# 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 risks[1]. 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 types[2] - 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 governance[3] – 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<br>Caltrans Project in Development (PID) | Private and public development projects<br>Restoration project planning and permits |
| **Codes and Standards** | **Long-Range Planning** |
| Building codes and standards<br>City ordinances<br>Construction codes<br>Design standards<br>State and federal standards<br>Other standards, e.g., professional organizations or committees | Agency or facility master plan<br>Climate Action Plan<br>Community-based planning<br>Regional Airport Sustainability Plan (RASP)<br>Regional Transportation Plan (RTP)<br>Sustainable Communities Strategy (SCC)<br>Integrated Water Resource Management Plan (IRWMP) |
| **Emergency and Hazard Planning** | **Land-Use Planning** |
| State or local hazard mitigation plans<br>Emergency response and recovery plans<br>Standardized Emergency Management Systems (SEMS)<br>National Incident Management System | General plan<br>Specific plan<br>Land use plan |
| **Operations** | **New Initiatives** |
| Annual budgeting<br>Continuity of Operations Plans (COOP)<br>State Highway Operation and Protection Program (SHOPP) | Partnerships and collaborations<br>Ballot measures<br>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 to 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

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 |

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 |

Information Vulnerability

**Vulnerability U1:** There is a lack of detailed, easily accessible, and well-coordinated information about the ownership, location, and condition of energy, pipeline, telecommunication, and stormwater infrastructure, which is needed for site- and asset-specific vulnerability and risk assessments.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U1.1** | Review existing asset management systems or information sources to identify gaps in completeness, quality, and accessibility, and to identify the types of information most relevant to adaptation planning | Evaluation | Long-range Planning, New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Unlocking, Multi-benefit, Do It Yourself, Local, Regional |
| **U1.2** | Address challenges and gaps in information most relevant to adaptation planning by developing new or updating existing asset management systems | Program/ operation | Long-range Planning, New Initiative, Operations | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Multi-benefit, Do It Yourself, Local, Regional |
| **U1.3** | Adopt data management and sharing agreements among utilities in similar sectors, e.g., wastewater, power, pipelines, telecommunications, to ensure there is complete, high quality, and accessible asset information available for vulnerability and risk assessments | Policy Development | New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Multi-benefit, Local, Regional, Long Lead Time |

Information Vulnerability

**Vulnerability U1 (continued):** There is a lack of detailed, easily accessible, and well-coordinated information about the ownership, location, and condition of energy, pipeline, telecommunication, and stormwater infrastructure, which is needed for site- and asset-specific vulnerability and risk assessments.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U1.4** | Develop and maintain a centralized database of unrestricted utility information that can support non-utility agencies and organizations in shoreline planning for sea level rise and storm events | Program/ operation | New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Multi-benefit, Local, Regional, Long Lead Time |

Management Control Vulnerability

**Vulnerability U2:** The infrastructure that comprises wastewater, stormwater, and flood control systems is either interconnected (e.g., stormwater pipes connect to flood control channels) or affected by other systems (e.g., stormwater contributes to wet weather flows to wastewater treatment plants), but is owned and managed by different public and private entities. Even within a single utility, different departments are often responsible for interdependent functions (e.g., reducing versus handling wet weather flows). Due to these interdependencies, many assets will be affected by the temporary disruption or permanent loss of, or adaptation responses for, other assets that are owned and operated by different departments or entirely separate agencies.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U2.1** | Improve communication, education, and coordination across departments within individual agencies | Coordination | Long-range Planning, Operations, New Initiative | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD | Unlocking , Multi-benefit, Do It Yourself, Local, Regional |
| **U2.2** | Consolidate management of interconnected infrastructure either by creating a single entity or establishing inter-agency agreements to guide capital investment, management, and operations decisions | Coordination, Policy Development | Long-range Planning, New Initiative | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD | Multi-benefit, Local, Regional, Long Lead Time |

Management Control Vulnerability

**Vulnerability U2 (continued):** The infrastructure that comprises wastewater, stormwater, and flood control systems is either interconnected (e.g., stormwater pipes connect to flood control channels) or affected by other systems (e.g., stormwater contributes to wet weather flows to wastewater treatment plants), but is owned and managed by different public and private entities. Even within a single utility, different departments are often responsible for interdependent functions (e.g., reducing versus handling wet weather flows). Due to these interdependencies, many assets will be affected by the temporary disruption or permanent loss of, or adaptation responses for, other assets that are owned and operated by different departments or entirely separate agencies.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U2.3** | Coordinate with owners and operators of interdependent infrastructure to articulate and advocate for shared objectives (e.g., reducing runoff through low impact development (LID), addressing wet weather flows), and to develop frameworks for decision-making and funding related to infrastructure maintenance and new investments | Coordination, Policy Development | Long-range Planning, New Initiative | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD | Unlocking, Multi-benefit, Local, Long Lead Time |
| **U2.4** | Establish inter-agency mutual aid agreements to provide assistance with inspection and repair of damaged or compromised facilities, and mobile or alternative facilities (e.g., portable pumps, generators) during emergency response and recovery | Coordination | Long-range Planning, Emergency and Hazard Planning | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD | Multi-benefit, Local, Regional |

Management Control Vulnerability

**Vulnerability U3:** Existing operations, maintenance, and emergency response plans and procedures for utility infrastructure may be inadequate to address contingencies associated with storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U3.1** | Review existing operations and maintenance plans to determine where preparation is inadequate for sea level rise and storm events | Evaluation | New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Unlocking, Do It Yourself, Local, Regional |
| **U3.2** | Require shut-off, overflow, and re-routing mechanisms to be designed and installed to function during an emergency, e.g., enable remote access or place them in easily accessible locations | Policy Development, Program/operation | Long-range Planning, Capital Planning, Codes and Standards, Project Planning and Design | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast, State and Federal | Multi-benefit, Do It Yourself, Local, Regional |
| **U3.3** | For power plants and substations, develop procedures for the shutdown of sensitive infrastructure in advance of flooding and for the restoration of power afterwards | Program/operation | Operations, Codes and Standards, Emergency and Hazard Planning | PG&E, Kinder Morgan, Shell | Do It Yourself, Local, Regional |

Management Control Vulnerability

**Vulnerability U3 (continued):** Existing operations, maintenance, and emergency response plans and procedures for utility infrastructure may be inadequate to address contingencies associated with storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U3.4** | For electricity transmission and telecommunications assets, develop a load transfer and re-routing plan for networked systems to maintain service when part of the system is jeopardized | Program/operation | Long-range Planning, Operations, Emergency and Hazard Planning | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U3.5** | Prepare for recovery from flooding by stockpiling materials, establishing turn-key agreements for equipment rental, and pre-positioning emergency power generation capacity, portable pumps, and debris removal equipment | Program/operation | Emergency and Hazard Planning, New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |

Management Control Vulnerability

**Vulnerability U4:** Cities and flood control districts have limited ability to increase revenues to address current stormwater and flood management needs, and sea level rise impacts will create a need for additional funding.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U4.1** | Pursue IRWMP and other state/federal funding for repair or improvement of stormwater management and flood control infrastructure | Program/operation | Capital Planning | City DPW, ACFCWCD, BCDC, ABAG, SFEP, RWQCB | Do It Yourself, Multi-benefit, Local, Regional |
| **U4.2** | Conduct public outreach to educate property owners about the importance of stormwater management and flood control so they support bond initiatives and increases in assessments for infrastructure repair and improvement | Education/outreach | New Initiative | City DPW, ACFCWCD, Landowners, Private Sector, NPOs, CBOs | Multi-benefit, Do It Yourself, Local |
| **U4.3** | Investigate and pursue alternative funding mechanisms, e.g., taxes, fee-based mechanism, assessment districts, or leveraging private sector resources | Program/operation | Long-range Planning, New Initiative | City DPW, ACFCWCD, Landowners, Private Sector | Multi-benefit, Do It Yourself, Local, Regional |

Functional Vulnerability

**Vulnerability U5:** Wastewater treatment systems are large, expensive, and complex, and there is little to no redundancy within each system or the ability to connect across systems, making them highly vulnerable to sea level rise and storm events.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U5.1** | Add redundancy or increase capacity to re-route around compromised wastewater system components | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, RWQCB | Multi-benefit, Do It Yourself, Local |
| **U5.2** | Reduce the vulnerability of components by improving the ability to operate remotely, ensuring access to backup power or portable pumps, or by redesigning (e.g., restrict pump station design capacity to be operable with portable pumps) | Program/operation | Capital Planning, Project Planning and Design | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, RWQCB | Multi-benefit, Do It Yourself, Local |
| **U5.3** | Institute operational changes to reduce system complexity, eliminate key vulnerable components, or minimize cost to maintain and repair the system | Program/operation, Policy Development | Operations, Codes and Standards | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD | Multi-benefit, Do It Yourself, Local, Long Lead Time |
| **U5.4** | Redesign or relocate wastewater treatment systems to areas not at risk using alternative strategies such as distributed wastewater treatment networks | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design, New Initiative | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, RWQCB | Multi-benefit, Local, Regional, Long Lead Time |

Functional Vulnerability

**Vulnerability U6:** Stormwater and flood control infrastructure is vulnerable to higher Bay water levels and rising groundwater levels that will reduce the capacity of these systems to collect, convey, and discharge flows.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U6.1** | Identify stormwater and flood control system components that have insufficient capacity to accommodate sea level and groundwater rise, e.g., existing pipe and channel sizes, outfall elevations, etc. | Evaluation | Long-range Planning, New Initiative | City DPW, ACFCWCD | Do It Yourself, Unlocking, Local |
| **U6.2** | Increase system capacity by increasing pipe size, installing backflow prevention devices, elevating outfalls, installing forced mains, installing new pump stations, or increasing existing pump station capacity | Program/operation | Long-range Planning, Capital Planning, Project Planning and Design | City DPW, ACFCWCD | Do It Yourself, Multi-benefit, Local |
| **U6.3** | Enforce creek protection, stormwater management, and discharge control ordinances, following the RWQCB Best Management Practices (BMPs), to keep watercourses free of obstructions and protect drainage facilities | Program/operation | Operations, Project Planning and Design | City DPW, ACFCWCD, CBOs, RWQCB, SFEP | Multi-benefit, Do It Yourself, Local, Regional |

Functional Vulnerability

**Vulnerability U6 (continued):** Stormwater and flood control infrastructure is vulnerable to higher Bay water levels and rising groundwater levels that will reduce the capacity of these systems to collect, convey, and discharge flows.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U6.4** | Conduct watershed analyses to identify opportunity sites for green infrastructure or low impact development (LID) techniques to improve stormwater and flood control system capacity to accommodate sea level and groundwater rise | Evaluation | Long-range Planning, New Initiative | Cities, ACFCWCD, CBOs, SFEP | Unlocking, Multi-benefit, Local |
| **U6.5** | Require new developments and redevelopments to reduce and manage stormwater through on-site capture and retention, low impact development (LID), green infrastructure, and other means | Policy Development | Long-range Planning, Codes and Standards | City, ACFCWCD, RWQCB | Multi-benefit, Local, Regional |

Physical Vulnerability

**Vulnerability U7:** Many mechanical and electrical components of utility infrastructure are vulnerable to groundwater rise and/or salinity intrusion due to water- and salt-sensitivity.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U7.1** | Monitor groundwater and salinity levels near vulnerable infrastructure by leveraging existing data or collecting site-specific data as necessary | Program/operation | Operations, New Initiative | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Unlocking, Do It Yourself, Local, Regional |
| **U7.2** | Increase inspection and maintenance of infrastructure that is sensitive to water or salt in areas at risk from sea level rise, storm events, or elevated groundwater levels | Program/operation | Operations | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U7.3** | Review and update standards, codes, and regulations for the construction and placement of utility infrastructure to avoid or address sea level rise, storm events, and elevated groundwater levels | Policy Development | Codes and Standards | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast, CPUC, FERC, RWQCB | Unlocking, Do It Yourself, Local, Regional, State, Federal, Long Lead Time |

Physical Vulnerability

**Vulnerability U7 (continued):** Many mechanical and electrical components of utility infrastructure are vulnerable to groundwater rise and/or salinity intrusion due to water- and salt-sensitivity.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U7.4** | Follow existing or develop new standards requiring that waterproof materials be used in the construction of new infrastructure and in the repair or protection of existing infrastructure | Program/operation, Policy Development | Operations, Project Planning and Design, Codes and Standards | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U7.5** | Follow existing or develop new standards to ensure corrosion-resistant materials or cathodic coatings are used when installing new or upgrading existing cables and pipelines | Program/operation, Policy Development | Operations, Project Planning and Design, Codes and Standards | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U7.6** | Follow existing or develop new standards requiring elevation of sensitive components above anticipated flood levels | Program/operation, Policy Development | Capital Planning, Project Planning and Design, Codes and Standards | PG&E, Kinder Morgan, Shell, EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |

Physical Vulnerability

**Vulnerability U8:** Certain critical utility infrastructure (e.g., cell towers, wastewater and stormwater pump stations) requires an uninterrupted power supply to function.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U8.1** | Establish plans to deliver fuel to backup power generation systems | Program/operation | Operations, Emergency and Hazard Planning | EBMUD, EBDA, Hayward, San Leandro, OLSD, USD, City DPW, ACFCWCD, Verizon, AT&T, Comcast | Do It Yourself, Multi-benefit, Local, Regional |
| **U8.2** | Review cell tower records to identify which ones do not have backup power generation systems | Evaluation | Long-range Planning, New Initiative | Verizon, AT&T, Comcast, County | Do It Yourself, Unlocking, Multi-benefit, Local, Regional |
| **U8.3** | Develop emergency alternate power supplies for cell towers that do not have a backup power supply, e.g., obtain portable backup power generators or ensure quick access through rental agreements; keep power generators with sufficient fuel for several days on site | Program/operation | Emergency and Hazard Planning | Verizon, AT&T, Comcast | Do It Yourself, Multi-benefit, Local, Regional |
| **U8.4** | Ensure access to Cells on Wheels (COWs) through rental or leasing agreements or by creating a county-wide fund through conditions on permits, which can provide service when permanent cellular towers are insufficient or non-operational | Program/operation | Emergency and Hazard Planning | Verizon, AT&T, Comcast, County | Do It Yourself, Multi-benefit, Local, Regional |

Physical Vulnerability

**Vulnerability U9:** Infrastructure such as pipelines, cables, and utility poles that are exposed to storm events are susceptible to damage. Scour and erosion can expose pipelines and cables, and pipelines can become buoyant when flooded, while high winds can topple utility poles and damage electrical wires, especially in flooded areas.

| Action Number | Action | Action Type | Process | Possible Actors | Action Characterization |
|---|---|---|---|---|---|
| **U9.1** | Inspect underground infrastructure, particularly after storm events and extreme tides, and improve cover as necessary to ensure it is sufficient to withstand scour and flooding | Program/operation | Operations, Emergency and Hazard Planning | PG&E, Kinder Morgan, Shell, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional, |
| **U9.2** | Improve existing and install new underground infrastructure to ensure pipelines and cables are adequately weighted and secure enough to remain in place even if cover is removed | Program/operation | Long-range Planning, Capital Planning, Operations | PG&E, Kinder Morgan, Shell, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U9.3** | Reinforce aboveground infrastructure to reduce the risk of erosion, undermining, and toppling | Program/operation | Capital Planning, Operations, Project Planning and Design | PG&E, Kinder Morgan, Shell, Verizon, AT&T, Comcast | Do It Yourself, Local, Regional |
| **U9.4** | Consider relocating critical elements that are necessary to continuity of utility services to areas that are not at risk from sea level rise and storm events | Policy Development | Long-range Planning, Capital Planning | PG&E, Kinder Morgan, Shell, Verizon, AT&T, Comcast | Local, Regional, Long Lead Time |

# 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