

Adaptation Responses

ADAPTING TO RISING TIDES PROJECT

JULY 2013

In considering how to best address the vulnerabilities identified in the ART subregion, the project team and working group determined the need for comprehensive approach that went beyond a simple list of strategy names. The result was the development of the ART subregional adaptation responses that clearly link actions to the vulnerability(s) that they would reduce, identify when it is important to take a phased or sequential approach, and acknowledge alternative actions that will require considering trade-offs and costs/benefits. For the cross-sector, cross-jurisdictional issues identified in the ART project, the adaptation responses are a springboard for participating agencies, organizations and communities to collectively begin to take action together. For the issues identified that affect a single jurisdiction or agency, the subregional adaptation responses are the foundation from which an adaptation plan can be developed or individual actions can be selected, refined and initiated.

The ART adaptation response contains three core elements: (1) a key vulnerability; (2) actions to directly address the vulnerability; and (3) the likely steps, partners, and processes necessary to initiate and administer the actions. Additionally, each action was characterized by its type and priority, and the scale(s) at which it would be implemented.

The ART adaptation responses consist of three elements:

A **key vulnerability** provides a direct link to the outcomes of the assessment so that the most critical issues identified are addressed. Including the key vulnerability is a clear and transparent means to ensure that each action is connected to an identified planning issue.

One or more **actions**. While some vulnerabilities can be addressed by a single action most require multiple actions. Many actions can be taken at the same time, while others act as a series of sequential steps that incrementally build towards resilience.

Implementation options are a guide for those that want to initiate actions. The options identify the possible actors that will need to be at the table, whether actions could be incorporated into existing planning or collaborative processes, or if new initiatives will be needed.

Components of an Adaptation Response

Assessment findings for the ART subregion were summarized within and across the twelve asset categories evaluated. This organization allowed the project team to identify asset categories that had similar vulnerabilities identified relationships and dependencies among the assets, eliminated redundancies, and highlighted the unique vulnerabilities of specific asset categories.

Five broader asset categories were developed from the original 12 asset categories assessed within the subregion:

- **Overarching** – Vulnerabilities that cut across many or all asset categories.
- **Community Land Use** – Community Land Use, Facilities and Services, Contaminated Lands and Hazardous Material Sites
- **Transportation** – Ground Transportation, Airport and Seaport
- **Utilities** – Energy, Pipelines & Telecommunications, Stormwater and Wastewater
- **Shorelines** – Natural Shorelines, Structural Shorelines and Parks and Recreation Areas

Key vulnerabilities were identified for these broader categories and this formed the basis of subregional scale adaptation responses.

Key Vulnerability

The ART subregional adaptation responses start with a key vulnerability that had been classified using the system developed by the ART project to characterize and communicate vulnerabilities and risks¹. The vulnerability classifications – information, management, physical and functional – classifications make it easier to identify specific and appropriate actions, the potential actors to be involved, and the processes and scales at which to implement the actions.

For example, “information vulnerabilities” describe assets and issues where a lack of information or inadequate access to information makes it difficult to assess the problem and develop an appropriate response. Information vulnerabilities that were identified during the ART assessment include a lack of information on the condition of shoreline protection; difficulty in obtaining access to information regarding the elevations and condition of ground transportation; and a lack of analysis and data on how ground water will be affected by rising sea levels. These kinds of vulnerabilities are more economically and effectively

¹ See Chapter 3 of the ART Vulnerability and Risk Assessment Report for a description of the classification system (www.adaptingtorisingtides.org/vulnerability-and-risk-report/).

addressed through evaluations or assessments conducted at a regional or system-wide scales. Informational vulnerabilities are often the necessary first step before more refined assessments can be conducted or actions prioritized and implemented.

Understanding the type of vulnerability can more quickly lead to a targeted and appropriate response to resolve the real issues faced, avoiding potentially costly and unnecessary actions.

Action

Each action in the adaptation responses is described and identified by action types² - evaluation, policy development, coordination, program/operation, and education/outreach. These action types communicate the activities and processes required, and provide a means to identify actions requiring similar kind of efforts.

Implementation Options, Possible

The adaptation responses include implementation options that highlight the potential actors –the agencies, organizations, individuals or groups – who should be involved and the processes into which the actions could be integrated.

Possible Actors in the ART Subregion

Possible actors are identifies in the ART subregional adaptation responses that will likely be involved in action initiation and administration. Actors include those that are likely to lead action implementation (often asset owners or operators), as well as potential decision-making or funding partners, regulatory or permitting agencies, non-profit and community organizations, the private sector, landowners, and the owners and operators of adjacent properties or interconnected infrastructure.

Not all of the actors identified will either choose or need to be engaged in implementation. In other cases, the list of possible actors is not comprehensive and it will be necessary to seek a broad range of participation from all levels of governance³ – from the private sector, to community organizations, to surrounding neighborhoods, organizations and agencies, as well as others with adjacent or interconnected assets.

Acronym	Full Name
ACEH	Alameda County Environmental Health
ACFCWCD	Alameda County Flood Control & Water Conservation District
ACPHD	Alameda County Public Health Department
AT&T	American Telephone and Telegraph Company
ABAG	Association of Bay Area Governments
BAAQMD	Bay Area Air Quality Management District
BART	Bay Area Rapid Transit

² Action Type was adapted from the Association of Bay Area Government's (ABAG) Regional Resilience Initiative Action Plan, available at http://quake.abag.ca.gov/resilience_initiative/.

³ For information on issues regarding governance and adaptation, see the *Adapting Governance to Rising Tides Issue Paper* available at <http://www.adaptingtorisingtides.org/governance/>.

Caltrans	California Department of Transportation
CalEMA	California Emergency Management Agency
CPUC	California Public Utilities Commission
CTC	California Transportation Commission
CCJPA	Capital Corridor Joint Powers Authority
CUPA	Certified Unified Program Agency
CBO	Community Based Organization
CMA	Congestion Management Agency
CDPH	California Department of Public Health
DBW	Department of Boating and Waterways
DFW	Department of Fish and Wildlife
DPW	Department of public works
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
EBDA	East Bay Dischargers Authority
EBMUD	East Bay Municipal Utility District
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HARD	Hayward Area Recreation and Park District
JPC	Joint Policy Committee
MTC	Metropolitan Transportation Commission
NOAA	National Oceanic and Atmospheric Administration
NPO	Non Profit Organization
OPR	Office of Planning and Research
OLSD	Oro Loma Sanitary District
PG&E	Pacific Gas & Electric
PHMSA	Pipeline and Hazardous Materials Safety Administration
RAPC	Regional Airport Planning Committee
RASPA	Regional Airport Systems Planning Analysis
RDA	Regional Development Agency
RWQCB	Regional Water Quality Control Board
BCDC	San Francisco Bay Conservation and Development Commission
SFBRA	San Francisco Bay Restoration Authority
SFEP	San Francisco Estuary Partnership
SWRCB	State Water Resources Control Board
UP	Union Pacific Railroad
USD	Union Sanitary District
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USACE	US Army Corps of Engineers
DOT	US Department of Transportation
WETA	Water Emergency Transportation Authority

Possible Processes

For the ART subregional adaptation responses, the possible planning mechanisms, governance structures or collaborative approaches that could be used to implement adaptation actions were grouped into eight broad categories. These include most of mechanisms, structures and approaches that agencies, organizations and stakeholders in the ART subregion currently use, as well as a new initiative category that indicates the possible need for changes to existing laws and policies, other organizational shifts, or a need for new funding sources.

Capital Planning	Project Planning and Design
Capital improvement plans Caltrans Project in Development (PID)	Private and public development projects Restoration project planning and permits
Codes and Standards	Long-Range Planning
Building codes and standards City ordinances Construction codes Design standards State and federal standards Other standards, e.g., professional organizations or committees	Agency or facility master plan Climate Action Plan Community-based planning Regional Airport Sustainability Plan (RASP) Regional Transportation Plan (RTP) Sustainable Communities Strategy (SCC) Integrated Water Resource Management Plan (IRWMP)
Emergency and Hazard Planning	Land-Use Planning
State or local hazard mitigation plans Emergency response and recovery plans Standardized Emergency Management Systems (SEMS) National Incident Management System	General plan Specific plan Land use plan
Operations	New Initiatives
Annual budgeting Continuity of Operations Plans (COOP) State Highway Operation and Protection Program (SHOPP)	Partnerships and collaborations Ballot measures Legislation

Action Implementation

Actions are also characterized according to potential priority, phasing, and scale of action implementation. Four of the action characterizations – Unlocking, Do It Yourself, Multi-Benefit, and Long Lead Time – indicate the potential timing or priority of action initiation, while one – Scale – indicates the possible geographic scales at which an action could be implemented.

Action Characterization	Description
Unlocking	Actions that can enable other actions. Some unlocking actions contribute independently to resilience, while others serve primarily as stepping stones to other actions. Unlocking actions are generally high priority for implementation as they are often the foundation on which many other actions depend. However, depending on the vulnerability the action addresses and the potential magnitude of the consequences, not all unlocking actions will be taken first as other actions may be higher priority or provide multiple benefits and therefore would be easier to gain support and funding for.
Do it Yourself (DIY)	Actions that an asset owner or operator could take on independently without the formation of new partnerships or collaborations. DIY does not imply a 'go it alone' approach, as owners and operator will need to comply with existing regulations and it may be beneficial to seek participation from other entities. DIY does indicate the actions that can be taken without changes to existing regulations, possibly using existing funding streams or operational processes such as regular maintenance or upgrades tied to asset lifecycle
Multi-benefit	Actions that will improve asset performance or provide community benefits beyond improving the resilience to climate change. These benefits may including addressing other hazards such as earthquakes, improving the local quality of life, for example through new recreational opportunities, or encouraging the local economy. Investments in actions that provide multiple benefits that in near term can improve sustainability and help to address address existing challenges.
Long Lead Time	Actions that should be implemented early as they generally require the coordination of many partners, will result in formal agreements, joint planning or funding decisions, require difficult decision making or are controversial, include a number of different assets, or require collaborative regional planning or research.
Scale	Indicates the geographic scale at which an action could be carried out. Local actions are those that would be taken at the city or county level; regional actions across the entire nine county Bay Area by the agencies, organizations or entities that operate at this scale; state actions by state agencies or state-wide organizations or entities; or at the federal level by national agencies or partners

The elements of each adaptation response are presented together in the **ART Subregional Adaptation Response Cards**, organized according to the five broader categories. A **Guide** that explains each element presented on the adaptation response cards follows

The ART Subregional Adaptation Responses

Guide to the Adaptation Response Cards

Vulnerability Classification: Indicates whether the vulnerability is related to lack of information, management control challenges, physical qualities or functional qualities.

Vulnerability: A brief description of the subregional vulnerability addressed in the adaptation response. Vulnerabilities are numbered for navigation only and number does not indicate priority.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
Actions are numbered to assist with navigation. They do not indicate ranking or priority. For actions that can be taken sequentially the numbers indicate that order.	The action or actions to address the identified vulnerability. Some responses include a series of related actions that could or should be taken together.	The type of action, categorized into one of five general themes.	The mechanism(s) through which the action could be implemented. Some processes are existing and possibly ongoing, while others will be new initiatives. There can be more than one process by which to implement any given action.	Agencies and organizations that could be involved in implementing the action. Actors include lead agencies (often asset owners or operators), as well as regulators, funders, and other potential partners.	Guidance for selecting and prioritizing actions.

Action Types

- Evaluation – actions to improve data and information or conduct new analyses
- Program/Operation – actions to update plans, procedures or management activities
- Policy development – actions to develop or revise policies and guidelines
- Coordination – actions to initiate or expand partnerships
- Education/ outreach – actions to communicate information and build awareness

Processes

- Long-range planning, e.g., master plan, climate action plan
- Land use planning, e.g., general plan, specific plan
- Capital planning, e.g., capital improvement plan
- Operations, e.g., annual budgeting
- Codes and Standards, e.g., city ordinance, design standards
- Emergency & hazard planning e.g., hazard mitigation plans
- Project planning & design, e.g., private and public development projects
- New Initiatives e.g., legislation, ballot measure

Action Characterization

- Local, Regional, State, Federal: scale(s) of implementation
- Unlocking: enables other actions
- Do it Yourself: land owner or manager could implement within existing laws and policies and with existing funding sources
- Multi-Benefit: confers benefits beyond sea level rise and storm event resilience
- Long Lead Time: Urgent due to long implementation timeframe, near-term impacts, complex planning process, or large number of actors

Overarching Adaptation Response

Adapting to Rising Tides

Information Vulnerability

Vulnerability O1: Information about the effects of sea level rise on groundwater levels and salinity intrusion is insufficient for assessing vulnerability and risk, supporting identification of priority issues, and developing adaptation responses.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O1.1	Coordinate with local, regional, state, and federal agencies, academic researchers, and the private sector to improve the region's understanding of how sea level rise will affect groundwater levels	Evaluation, Coordination	Long-range Planning, New Initiative	USGS, FEMA, NOAA, USACE, RWQCB, ABAG, Regional Agencies, DTSC, Cities, County, Water Districts, Academic Institutions, Private Sector	Unlocking, Multi-benefit, Regional, Long Lead Time
O1.2	Develop a collaborative monitoring program to measure groundwater levels and salinity intrusion through cost-sharing or other agreements, and make the data publically available through a centralized database	Evaluation, Coordination	Long-range Planning, Operations, New Initiative	USGS, FEMA, NOAA, USACE, RWQCB, ABAG, DTSC, Cities, County, Water Districts, Private Sector	Unlocking, Multi-benefit, Regional, Long Lead Time

Information Vulnerability

Vulnerability O2: There is limited availability of and access to regionally relevant, current and historic weather data needed to understand flood risk.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O2.1	Develop agreements with state and federal agencies to make historic weather observations easily accessible, improve collection of current weather and water condition data, and provide summarized weather data through a centralized coordinated database	Coordination	New Initiative	NOAA, USGS, USACE, FEMA, DWR, BCDC, SCC, RWQCB	Multi-benefit, Unlocking, Regional, State, Long Lead Time

Information Vulnerability

Vulnerability O3: Flood risk maps rely on historic flooding to determine coastal hazard zones and do not factor in sea level rise. Additionally, many communities do not have access to recent coastal hazard (100-year flood) maps or the underlying data that could support shoreline adaptation planning.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O3.1	Engage federal agencies including FEMA, NOAA and USGS in a regional coordination effort to ensure the timely update of flood maps and access to data, studies, and models to help the region better understand future risks as sea level rises	Coordination	Long-range Planning, New Initiative	NOAA, USGS, USACE, FEMA, OPR, DWR, ABAG, BCDC, SCC, RWQCB, Cities, County, Flood Control Districts	Unlocking, Multi-benefit, Regional, Long Lead Time

Information Vulnerability

Vulnerability O4: There is a limited understanding of how dynamic baylands habitats such as tidal marshes, intertidal mudflats, and subtidal areas will respond to accelerating sea level rise, or how these habitats will be affected by shoreline adaptation responses (e.g., structural solutions such as levees) that may change tide, wave or sediment conditions.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O4.1	Establish and support a regional research agenda to advance the understanding of how baylands will respond to accelerating sea level rise in light of declining sediment supply and limited space to migrate inland	Evaluation, Coordination	Long-range Planning, New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector, SFBRA	Unlocking, Regional, Long Lead Time
O4.2	Research and test restoration and management actions that will improve baylands resilience	Evaluation	Project Planning and Design	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector, SFBRA	Unlocking, Regional, Long Lead Time
O4.3	Develop and implement a Regional Sediment Management Plan for the Bay	Coordination, Policy Development	Long-range Planning, New Initiative	CSMW, BCDC, USEPA, USACE, RWQCB, LTMS stakeholders, USFWS, NOAA, City DPW, Flood Control Agencies, Private Sector	Unlocking, Multi-benefit, Regional, Long Lead Time

Information Vulnerability

Vulnerability O4 (continued): There is a limited understanding of how dynamic baylands habitats such as tidal marshes, intertidal mudflats, and subtidal areas will respond to accelerating sea level rise, or how these habitats will be affected by shoreline adaptation responses (e.g., structural solutions such as levees) that may change tide, wave or sediment conditions.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O4.4	Develop a decision-making framework for selecting resilient, multi-objective shoreline adaptation responses given economic, environmental and social equity trade-offs	Policy Development	New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private sector, SFBRA	Unlocking, Regional, Long Lead Time

Information Vulnerability

Vulnerability O5: Proactive management of baylands to improve their resilience to sea level rise and storm events involves confronting regulatory requirements related to state and federal threatened, endangered, and special status species. Maintenance, upgrade, repair and restoration of baylands require review and authorization from multiple state and federal agencies, often with limited work windows and restrictions on the type of actions that can be taken.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O5.1	Research the potential benefits or conflicts of various types of potential baylands adaptation responses to better quantify potential impacts to habitat values and ecosystem services in the short and long term and at the local and regional scale	Evaluation	New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector, SFBRA	Unlocking, Regional, Long Lead Time

Management Control Vulnerability

Vulnerability O6: Capital investment planning, design, and funding for new infrastructure or for substantial repairs and improvements to existing infrastructure do not consider sea level rise impacts. Infrastructure designed to remain in place for longer spans of time and that is not built or rebuilt to be resilient to flooding and salt-water exposure will need to be protected or retrofitted long before the end of the expected life of the infrastructure. Resources to maintain or improve existing infrastructure are limited, and investments needed in the future to address sea level rise will affect financial resources, economic opportunities, and communities.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O6.1	Develop policies or incentives to require or encourage the consideration of sea level rise and storm events in developing, planning, and funding capital investments	Policy Development	Long-range Planning, Land Use Planning, Capital Planning, Codes and Standards	DWR, BCDC, ABAG, MTC, CPUC, Caltrans, CMAs, County, Cities	Do It Yourself, Unlocking, Local, Regional, State
O6.2	Prioritize capital investments and new infrastructure in low-risk areas; in particular, plan and construct new public infrastructure in areas not projected to be at risk of sea level rise or storm events	Policy Development, Program/Operation	Long-range Planning, Land Use Planning, Capital Planning	DWR, BCDC, ABAG, MTC, CPUC, Caltrans, CMAs, County, Cities	Do It Yourself, Local, Regional, State
O6.3	Develop a decision-making framework for determining if substantial repairs or improvements to protect existing infrastructure from sea level and groundwater rise should be made, or if it should be located or relocated in an area not at risk	Policy Development	Long-range Planning, Capital Planning, New Initiative	DWR, BCDC, ABAG, MTC, CPUC, Caltrans, CMAs, County, Cities	Do It Yourself, Unlocking, Local, Regional, State, Long Lead Time

Overarching Adaptation Response

Adapting to Rising Tides

Management Control Vulnerability

Vulnerability O7: Many of the plans, policies, and practices that guide community development, land use planning, emergency planning, and capital investments do not consider sea level rise or the adaptation responses that will be necessary to reduce the vulnerabilities and risks to both natural and built environments associated with sea level rise.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O7.1	Qualify for and maintain the highest feasible rating under the Community Rating System of the National Flood Insurance Program to reduce flood risks and the cost of private property insurance	Policy Development, Program/Operation	Emergency and Hazard Planning	ABAG, FEMA, CalOES, Cities, County	Do It Yourself, Local
O7.2	Prepare, adopt, implement, and update comprehensive recovery plans to direct how and where state or federal disaster recovery funds are used to rebuild resilient communities after storm events	Policy Development	Emergency and Hazard Planning	ABAG, FEMA, CalOES, Cities, County	Do It Yourself, Multi-benefit, Local, Regional, State, Long Lead Time
O7.3	Require the consideration of sea level rise in land use plans and project designs, e.g., General Plan Safety Elements	Policy Development	Land Use Planning, Codes and Standards	Cities, Counties, OPR	Do It Yourself, Unlocking, Local, Regional, State
O7.4	Evaluate the feasibility of applying adaptive management to Land Use Planning and decision making	Evaluation	New Initiative	BCDC, ABAG, MTC, OPR	Regional, State

Management Control Vulnerability

Vulnerability O7 (continued): Many of the plans, policies, and practices that guide community development, land use planning, emergency planning, and capital investments do not consider sea level rise or the adaptation responses that will be necessary to reduce the vulnerabilities and risks to both natural and built environments associated with sea level rise.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O7.5	Improve coordination among agencies to ensure consistent regulatory and planning approaches to sea level rise adaptation, and to reduce programmatic or legislative barriers to assessing and addressing future risks	Coordination, Policy Development	Long-range Planning	BCDC, ABAG, MTC, Cities, County	Unlocking, Regional, Long Lead Time
O7.6	Develop incentives for clustered development in low-risk areas using density bonuses, reduced impact fees, tax incentives and streamlined permitting	Policy Development	Long-range Planning, Land Use Planning	BCDC, ABAG, MTC, OPR, Cities, County, California Natural Resources Agency	Do It Yourself, Local, Regional, State
O7.7	Create a voluntary transfer of development rights program to allow property owners to sell development rights in high-risk areas in exchange for rights in a low-risk areas	Policy Development	Land Use Planning, Codes and Standards	Cities, County, State	Do It Yourself, Local, Regional, State
O7.8	Use rolling easements to establish a boundary that moves inward as sea level rises along the Bay shoreline	Policy Development	Long-range Planning, Land Use Planning, Legislation	Cities, County, Special Districts, State	Do It Yourself, Local, Regional, State

Management Control Vulnerability

Vulnerability O8: Non-profit, faith, and community-based organizations play a critical role in building and maintaining community resilience. Many of these organizations do not have the capacity to fully participate in climate planning efforts. Government agencies and organizations also lack the capacity and processes to engage non-governmental organizations in planning and decision-making to ensure the robust, sustained partnerships that will be necessary to address climate change in an equitable, environmentally conscientious, and economically feasible manner.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O8.1	Conduct community-led campaigns to build public support for community groups and leaders to participate in collaborative efforts to address current and future climate stressors, including sea level rise and storm events	Education/ Outreach	Long-range Planning, New Initiative	BCDC, ABAG, MTC, BAAQMD, Cities, Counties, NPOs, CBOs, CDPH	Unlocking, Local, Regional
O8.2	Work with decision-makers to provide public funds for community groups to participate in local climate resilience building efforts, for example in developing and implementing local climate adaptation plans or conducting public education on local climate impacts and emergency response in multiple languages	Policy Development	New Initiative	BCDC, ABAG, MTC, BAAQMD, Cities, Counties, NPOs, CBOs, CDPH, State, Federal	Unlocking, Regional, State, Federal, Long Lead Time
O8.3	Create and implement a framework that government agencies, organizations and community partners can use to engage in open, transparent, and well publicized planning and decision making processes	Education/ Outreach, Program/ Operation	New Initiative	BCDC, ABAG, MTC, BAAQMD, Cities, Counties, NPOs, CBOs, CDPH	Multi-benefit, Local, Regional, Long Lead Time

Functional Vulnerability

Vulnerability O9: Proper functioning of utilities, which themselves are vulnerable to sea level rise and storm events, is essential for communities to effectively respond during a disaster, and for communities, businesses, the airport, seaport, parks and recreation areas, and natural shorelines to function on a day-to-day basis.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O9.1	Reduce downstream flood risk and stress on stormwater and flood control systems by minimizing runoff volumes and peak flow rates from new developments and substantial redevelopments using site-specific low impact design (LID) and source control techniques	Policy Development	Land Use Planning, Codes and Standards	Cities, County, RWQCB, SFEP	Do It Yourself, Multi-benefit, Local, Regional
O9.2	Avoid new development and substantial redevelopments that will require expanding the capacity of utilities and infrastructure in areas at risk	Policy Development	Land Use Planning, Codes and Standards	Cities, County, RWQCB, CPUC, City DPW, ACFCWCD	Local, Regional

Functional Vulnerability

Vulnerability O10: Some assets along the Bay shoreline function as a continuous corridor, or as a series of linked segments, and impacts to one segment of the Bay shoreline can compromise the function of the other segments. This is especially true of the system of natural and structural shorelines along the Bay edge; energy, gas, and pipelines infrastructure; and for long, linear ground transportation assets such as the Bay Trail and the regional rail network.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O10.1	Conduct a regional evaluation of transportation and utility networks that are vulnerable to sea level rise to determine hot spots or weak links that would cause significant disruption to the regional economy and quality of life	Evaluation	Long-range Planning, Operations, Capital Planning	Caltrans, BART, CCJPA, UP, PG&E, Kinder Morgan, EBMUD, EBDA, Cities, County, MTC, Private Sector, Regional Agencies	Do It Yourself, Unlocking, Regional
O10.2	Conduct a regional evaluation of structural shorelines and determine how they are connected/interconnected to natural shorelines in providing flood risk reduction benefits	Evaluation	New Initiative	Cities, County, USACE, EBRPD, HARD, ABAG (Bay Trail), DFW, USFWS, BCDC, City DPW, ACFCWCD, SCC, Regional Agencies	Unlocking, Regional

Physical Vulnerability

Vulnerability O11: Changes in groundwater levels due to sea level rise may increase the risk of liquefaction during an earthquake. Residences, utilities and other infrastructures that are not designed for these conditions are likely to be damaged during an earthquake. Long, linear infrastructure such as utility pipelines, surface roads, and rail lines are highly susceptible to damage during earthquakes, particularly due to liquefaction. Much of the airport is built on Bay fill, which has a high liquefaction potential. During an earthquake, liquefaction could cause damage to runways and other infrastructure, and could cause the perimeter levee to fail.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O11.1	Conduct a regional study on the impacts of rising sea level on groundwater elevations, and on the potential for increased liquefaction potential	Evaluation	New Initiative	USGS, FEMA, NOAA, USACE, RWQCB, Regional Agencies, ABAG, DTSC, Cities, County, Water Districts, MTC, Caltrans, BCDC, Private Sector	Unlocking, Multi-benefit, Regional
O11.2	Conduct vulnerability assessments of critical infrastructure and land uses in areas exposed to sea level rise and liquefaction to identify strategies that can improve resilience to both hazards	Evaluation	Long-range Planning, New Initiative	ABAG, Caltrans, MTC, BCDC, ABAG, Special Districts, Cities, County, Private Sector	Do It Yourself, Unlocking, Multi-benefit, Local, Regional

Physical Vulnerability

Vulnerability O12: Public health, safety, and welfare are at risk from sea level rise and storm events, particularly where the land uses are predominately residential, e.g., single-family, multi-family, and senior housing. These communities were developed in a manner that makes protecting them from future flood risks extremely challenging. It is likely that planning for future growth in the region will follow this past pattern without consideration of future flooding, increasing the number of people at risk.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
O12.1	Initiate a regional collaboration to discuss and analyze approaches to improve the resilience of current vulnerable communities and how to plan future growth to avoid placing more of the region's population at risk	Evaluation, Coordination	New Initiative	Local, Regional, State, Federal, Private sector, NPOs, CBOs	Unlocking, Regional, Long Lead Time
O12.2	Improve regional coordination on policies targeted at improving Bay Area resilience to climate change	Coordination	Long-range Planning, New Initiative	JPC Agencies	Unlocking, Regional, Long Lead Time

Shorelines Adaptation Response

Adapting to Rising Tides

Information Vulnerability

Vulnerability S1: Publicly available information about the ownership, elevation, and condition of structural shorelines is insufficient for conducting vulnerability and risk assessments and developing adaptation responses.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S1.1	Review and improve existing structural shoreline asset information to identify and address gaps in completeness, quality and accessibility	Evaluation	New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector	Do It Yourself, Unlocking, Multi-benefit, Local, Regional
S1.2	Develop and keep current a centralized structural shoreline asset management database that includes ownership, location, elevation, condition and management status	Program/operation	New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, NPOs, CBOs, Private Sector	Multi-benefit Local, Regional, Long Lead Time

Shorelines Adaptation Response

Adapting to Rising Tides

Management Control Vulnerability

Vulnerability S2: Landowners, agencies and facility managers do not always have control over the shorelines (structural and natural) that protect their vulnerable assets from flooding or storm event impacts.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S2.1	Improve communication and coordination between those that own and manage the shoreline (levees, marsh, beach) and those that own and manage the assets that are protected by these shorelines	Coordination	New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector	Unlocking, Local, Regional
S2.2	Expand or form partnerships among agencies, organizations and community members to facilitate decision-making regarding shoreline improvements and new investments	Coordination, Program/operation	New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, City, County, CBOs, Private Sector	Unlocking, Local, Regional, Long Lead Time

Management Control Vulnerability

Vulnerability S3: Structural shorelines that lack dedicated funding and permit authorizations for maintenance and improvements, and which are not included in long-range capital improvement planning, are particularly vulnerable because shoreline managers cannot easily maintain or make repairs to address sea level rise and storm event impacts for these "at risk" structural shorelines.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S3.1	Prioritize the inspection, maintenance, upgrade, and repair of vulnerable, at-risk structural shorelines	Program/operation	Capital Planning, Operations	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, Private Sector	Do It Yourself, Local, Regional
S3.2	Dedicate funding and resources to inspect, maintain, upgrade, and repair vulnerable, at-risk structural shorelines	Program/operation	Capital Planning	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, Private Sector	Do It Yourself, Local, Regional
S3.3	Develop and implement a regional permit authorization program to expedite the ongoing maintenance, minor repair, or upgrade of structural shorelines	Policy Development, Program/operation	New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA, NOAA, Private Sector	Multi-benefit, Regional, State, Federal, Long Lead Time

Management Control Vulnerability

Vulnerability S4: Existing inter-agency coordination, governance structures, and financing strategies are insufficient for planning and implementing the types of large-scale, phased, structural and/or natural shoreline projects that will be needed to address sea level rise and storm events.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S4.1	Establish a working group of agencies and organizations, including community-based organizations and private landowners, to develop a shoreline project decision-making framework that considers existing policies, procedures, and practices as well as the value of ecosystem services, public access and recreation, and social equity	Coordination, Policy Development	New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, SFEP, RWQCB, Port, USACE, USFWS, FEMA, NPOs, CBOs, Private Sector	Unlocking, Regional, Long Lead Time
S4.2	Expand or form partnerships among agencies, organizations, and private shoreline landowners to facilitate cost-sharing for planning, implementing, and monitoring multi-objective shoreline improvements and new investments	Coordination, Program/operation	Capital Planning, New Initiative	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, SFEP, RWQCB, Port, USACE, USFWS, FEMA, NPOs, CBOs, Private Sector	Local, Regional, Long Lead Time

Management Control Vulnerability

Vulnerability S5: Planning and implementing improvements or changes in use at shoreline parks is complicated because parks are often owned and managed by different agencies. Some parks have multiple managers and owners, adding complexity to funding and decision-making.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S5.1	Develop agreements among park managers and park landowners that articulate shared objectives, decision-making, and funding responsibilities for sea level rise and storm event adaptation planning and response	Policy Development	New Initiative	EBRPD, HARD, DFW, State Parks, City, County	Unlocking, Local Regional
S5.2	Expand or form partnerships among agencies, organizations, and community members to facilitate decision-making regarding park improvements and new investments in light of sea level rise and storm event flooding	Coordination	New Initiative	EBRPD, HARD, DFW, State Parks, City, County, CBOs, Private Sector	Unlocking, Local, Regional, Long Lead Time

Functional Vulnerability

Vulnerability S6: Many Bay Trail segments are vulnerable because they are situated on shoreline levees, cannot be used when flooded, and often have surface materials that erode easily. Because of the interconnected nature of the Bay Trail, disruption of one segment can affect the function of the entire Bay Trail.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S6.1	Develop and maintain a Bay Trail asset management database that includes ownership, location, elevation, condition, and management status	Evaluation	New Initiative	ABAG, SCC, BCDC, EBRPD, HARD, NPOs, Private Sector	Unlocking, Regional
S6.2	Prioritize resurfacing vulnerable trail segments with erosion-resistant materials	Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, State Parks, City DPW or Parks, County, NPOs, Private Sector	Do It Yourself, Local, Regional
S6.3	Establish agreements among shoreline managers to maintain, repair, and upgrade shoreline levees in a manner that best preserves the Bay Trail and connected shoreline access	Policy Development	Long-range Planning	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA	Multi-benefit, Local, Regional

Shorelines Adaptation Response

Adapting to Rising Tides

Functional Vulnerability

Vulnerability S7: Shoreline access for people with limited mobility is especially vulnerable to sea level rise and storm events.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S7.1	Prioritize maintenance and repair of barrier-free access to the shoreline and recreation facilities in order to minimize re-routing or closure	Policy Development, Program/operation	Operations	ABAG, EBRPD, HARD, State Parks, CBOs, Private Sector	Do It Yourself, Local, Regional
S7.2	Stockpile materials to create temporary bridges, ramps or pathways to maintain safe access for those with limited mobility	Program/operation	Operations, Emergency and Hazard Planning	ABAG, EBRPD, HARD, State Parks, NPOs, Private Sector	Multi-benefit, Do It Yourself, Local, Regional
S7.3	Effectively communicate trail closures, e.g., establish specific notification practices	Education/Outreach	Long-range Planning, Operations, Emergency and Hazard Planning	ABAG, EBRPD, HARD, State Parks, CBOs, Private Sector	Do It Yourself, Local, Regional
S7.4	Develop a public outreach and education campaign to inform and engage the public in maintaining shoreline access for all	Education/Outreach	Operations	ABAG, EBRPD, HARD, State Parks, NPOs, CBOs, BCDC, SCC, Private Sector	Unlocking, Local, Regional

Shorelines Adaptation Response

Adapting to Rising Tides

Functional Vulnerability

Vulnerability S8: Shoreline recreation areas with activities that depend on grass (sports fields, golf) are vulnerable to coastal flooding and saltwater intrusion.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S8.1	Plant salinity-resistant grass species in areas exposed to flooding and saltwater intrusion	Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, State Parks, City DPW, City Parks Department, County	Do It Yourself, Local, Regional
S8.2	Install artificial turf, if appropriate, at sports fields exposed to flooding and saltwater intrusion	Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, State Parks, City DPW, City Parks Department, County	Do It Yourself, Local, Regional
S8.3	Develop new or enhance existing venues for grass-dependent recreation activities (sports fields, golf) in areas not exposed to flooding and saltwater intrusion	Policy Development, Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, State Parks, City DPW, City Parks Department, County	Do It Yourself, Local, Regional

Shorelines Adaptation Response

Adapting to Rising Tides

Functional Vulnerability

Vulnerability S9: Loss of sandy beaches due to sea level rise and storm events will diminish access to the Bay for certain water recreation activities (swimming, boardsailing, paddle boating).

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S9.1	Implement strategies to preserve sandy beaches, e.g., nourish, construct groins, setbacks, and buffers	Program/operation	Capital Planning, Project Planning and Design	EBRPD, State Parks, City of Alameda	Multi-benefit, Local
S9.2	Enhance existing boardsailing and paddle boat launch areas	Program/operation	Capital Planning, Project Planning and Design	EBRPD, State Parks, SCC, Water Trail, City, County, DFW, BCDC, DBW	Do It Yourself, Local, Regional
S9.3	Improve the capacity of existing boardsailing and paddle boat launch areas, or develop new areas, in locations not at risk	Policy Development, Program/operation	Long-range Planning	EBRPD, State Parks, SCC, Water Trail, City, County, DFW, BCDC, DBW	Do It Yourself, Local, Regional

Functional Vulnerability

Vulnerability S10: Birds and wildlife that rely on tidal marshes will be displaced by changing (i.e., downshifting) habitat and more frequent or permanent inundation. These changes will force them to forage and nest closer to people and infrastructure, such as roads and highways, and will reduce the amount of available high tide refugia.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S10.1	Develop policies, guidance or incentives to encourage setbacks and buffers adjacent to tidal marshes that protect sensitive species and allow appropriate types of public access and recreation uses	Policy Development	Long-range Planning, Land Use Planning	EBRPD, HARD, SCC, DFW, BCDC, State Parks, RWQCB, USFWS, NOAA, City, County, Private Sector, NPOs	Do It Yourself, Unlocking, Multi-benefit, Local, Regional
S10.2	Improve or protect high tide refugia where it is already limited and vulnerable to increased inundation, e.g., install artificial refugia	Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, SCC, DFW, BCDC, State Parks, USFWS, NOAA, Private Sector, NPOs	Do It Yourself, Local, Regional
S10.3	Protect existing, or create new, corridors that facilitate the movement of birds and wildlife to viable adjacent or nearby habitats	Program/operation	Long-range Planning, Land Use Planning	EBRPD, HARD, SCC, DFW, BCDC, State Parks, USFWS, NOAA, NPOs	Do It Yourself, Multi-benefit, Local, Regional, Long Lead Time

Physical Vulnerability

Vulnerability S11: Depending on the type and design, structural shorelines will have varying sensitivity to sea level rise and storm events. Daily tides can cause wear and tear of varying degrees depending on type and design of shoreline, while overtopping during larger storm events can cause destabilization and failure.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S11.1	Protect, enhance, or restore baylands outboard of structural shorelines to preserve wave attenuation benefits, thereby reducing wave erosion, the likelihood of overtopping, and maintenance needs of structures such as non-engineered berms and levees	Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, SFEP, RWQCB, USACE, USFWS, NOAA, SFBRA	Multi-benefit, Local, Regional, Long Lead Time
S11.2	Increase the size or amount of armor on structural shorelines to reduce erosion and scour	Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA	Do It Yourself, Local
S11.3	Enhance or reinforce non-engineered berms, e.g., armor to protect from erosion	Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA	Do It Yourself, Local

Physical Vulnerability

Vulnerability S11 (continued): Depending on the type and design, structural shorelines will have varying sensitivity to sea level rise and storm events. Daily tides can cause wear and tear of varying degrees depending on type and design of shoreline, while overtopping during larger storm events can cause destabilization and failure.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S11.4	Increase the height of structural shorelines, if technically feasible and if physical and environmental constraints allow, to reduce potential overtopping	Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA	Do It Yourself, Local
S11.5	Combine different types of structural shorelines, e.g., construct a flood wall on top of a levee	Program/operation	Capital Planning, Project Planning and Design	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, FEMA	Do It Yourself, Local
S11.6	Reinforce bulkheads and relocate any infrastructure that is located underneath them	Program/operation	Capital Planning, Project Planning and Design	Port, BCDC	Do It Yourself, Local
S11.7	Relocate or re-align structural shorelines to a landward location	Program/operation	Long-range Planning	EBRPD, HARD, ACFCWCD, SCC, DFW, BCDC, RWQCB, Port, USACE, USFWS, NOAA, Counties, Cities	Local, Long Lead Time

Physical Vulnerability

Vulnerability S12: Natural, non-wetland shorelines (e.g., sandy beaches, bluffs, and cliffs) are vulnerable to sea level rise and storm events, which cause erosion and land loss.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S12.1	Nourish beaches to replenish sand	Program/ operation	Capital Planning, Project Planning and Design	EBRPD, State Parks, City of Alameda	Multi-benefit, Local
S12.2	Construct sand trapping structures such as groins	Program/ operation	Capital Planning, Project Planning and Design	EBRPD, State Parks, City of Alameda	Multi-benefit, Local
S12.3	Establish setbacks and buffers that will allow beaches to migrate landward	Program/ operation	Long-range Planning, Codes and Standards	EBRPD, State Parks, City of Alameda	Multi-benefit, Local

Shorelines Adaptation Response

Adapting to Rising Tides

Physical Vulnerability

Vulnerability S13: Tidal marshes will not keep up with sea level rise solely through vertical accretion, especially in light of the Bay's declining suspended sediment supply and the lack of space to shift landward.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S13.1	Establish a monitoring program to obtain baseline information to track changes in tidal marsh habitat and identify when it is approaching key thresholds, e.g., measure vertical accretion, observe changes in vegetation and indicator species, document marsh edge erosion (photo-points/surveys)	Program/operation Evaluation	Long-range Planning, Operations	EBRPD, HARD, SCC, DFW, BCDC, RWQCB, USFWS, NOAA, SFBRA, SFEP	Unlocking, Multi-benefit, Local, Regional
S13.2	Factor sea level rise into ongoing management of tidal marsh restorations to address potential higher water levels and larger waves	Policy Development, Program/operation	Long-range Planning, Capital Planning, Project Planning and Design	EBRPD, HARD, SCC, SFEP, DFW, BCDC, RWQCB, USFWS, NOAA, SFBRA, Counties, Cities	Do It Yourself, Local, Regional
S13.3	Factor sea level rise into design of new tidal marsh restorations, e.g., consider marsh future capacity to build upward and move landward	Policy Development, Program/operation	Long-range Planning, Capital Planning, Project Planning and Design	EBRPD, HARD, SCC, DFW, BCDC, SFEP, RWQCB, USFWS, NOAA, SFBRA, Counties, Cities	Do It Yourself, Local, Regional

Physical Vulnerability

Vulnerability S13 (continued): Tidal marshes will not keep up with sea level rise solely through vertical accretion, especially in light of the Bay's declining suspended sediment supply and the lack of space to shift landward.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S13.4	Develop strategic plan to acquire and conserve upland areas that are appropriate to support marsh landward migration	Policy Development	Long-range Planning, Capital Planning	EBRPD, HARD, SCC, DFW, BCDC, SFEP, USFWS, Counties, Cities	Do It Yourself, Local, Regional
S13.5	Establish rolling easements to prevent shoreline armoring that would foreclose options for the landward migration of tidal marshes	Policy Development	Long-range Planning, Capital Planning, Ordinances, regulations, codes	EBRPD, HARD, DFW, Counties, Cities	Local, Regional, State

Shorelines Adaptation Response

Adapting to Rising Tides

Physical Vulnerability

Vulnerability S14: Managed marsh systems are particularly sensitive to sea level rise and storm events because they rely on water level control structures (tide gates, berms, and levees), some of which are already in need of repair.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S14.1	Prioritize the inspection, maintenance, and repair of control structures such as tide gates, berms, and levees, especially after large storm events	Policy Development, Program/operation	Operations	EBRPD, HARD, DFW	Do It Yourself, Local
S14.2	Enhance or improve control structures such as tide gates, berms, and levees, especially those in need of repair	Program/operation	Long-range Planning, Capital Planning, Project Planning and Design	EBRPD, HARD, DFW, BCDC, USACE, EPA, RWQCB, SCC, USFWS	Do It Yourself, Local
S14.3	Restore managed marshes to tidal action	Program/operation	Long-range Planning, Capital Planning, Project Planning and Design	EBRPD, HARD, DFW, BCDC, USACE, EPA, RWQCB, SCC, USFWS	Multi-benefit, Local, Regional, Long Lead Time

Shorelines Adaptation Response

Adapting to Rising Tides

Physical Vulnerability

Vulnerability S15: Stormwater drainage at shoreline parks and golf courses in low-lying areas will worsen with sea level and groundwater rise.

Action Number	Action	Action Type	Process	Possible Actors	Action Characterization
S15.1	Improve drainage by installing under-drains, cross-drains, backflow or flex valves, or perimeter drains	Program/operation	Capital Planning, Operations, Project Planning and Design	EBRPD, HARD, City DPW or City Parks	Do It Yourself, Multi-benefit, Local
S15.2	Elevate the surface or grade of facilities in low-lying areas with poor drainage, or relocate them to higher areas	Program/operation	Long-range Planning, Capital Planning, Project Planning and Design	EBRPD, HARD, City DPW or City Parks, CBOs	Do It Yourself, Local
S15.3	Convert active use areas to passive uses and re-purpose low-lying areas for uses that can be temporarily flooded	Program/operation	Long-range Planning, Capital Planning, Project Planning and Design	EBRPD, HARD, City DPW or City Parks, CBOs	Do It Yourself, Local

Sources Used to Develop the ART Subregional Adaptation Responses

Input from Subregional ART Working Group
Working Group Meeting #9, March 26, 2013
<http://www.adaptingtorisingtides.org/news-events/>

Adapting to Climate Change: A Planning Guide for State Coastal Managers
NOAA Ocean and Coastal Resources Management Center for Climate Strategies
<http://coastalmanagement.noaa.gov/climate/adaptation.html>

Synthesis of Adaptation Options for Coastal Areas
EPA Climate Ready Estuaries
http://www.epa.gov/climatereadyestuaries/downloads/CRE_Synthesis_1.09.pdf

Flood Damage Reduction Measures
US Army Corps of Engineers
http://www.nwo.usace.army.mil/nfpc/NFPC_Measures_Matrix.pdf

Center for Climate Strategies Adaptation Guidebook: Comprehensive Climate Action
Center for Climate Action
<http://www.climatechange.ca.gov/ecrcf/docs/CCSAdaptationGuidebook2011.pdf>

California Climate Adaptation Planning Guide
California Natural Resources Agency and California Emergency Management Agency
http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html

Climate Ready Water Utilities Updated Adaptation Strategies Guide for Water Utilities
U.S. Environmental Protection Agency
<http://water.epa.gov/infrastructure/watersecurity/climate/upload/epa817k13001.pdf>

Flooded Bus Barns and Buckled Rails: Public Transportation and Climate Change Adaptation
Federal Transit Administration Office of Research, Demonstration and Innovation
<http://www.fta.dot.gov/research>

Taming Natural Disasters: ABAG Multi-Jurisdictional Local Hazard Mitigation Plan for the San Francisco Bay Area (2010 Update of 2005 Plan)
Association of Bay Area Governments
<http://quake.abag.ca.gov/mitigation/>

Adapting to Climate Change Project Summary Report and Action Plan
City of Castlegar and Colombia Basin Trust
http://www.cbt.org/Initiatives/Climate_Change