planning horizon, local and regional opportunities and constraints, and triggers and thresholds
4. **Define Guiding Principles**
5. **Explore Future Outcomes** by identifying strategic approaches, including Protect, Retreat or Avoid, Adapt, and Prepare, and through identifying desired future outcomes (scenarios)
6. **Select Actions and Create Strategies**
7. **Evaluate Strategies using Evaluation Criteria**
8. **Create an Adaptation Pathway** that sequences actions, establishes timelines, and identifies simultaneous pathways that account for the timing and certainty of vulnerabilities.

This guidance, when published, will include a How-To Guide, illustrative process diagram, and worksheets. Figure 4-2 provides a visual overview of the draft process.

1. IDENTIFY COMMUNITIES AND RELEVANT STAKEHOLDERS TO ENGAGE IN PROCESS

+

2. IDENTIFY APPROPRIATE IMPLEMENTING PARTNERS

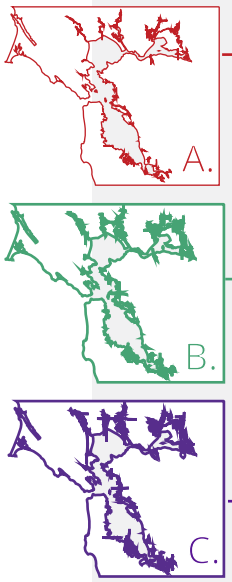
3. ESTABLISH PLANNING ASSUMPTIONS

- Local opportunities
- Barriers and constraints
- Planning Horizon
- Thresholds and Triggers

4. COLLECTIVELY DEFINE GUIDING PRINCIPLES*

5. EXPLORE HOW FUTURE OF THE SHORELINE COULD LOOK*

Scenario planning may include the following strategic approaches: Protect, Avoid/Managed Retreat, Adapt, and/or Prepare



6. SELECT ACTIONS FROM ADAPTATION CATALOG THAT WORK TOGETHER (STRATEGY) FOR PREFERRED SCENARIO(S)*

Capacity Building | Plans and Policies | Programs and Operations | Funding and Financing | Build a Project

7. EVALUATE STRATEGIES (BENEFITS/TRADE-OFFS)*

- Feasibility
- Economic or Social Benefits
- Environmental Improvements
- Governance
- Disaster Lifecycle
- Regional or Neighboring Impacts

8. CREATE ADAPTATION PATHWAYS (FLEXIBLE PLANNING)

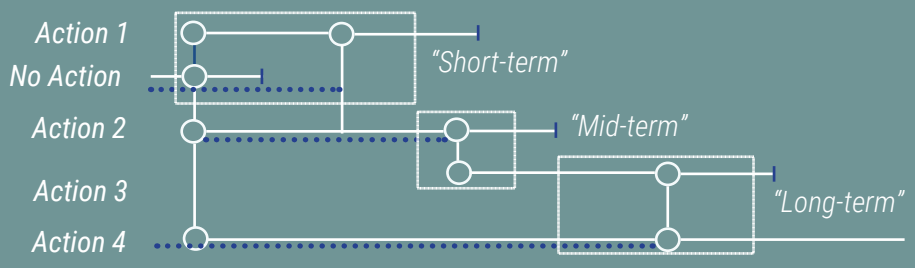


Figure 4-2. Diagram representing the various iterative steps of the upcoming ART Local Adaptation Guidance to be published in 2020. *Many of the steps are intended to be iterative processes.

Flooding from Redwood Creek impacts trails during King Tides in January 2020. Photo courtesy of California Bay King Tides Project.

Organizing and Choosing Adaptation Actions from the Adaptation Catalog

Many entities have already documented the universe of adaptation actions that can be combined to create adaptation strategies, plans, and responses to climate change impacts. The ART Adaptation Catalog pulls together several action sources and was created to help local jurisdictions navigate the wealth of resources for choosing adaptation strategies by understanding the universe of actions available. The Adaptation Catalog can be released alongside the Advancing Local Adaptation Guidance outlined in Figure 4-2 and can be used to identify specific adaptation actions, learn more about what they are, and understand how actions can be used together to create bundled strategies that work together over time.

The Adaptation Catalog is an excel tool that organizes hundreds of adaptation actions and strategies into five categories: Capacity Building, Plans and Policies, Programs and Operations, Funding and Financing Mechanisms, and Build a Project (described previously in Table 4-1 Adaptation Strategy Categories in ART Program). The actions can also be organized by Strategic Approach: Protect, Avoid or Retreat, Adapt, or Prepare. Actions may also have a secondary category, as some actions fit into multiple categories, as well as a sub-type within each category. The Adaptation Catalog provides a brief description of each action and is designed to provide a more user friendly database for navigating the wealth of adaptation solutions.

Testing Local Adaptation Guidance in Two Case Studies Around the Bay

The ART Program worked with consultants at AECOM to identify two case study areas to test the application and feasibility of the new local adaptation guidance approach. These case studies were intended to identify gaps and challenges in the process and provide feedback to help refine the process. The case studies were selected in areas that 1) did not have significant planning processes underway, and 2) reflected two different shoreline scenarios: urban edge and wetlands area. The two case studies were conducted in East Bay Crescent in the South Richmond/El Cerrito area, and Suisun Slough in Suisun City.

While these case studies resulted in adaptation approaches for the two locations, the process was intended to be a desktop exercise and did not reflect the degree of public and community engagement through an inclusive, iterative planning process that would be required to apply the guidance fully. Emphasis was placed on understanding the ease of implementation, comprehensiveness, and relevance of the guidance rather than outcome. However, each case study was provided to the respective jurisdictions to serve as a starting point for a more robust local process.

Lessons learned from the application of local guidance from the two case studies will be included in the Advancing Local Adaptation Guidance to be released in 2020.

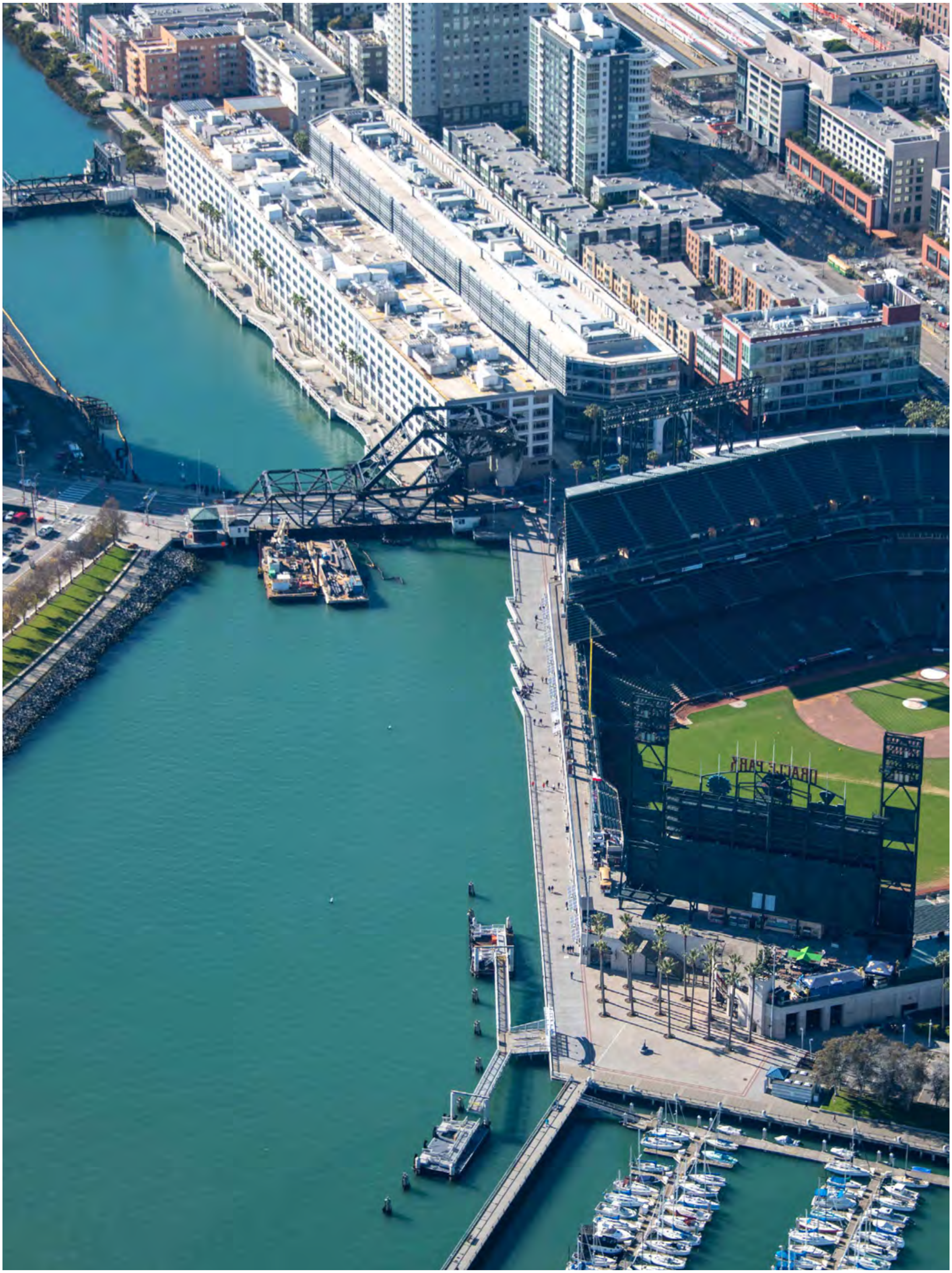
4.4 Regional Adaptation Conclusion

Planning for and implementing adaptation strategies for the Bay Area will be a highly collaborative process that involves many stakeholders at many levels – the degree of work over the next several decades is magnitudes above and beyond what any single agency or jurisdiction could or should take on alone. This chapter provides a starting point for coordinated adaptation responses that address the major planning issues identified through ART Bay Area, but much additional work is required to fully identify:

- **Shared priorities and goals for adaptation;**
- **Additional planning and implementation timelines, responsibilities, funding, and interim steps;**
- **A comprehensive, equitable, flexible, and scalable approach to paying for planning, implementation, and maintenance of adaptation projects;**
- **Ownership, buy-in, and authority required to lead planning and projects;**
- **Barriers to planning and implementation, and strategies to overcome these;**
- **Existing and needed tools to incentivize, mandate, or reward actions that meet regional priorities and goals.**

Additionally, more local planning work is also required to complete the tapestry of planning and implementation that will ensure the region's resilience. This may include more robust local vulnerability assessment, local community and stakeholder engagement processes, and local decision-making about the most appropriate strategic approach for each individual community. Changes in local land use and coastal planning, zoning, capital planning, and project implementation processes will also need to occur locally. The updated ART Plan Step guidance, forthcoming in 2020, will help build capacity for this local work.

This chapter can serve as a catalyst for moving from vulnerability assessment to action that is based in robust regional assessment, but the true work will come over the next several decades as we learn, create new pathways, change plans and policies, identify ways to pay, and build projects that help protect what we love about the Bay Area's shoreline.



Critical infrastructure, homes, businesses, natural areas and more line the edges of the San Francisco Bay. In this photo, AT&T Park can be seen in San Francisco near Isais Creek. Photo by SF Baykeeper, Robb Most, and LightHawk.

Looking out across Richardson Bay, it becomes clear how the San Francisco Bay connects nine-counties and millions of people together. Photo by SF Baykeeper, Cole Robb Most, and LightHawk.

Chapter 5.0

LOOKING FORWARD

5.1 Where We Are Heading

ART Bay Area provides an extensive and detailed foundation for future sea level rise planning in the Bay Area, with analysis that can be used to inform local, regional, and state level planning. These findings provide definitive answers about what is anticipated to get wet, where, and when -- in the absence of significant intervention. A valuable outcome of this project has been the robust network of action-oriented practitioners and community leaders from across the region who are ready to move into this critical phase of work.

The findings of this report are not final decisions about where and what the region should do to respond to flooding and rising sea level. The region must come together, using the findings to guide *shared* decision making. Data on its own does not make decisions – another layer of coordinated regional priorities and decision-making criteria is necessary to fully engage the power of the data.

DEVELOPMENT OF REGIONAL GUIDING PRINCIPLES

To support the prioritization of one location over another, or one type of adaptation approach over another, stakeholders across the region can work together to develop shared priorities and goals that can be applied to decision making at the local level. While striving for "win-win" situations is the ideal, many decisions regarding adaptation planning and actions will require choosing between conflicting values or priorities and will involve a set of tradeoffs.

It is critical that the region comes together to utilize ART Bay Area findings to guide shared decision making about actions.

The region must come together, using the findings to guide shared decision making. A shared set of priorities will help the region decide what it values to help inform decisions about what to pay for, what types of adaptation strategies are most appropriate, and what actions should be taken first.

Looking out across one of the many piers in San Francisco towards the waters of the Bay. Photo by Melinda*Young licensed CC BY-NC-ND 2.0.

TAKING ACTION TOGETHER

Once shared priorities are developed, the next step will be to identify a suite of priority actions at various scales. Many of these actions are outlined in the ART Bay Area report, but others likely will emerge as well. Critical to the development and implementation of priority actions are:

- **Balancing Local and Regional Priorities** – What actions can or should only happen locally or regionally? Land use authority rests with local government. So many planning, zoning, and building strategies can only be initiated, permitted, and implemented locally. Even today, some jurisdictions are already planning for and implementing flood control projects that they believe will help reduce their localized risk to flooding. However, it also will be important to identify cross-jurisdictional, cross-agency strategies that provide greater benefit than if each local jurisdiction or agency were to conduct adaptation – on wetlands restoration, major infrastructure projects, multi-benefit projects – on its own.
- **Pulling the Right Levers** – Identifying the most appropriate levers at local, regional, and statewide scales can help operationalize decisions that support shared regional goals. Many levers are outlined in the regional adaptation responses, including local and regional planning documents such as General Plans and Plan Bay Area; capacity-building initiatives like education, training, and data-sharing; programs like ongoing monitoring or research; and financial tools such as tax incentives. Even these levers may not be sufficient – new mechanisms may be needed.

Stakeholders participating in the ART Bay Area Regional Working Group. Photo by BCDC.

- **Articulating Roles and Responsibilities** – Adaptation action across the region will rely on a wide variety of local and regional actors to play both independent and coordinated roles as planners, implementers, conveners, coordinators, and funders. How do we organize these different stakeholders – who each have critical skills and expertise – within a larger framework that groups key activities and approaches, while helping to measure and monitor how these activities add up to greater regional resiliency?

BALANCING CURRENT AND FUTURE NEEDS

While the data on sea level rise exposure and consequences is compelling, it also competes with many other current challenges, such as housing affordability, insufficient and aging infrastructure, and wildfires. Sea level rise is a slow-moving disaster with a long time horizon, and there is significant uncertainty about exact timing and impacts. Yet flooding is happening now. And while today's flooding may not be as extensive or damaging as future flooding, it is critical that we treat rising sea levels as a *now* problem, not a *future* problem.

These challenges are not independent. Housing and transportation issues will only worsen as sea level rise progresses. Wildfires are the first signal of the climate crisis, but as sea levels rise, we may find ourselves increasingly squeezed between wildfire-ravaged hills and an encroaching shoreline. Approaches to address any one challenge must also consider the whole range of challenges the region faces.

Many of the crises we find ourselves in today reinforce the lesson that after-the-fact reaction is more stressful and damaging to society than before-the-fact preparation. Both with the housing crisis and the wildfire crisis, the writing on the wall was clear far ahead of time. Housing underproduction and rising prices were occurring for decades, but there was no urgent need to correct the problem. Similarly, we knew that power infrastructure was aging and our forest management practices were out of date; yet devastating wildfires nonetheless killed dozens of people and caused billions of dollars in damage.

We know that rising sea levels are coming. And we know what the potential impacts will be. What will catalyze us to action *before* people, the environment, the economy, and our infrastructure are extensively impacted? And what is the cost if we fail to act?

These challenges are not independent. What will catalyze us to action before people, the environment, the economy, and our infrastructure are extensively impacted? And what is the cost if we fail to act?

A CALL TO ACT

There will never be a perfect time to act – there will always be uncertainty and lack of information about what the future may bring. But it's never the wrong time to do the right thing.

The Bay Area is at a tipping point, poised between a growing body of information, tools, and awareness, and the beginnings of irreversible impacts, especially to sensitive shoreline ecosystems and our most vulnerable populations. Our actions today will determine the path ahead.

The time is ripe is for the Bay Area to come together to clearly lay out the overall planning framework that will allow appropriate and informed actions that reflect shared priorities and values and that move the region forward towards greater resiliency.

The ART Bay Area project team hopes that this report will help catalyze this era and serve as a foundation upon which to build the region's future.

There will never be a perfect time to act - but the Bay Area is at a tipping point. Our actions today will determine the path ahead.

Our highly connected Bay is a place where we can move around the region, access our homes, jobs and services, and enjoy the natural beauty of the Bay while also protecting people and habitats most vulnerable. Photographs (clockwise, starting upper right): Amtrak train along Martinez shoreline, by Cadet Wilson; silhouettes along the water, San Francisco, by Thomas Hawk, CC BY 2.0; San Francisco and East Bay, Jitze Couperus, CC BY 2.0 and birds at Palo Alto Baylands Nature Preserve by Stanislav Sedov, CC BY 2.0.