CALIFORNIA ADAPTATION
PLANNING GUIDE

June 2020

Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

CALIFORNIA ADAPTATION PLANNING GUIDE

June 2020

Prepared By:

The California Governor's Office of Emergency Services

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With Valuable Input From:

Adaptation Planning Guide Interagency Planning Workgroup

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Dear Reader,

The California Governor's Office of Emergency Services is pleased to present the 2020 update of the Adaptation Planning Guide. The Guide is designed to help local government, regional entities, and climate organizations incorporate best practices and current science and research into their adaptation plans.

The Adaptation Planning Guide update meets the requirements of Assembly Bill 246, which also established the Integrated Climate Adaptation and Resiliency Program to link the state's climate adaptation strategies with local and regional efforts.

Since the first release of the Adaptation Planning Guide in 2012, California's adaptation program has progressed to include the Adaptation Clearinghouse hosted by the Governor's Office of Planning and Research; the Safeguarding California Plan: 2018 Update; California's Fourth Climate Change Assessment; and Cal-Adapt, an interactive tool that helps users assess their climate risk. The Adaptation Planning Guide adds to California's toolkit and will ultimately evolve to a web-based platform within the Adaptation Clearinghouse.

During these uncertain times, addressing the impacts of climate change is more critical than ever to protect our communities, our infrastructure, our natural resources, and all Californians. Thank you to the many partner agencies and individuals who contributed their time, expertise, and input to the success of this next generation Adaptation Planning Guide.

Sincerely,

MARK S. GHILARDUCCI
Director
Governor's Office of Emergency Services

Team Acknowledgements

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List of Abbreviations

AB	Assembly Bill
APG	Adaptation Planning Guide
ART	Adapting to Rising Tides
BCDC	San Francisco Bay Conservation and Development Commission
CalBRACE	California Building Resilience Against Climate Effects
CAL FIRE	California Department of Forestry and Fire Protection
Cal OES	Governor's Office of Emergency Services
CAP	climate action plan
CBPR	community-based participatory research
CDPH	California Department of Public Health
CHAT	California Heat Assessment Tool
CIP	capital improvement program
Coastal Commission	California Coastal Commission
COG	council of governments
FEMA	Federal Emergency Management Agency
GHG(s)	greenhouse gas(es)
GIS	Geographic Information Systems
ICARP	Integrated Climate Adaptation and Resilience Program
IPCC	Intergovernmental Panel on Climate Change
IRWM	integrated regional water management
IRWMP	integrated regional water management plan
LCP	local coastal program
LHMP	local hazard mitigation plan
OES	Governor's Office of Emergency Services
OPC	Ocean Protection Council
OPR	Governor's Office of Planning and Research
SB	Senate Bill
SHMP	state hazard mitigation plan
TAC	technical advisory council
WUI	wildland-urban interface

INTRODUCTION

Local government has an important role to play in efforts to reduce greenhouse gas (GHG) emissions and limit the impacts of climate change. The State of California provides resources to local governments to support local action on climate change. The *California Adaptation Planning Guide* (APG) continues this effort by providing guidance to support communities in addressing consequences of climate change.

To support local and regional adaptation planning efforts, the state has developed an integrated set of policies and tools:

- *California Adaptation Planning Guide* (this guide)
- *Safeguarding California Plan: California's Climate Adaptation Strategy* (2018 Update)
- Cal-Adapt 2.0 (released October 2017 and updated continuously with new tools and data from California's research community
- *California's Climate Change Assessment* (most recently updated in 2018)
- *State of California General Plan Guidelines* (updated periodically, most recently updated in 2017)
- Adaptation Clearinghouse
- *State Hazard Mitigation Plan* (2018 Update)

While California's state government proudly advances initiatives to mitigate and adapt to the effects of climate change, local and regional government agencies are critical partners implementing and pushing forward climate action. To best serve the people of California on responding to the challenges of climate change, coordination across different levels of government is necessary. Local, regional, and federal agency partners have key jurisdictional responsibilities that must be integrated to achieve resilience to climate change in every area of the state, and California's administration is a committed and engaged partner for those agencies' adaptation efforts.

- from *Safeguarding California*, page 14.

What Is the APG?

The APG provides guidance to local governments on local adaptation and resiliency planning. As illustrated in Figure 1 and described in Table 1, the APG presents an updated, step-by-step process that communities can use to plan for climate change. The APG is designed to be flexible and guide communities in adaptation planning that best suits their needs, whether taking a preliminary broad look at adaptation issues or conducting a detailed formal planning process. The APG also provides the most recent summaries of statewide information and guidance on where to find and how to use key adaptation planning tools.

Since the state's release of the first APG in 2012, it has been widely used by communities, government agencies, tribal governments, nongovernmental organizations, institutions, and others throughout California to help guide adaptation planning efforts. In 2020, the state updated the APG to reflect the latest best practices; to integrate recent updates to state plans, policies, programs, and regulations (see Figure 2); and to ensure that communities have guidance on using the best available science and information.

Figure 1. Adaptation Planning Process
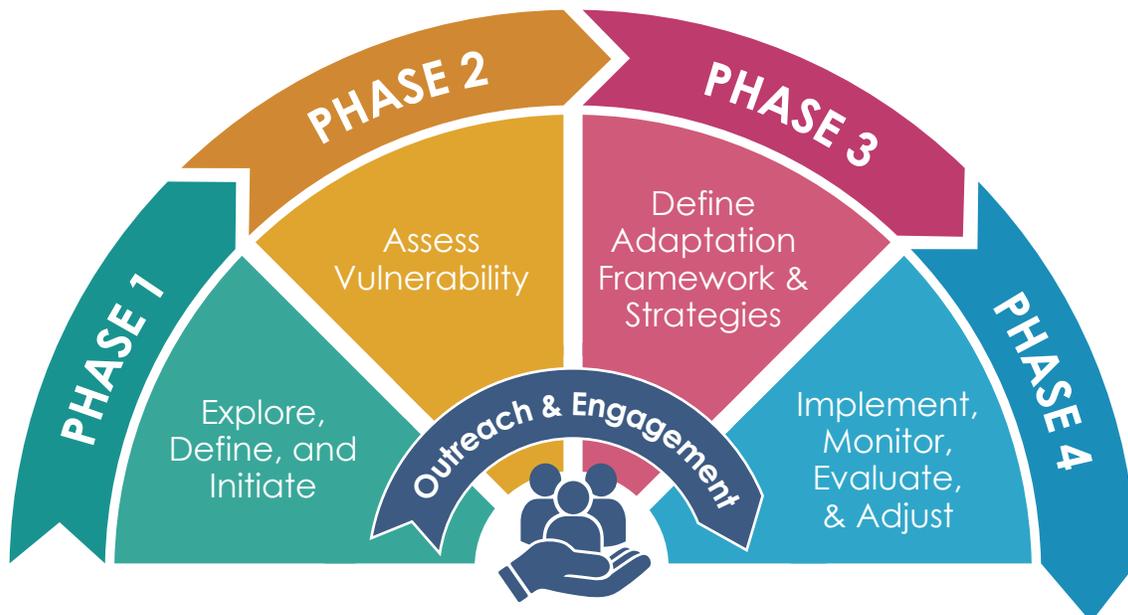
Figure 2.   State and Federal Resources Related to the APG

Safeguarding California

Climate Adaptation Clearinghouse

Cal-Adapt.org

Fourth Climate Change Assessment

Adaptation Planning Guide

State Hazard Mitigation Plan

FEMA Local Mitigation Planning Handbook

California General Plan Guidelines

TABLE 1. WHAT IS THE CALIFORNIA ADAPTATION PLANNING GUIDE		
USE THE APG AS	**THIS DOCUMENT IS NOT**	**RELATED RESOURCES**
Guidance for local governments on how to plan for and adapt to climate change.	Guidance for state agencies.	*Safeguarding California Plan: 2018 Update* is a roadmap of the ongoing actions and next steps currently being taken by California's state government on climate resilience and adaptation. Agencies may also consult the State Hazard Mitigation Plan which incorporates climate change into the state's hazard mitigation strategies. The guidebook, *Planning and Investing for a Resilient California*, provides guidance to state agencies on how to incorporate climate change into state planning and state investment in decisions.[1, 2]
This update focuses on guidance for use by city, county, tribal, and regional governments in California. This update supports consistency between state, regional, and local adaptation planning efforts.		
A planning process for developing local climate adaptation and resilience policies, programs, and actions.	A clearinghouse of case studies, guidance, and resources for adaptation practitioners.	The Governor's Office of Planning and Research hosts the Adaptation Clearinghouse (https://resilientca.org) as part of its Integrated Climate Adaptation and Resiliency Program. The Adaptation Clearinghouse is California's centralized collection of adaptation and resilience resources intended to guide decision-makers at the state, regional, and local levels.
This update provides a four-phase process for local governments to develop specific adaptation and resilience strategies at the local level.		
A framework for local, solutions-oriented initiatives based in climate science.	A compendium of science on climate impacts and vulnerabilities.	California's *Climate Change Assessments* provide extensive information about climate impacts and vulnerabilities based on the latest climate change research. The underlying climate data for the assessments is made available on Cal-Adapt.org. Cal-Adapt provides tools and data for assessing local climate change impacts.
This update references the most recent climate science and provides guidance to obtain data and use California-specific climate science tools. It is not a comprehensive collection of science or research on hazards and vulnerabilities in California.		

TABLE 1. WHAT IS THE CALIFORNIA ADAPTATION PLANNING GUIDE		
USE THE APG AS	**THIS DOCUMENT IS NOT**	**RELATED RESOURCES**
A framework for integrating an array of local government climate adaptation policies and programs, including local hazard mitigation plans and general plans.	Guidance on how to systematically prepare local hazard mitigation plans and general plan elements, such as safety elements.	FEMA's _Local Mitigation Planning Handbook_ provides guidance on preparing a local hazard mitigation plan. State of California's _General Plan Guidelines_ provide guidance on incorporating climate considerations into general plans. The Office of Planning and Research provides guidance on the preparation of general plans, including safety elements, and associated LHMP incorporation guidance in the _General Plan Guidelines_.
This update provides guidance to complete a vulnerability assessment and adaptation framework that can be used in a variety of local government plans. The APG's guidance includes considerations for different plans and plan integration of climate where applicable. It is not a comprehensive guide for updating a local hazard mitigation plan or safety element.		

Phases of the Adaptation Planning Process

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

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

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

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

Who Developed the APG and Why?

The California Governor's Office of Emergency Services (Cal OES) prepared the first APG in 2012 through a partnership with California Polytechnic State University (San Luis Obispo), other state agencies, and experts from local jurisdictions and nongovernmental organizations. From 2018 to 2020, Cal OES led an update, which resulted in this APG. Cal OES updated the APG in collaboration with a consultant team, the Governor's Office of Planning and Research (OPR), and an interagency working group made up of state agencies, nongovernmental organizations, and experts from local and regional jurisdictions.

> ## OES Mission
>
> *The mission of Cal OES is to protect lives and property, build capabilities, and support communities for a resilient California. With funding from the Federal Emergency Management Agency and the California Energy Commission, the state developed the 2012 APG to assist local and regional government agencies with planning for climate change adaptation.*

In 2015, the governor signed Senate Bill 246 (SB 246), which required Cal OES to update the APG within one year of an update to the *Safeguarding California Plan* and also established the Integrated Climate Adaptation and Resiliency Program (ICARP) in OPR. The *Safeguarding California Plan* integrates the ICARP vision and principles, which represent the overarching vision and priorities for statewide adaptation planning (See ICARP's Adaptation Vision and Principles text box on the next page). This APG follows the requirements of SB 246 and explains the connections between climate adaptation, community resiliency, public safety, and security; provides information and planning support for assessing climate vulnerabilities across sectors and regions; and supports tools to create and implement adaptation strategies that can be tailored to meet local needs.

Since the development of the 2012 APG, the state enacted requirements for local adaptation planning, which are summarized in the following section. This APG provides helpful resources to local governments as they comply with these requirements and provides recommendations and advice on community-level climate change adaptation planning—such as the preparation of vulnerability assessments and adaptation strategies. The APG also explains how these plans and processes can be integrated with other local and tribal government planning and operations.

CLIMATE ADAPTATION AND RESILIENCE REQUIREMENTS FOR LOCAL GENERAL PLANS

California Government Code § 65302 was amended by SB 379 and SB 1035 to require that local cities and counties include climate adaptation and resiliency and new information relating to flood and fire hazards in the safety element of their general plans.

In 2015, SB 379 revised § 65302(g)(4) to require that cities and counties update their safety elements to address climate adaptation and resiliency strategies applicable to their jurisdiction. The updates are required at the next update of their local hazard mitigation plan (LHMP) on or after January 1, 2017. Local jurisdictions without an LHMP must update their safety elements beginning on or before January 1, 2022. The safety element update must include:

1. A vulnerability assessment identifying the risks that climate change poses to the local jurisdiction.

2. A set of goals, policies, and objectives based on a vulnerability assessment for the protection of the community.

3. A set of feasible implementation strategies to carry out the goals, policies, and objectives.

ICARP Adaptation Vision and Principles

Vision

All Californians thrive in the face of a changing climate. Leading with innovation, California meets the challenge of climate change by taking bold actions to protect our economy, our quality of life, and all people. The state's most vulnerable communities are prioritized in these actions. Working across all levels of government, the state is prepared for both gradual changes and extreme events. Climate change adaptation and mitigation is standard practice in government and business throughout the state. California meets these goals with urgency, while achieving the following long-term outcomes:

- All people and communities respond to changing average conditions, shocks, and stresses in a manner that minimizes risks to public health, safety, and economic disruption and maximizes equity and protection of the most vulnerable.

- Natural systems adjust and maintain functioning ecosystems in the face of change.

- Infrastructure and built systems withstand changing conditions and shocks, including changes in climate, while continuing to provide essential services

Principles

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

- Prioritize actions that promote equity, foster community resilience, and protect the most vulnerable. Explicitly include communities that are disproportionately vulnerable to climate impacts.

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

- Avoid maladaptation by making decisions that do not worsen the situation or transfer the challenge from one area, sector, or social group to another. Identify and take all opportunities to prepare for climate change in all planning and investment decisions.

- Base all planning, policy, and investment decisions on the best-available science, including local and traditional knowledge, including consideration of future climate conditions out to 2050 and 2100, and beyond.

- Employ adaptive and flexible governance approaches by utilizing collaborative partnership across scales and between sectors to accelerate effective problem solving. Promote mitigation and adaptation actions at the regional and landscape scales.

- Take immediate actions to reduce present and near future (within 20 years) climate change risks for all Californians; do so while also thinking in the long term and responding to continual changes in climate, ecology, and economics using adaptive management that incorporates regular monitoring.[3]

Section 65302(g)(4) identifies resources and considerations in support of the requirements, including the APG. Section 65302(g)(4)(D) allows local jurisdictions to meet this requirement in the safety element of the general plan or with an adopted LHMP, stand-alone climate adaptation plan, or a similar document if it "fulfills commensurate goals and objectives and contains the information required." If a local jurisdiction elects to meet this requirement with other stand-alone plans or equivalent content in other portions of the general plan, it "shall summarize and incorporate by reference into the safety element the other general plan provisions, climate adaptation plan or document, specifically showing how each requirement of this subdivision has been met."

In 2018, SB 1035 further revised § 65302 to require that after 2022 the safety element be reviewed and updated upon each revision of the housing element or LHMP, but no less than once every eight years, to address climate adaptation and resiliency and identify new information relating to flood and fire hazards.

Who Should Use the APG?

The state prepared the APG with a community focus to guide local governments, regional planning agencies, and tribal governments in the development and integration of climate adaptation and resilience components of stand-alone climate action and/or adaptation plans, hazard mitigation plan updates, and general plan updates consistent with state statutes.

While the primary audience for the APG is local and tribal government public agencies, the process and many of the resources can also be of value to nongovernmental and private-sector planning efforts. Additionally, formally engaging businesses, community-based organizations, and other private entities is key to achieving comprehensive results and implementing adaptation actions. Additional guidance on local and regional collaboration and public-private partnerships is presented in the Regional Collaboratives and Adaptation Planning text box and Public-Private Partnership section in Phase 1.

How Should the APG Be Used?

Communities throughout California have different needs and capabilities. Regardless of the size, capacity, or resources of the community, the APG provides a four-phase process that can increase resilience and support compliance with state requirements (see Figure 1). Communities can use the APG as a step-by-step guidance document for conducting adaptation planning processes, preparing vulnerability assessments, and developing and implementing communitywide adaptation strategies.

The APG provides a standard approach to adaptation planning that can be modified to suit the unique needs of each community. Although each phase has unique steps for completing the process, the APG allows flexibility in the commitment of time, staffing, money, and scope. Communities can follow a basic process that draws on readily available data and minimizes staff commitment or they can follow a more in-depth approach. The logic is the same—what will differ is the sophistication of the vulnerability assessment and the extent of the adaptation strategy development.

The APG includes an introduction that will help orient users to adaptation planning in California. This introduction introduces key terms used in the APG in text boxes and directs users to the Definitions section between Phase 4 and the Appendices for reference when using the APG. The primary content of the APG, the four phase planning process, is presented in four sections with four supporting appendices. The Endnotes section provides sources and supporting notes. Text boxes throughout the APG provide examples, summaries of key resources, or other supportive information. In each phase, the APG further provides outreach and engagement tools to help local planners and staff collaborate with the local community and stakeholders throughout the process.

As illustrated in Figure 2, the APG integrates with other key state resources to support local adaptation planning. In addition, when using the APG, communities can tap state, regional, and local entities, including academic institutions and collaboratives, for specialized information. For example, in communities where wildfire occurrence or intensity is expected to increase, the California Department of Forestry and Fire Protection can provide tools, guidance, and coordination. Likewise, a Bay Area community facing sea level rise may utilize data resources from the Ocean Protection Council, California Coastal Commission, and the San Francisco Bay Conservation and Development Commission (BCDC) to support and facilitate adaptive efforts.

Key Terms

The APG uses the following key terms. For detailed definitions of key terms, please refer to the glossary.

Climate change refers to a change in the climate that can be identified by changes in the mean and/or variability of its properties and that persists for an extended period, typically decades or longer.[4]

A **climate change effect** is any consequence, generally a negative one, that is caused by climate change.

A **hazard** is an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss. A **climate change hazard** is a dangerous or potentially dangerous condition created by the effects of the local climate.

An **extreme (climate) event** occurs when a weather or climate variable exceeds the upper or lower thresholds of its observed range.[5]

Climate change adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, and which moderates harm or exploits beneficial opportunities.[6] Climate change adaptation is focused on long-term threats to human life, property, economic continuity, ecological integrity, and community function.[7]

Resilience is the "capacity of any entity—an individual, a community, an organization, or a natural system—to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience."[8] Adaptation actions contribute to resilience, which is a desired outcome or state of being.

Mitigation is an act or sustained actions to reduce, eliminate, or avoid negative impacts or effects. **Hazard mitigation** is a sustained action taken to reduce or eliminate the long-term risk to human life and property through actions that reduce hazard, exposure, and vulnerability.[9] Hazard mitigation can be one component of climate change adaptation.[10] **Climate change mitigation,** also referred to as **GHG mitigation** or **GHG reduction**, refers to actions to reduce GHG emissions to reduce the severity of climate change.

Vulnerability is the exposure of human life and property to damage from natural and human-made hazards. Climate vulnerability describes the degree to which natural, built, and human systems are at risk of exposure to climate change impacts. Differences in exposure, sensitivity, and adaptive capacity affect an individual's or community's vulnerability to climate change. Vulnerability can increase because of physical (built and environmental), social, political, and/or economic factor(s). Vulnerability is considered a function of exposure, sensitivity, and adaptive capacity.[11]

Exposure is the presence of people, infrastructure, natural systems, and economic, cultural, and social resources in areas that are subject to harm.[12]

Sensitivity is the degree to which a species, natural system, or community, government, and other associated systems would be affected by changing climate conditions.

Impact is a specific negative result of a climate change effect, generally on a particular population or asset. Impact is often determined by the combination of exposure and sensitivity. For example, if the effect of climate change is that droughts are likely to become more frequent and severe, a potential impact to farmers is that less water could be available for irrigation.

Adaptive capacity is the "combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts [or] moderate harm or [to] exploit beneficial opportunities."[13] Simply stated, it is the ability to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.[14]

Risk is the potential for damage or loss created by a hazardous condition that affects populations or community assets. For example, a freeway in an area that can experience flooding can be labeled as "at risk" of flooding. Sometimes a level of risk will be assigned, which can be either qualitative or quantitative (e.g., a house that faces a "high risk" from wildfires, or a community that faces a 30 percent chance of a major earthquake in the next 40 years).

What Is Climate Adaptation Planning?

Climate adaptation planning allows communities to identify ways that they might be harmed by future conditions, including those unique to their communities, and to prepare for these conditions before they happen. Climate adaptation planning can be conducted on its own or integrated with other planning efforts across programs, department, and sectors to develop a comprehensive and connected adaptation system. (Integration of climate adaptation into and across sectors, disciplines, and municipal programs and departments is also referred to as "mainstreaming.") Examples include climate action or GHG reduction planning, local comprehensive land use and environmental planning, and local hazard mitigation planning.

An integrated approach to climate change and resilience will involve both adapting to future climate conditions and reducing GHG emissions. Climate adaptation activities can also have several benefits, such as increased public health and safety, reduced GHG emissions, greater economic stability, reduced cost savings of healthcare and infrastructure, increased resiliency of housing, improved air and water quality, and better stormwater management.

This APG's adaptation planning process includes four phases, and each one has a dedicated chapter and supporting resources to detail key steps and considerations (see Figure 1). At the end of the process, the outcome ideally is a locally focused, easy-to-follow framework that includes vulnerabilities in a community as well as strategies and implementation actions. The framework can be integrated into general plans, local hazard mitigation plans, and other planning efforts or be a stand-alone document.

CLIMATE CHANGE ADAPTATION AND MITIGATION

Addressing climate change relies on two high-level approaches. One is adaptation, the focus of this guide, which is about reducing harm from the effects of a changing climate. The other is reducing GHG emissions that are responsible for causing climate change, also called climate change mitigation, GHG mitigation, or climate action. Figure 3 illustrates the relationship of these approaches. Communities should take advantage of strategies that support both goals. For example, homes that install solar panels and battery storage systems are better protected against climate-related disruptions to the electricity supply (an adaptation effort), but solar panels also generate electricity without any GHGs and allow homes to use less energy from GHG-emitting power plants (a reduction effort). However, there is potential for conflict. Consider a program to install air conditioning systems in homes. While this will help protect residents against extreme heat (an adaptation effort), these systems will

require more energy to run and could increase GHG emissions if the energy source is not carbon-free (working against reduction efforts).

State law requires communities to address GHG emissions (and reductions) in local planning and environmental review processes and climate adaptation in local long-range planning processes, such as general plans (or acceptable alternative). Communities should evaluate their specific needs and priorities when deciding how best to balance these strategies. Communities can prepare one stand-alone plan to address GHG reduction and climate adaptation, prepare separate stand-alone plans for each topic, or integrate the topics into other plans and planning processes. While there are numerous co-benefits between climate adaptation and GHG reduction, there are also instances where there may be trade-offs. These trade-offs should be considered and balanced in the context of a broader planning framework that addresses community goals and needs. It is essential to reduce emissions and plan for impacts simultaneously because efforts to adapt will be overwhelmed by the harm done by climate change if emissions are not reduced.

Resilience and Adaptation

Adaptation and resilience are not the same thing, although they are related. According to the State's Planning and Investing for a Resilient California guidebook, **adaptation** is "an adjustment in natural or human systems to a new or changing environment"[15] (such as the increased frequency and intensity of climate-related hazards or other climate-related conditions). An adaptation adjustment "moderates harm or exploits beneficial opportunities" brought about by the change.

Resilience is "the capacity of any entity—an individual, a community, an organization, or a natural system—to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience."[16] A community's resilience is determined by its ability to survive, adapt, and thrive no matter what acute shock or chronic stressor it experiences.

Figure 3. Illustration of the Roles of GHG Emissions Reduction and Climate Adaptation in Combating the Sources and Effects of Climate Change

Climate change **mitigation** seeks to reduce the amount of GHG emissions from communities to slow global warming.

Communities emit GHGs into the atmosphere. These trap additional heat and cause global warming.

Global warming changes the local climate (temperature and precipitation) and drives sea-level rise, which may impact cities.

Climate change **adaptation** seeks to address the impacts of climate change on communities.

HOW DOES ADAPTATION PLANNING RELATE TO OTHER COMMUNITY PLANNING PROCESSES?

The ways to integrate climate adaptation into other community planning processes vary by the needs of the community and how local adaptation and resilience fit within those needs. Adaptation and resilience policies can be integrated into local policy and programs in a variety of ways—for example, development of a stand-alone climate action or adaptation plan, update of a general plan safety element, preparation of an LHMP, or integration of adaptation strategies into any number of local planning and policy documents.

Although there are options for addressing climate adaptation and resilience, local jurisdictions in California, as noted earlier, must incorporate climate adaptation and resilience in the next update of their general plans (individual element update or comprehensive update) and/or address it in a stand-alone plan or LHMP update, as directed by California Government Code § 65302(g)(4). Communities may determine that one plan, implementation mechanism, or outcome is not sufficient to meet their vision and goals and opt to pursue multiple plans. For example, communities may want to develop a stand-alone climate adaptation plan in response to community values and to support strategic implementation and to provide guidance for implementation across other plans, programs, and policies; to provide more in-depth analysis than required in the general plan or LHMP; and/or to elevate the importance of the issues. State law also requires local agencies to consult California Native American tribes to aid in the protection of traditional tribal cultural places through local planning processes. Local agencies should consider following the OPR Tribal Consultation Guidelines for any climate adaptation-related update to the General Plan or other planning documents as early as possible in the planning phase.

Local governments can choose the best way to implement and monitor the adaptation effort depending on their own capabilities and those of their community. The APG's guidance includes considerations for different plans and plan integration where applicable. However, communities should consider using the adaptation planning process to develop a comprehensive, integrated plan that guides implementation of adaption and resilience policies. Regardless of the choice of adaptation framework, the ultimate goal should be to consider climate adaptation and resilience in all local-government, regional-sector, and policy-making processes.

One of the biggest challenges to developing climate adaptation strategies is the diversity in the potential effects on community services, equity, public health, economic vitality, ecosystem health, water supply, etc. Fortunately, many existing local and regional plans, such as general plan safety elements and LHMPs, already address some of these impacts, meaning that communities are likely to have a good

idea of the types of strategies that would be most effective. In some cases, developing adaptation policy can mean simply integrating and bolstering existing policies and strategies through the periodic plan update process.

HOW SHOULD COMMUNITIES TAKE ACTION?

Communities have a range of possibilities for taking action on climate change adaptation. Some common municipal plans and programs include:

- **Administrative policy, procedures, and initiatives.** Some strategies may be implemented by agency staff without first needing authorization by a governing board.

- **Climate action plan (CAP) / climate change action plan / climate adaptation plan / climate adaptation and resilience plan / climate mitigation and adaptation plan.** A community can choose to create a stand-alone plan focused on climate change. Stand-alone climate action plans (including climate adaptation plans and related documents) are strategic plans to address climate change. They can include GHG reduction and climate adaptation together or separately. Many California communities have climate action plans, and though some focus exclusively on climate mitigation, many address climate mitigation and climate adaptation. Stand-alone climate adaptation plans contain background data and analysis, adaptation strategies, and often an implementation program. A community with a stand-alone plan would achieve an integrated approach to adaptation and resilience through subsequent revisions to community plans and programs through normal, periodic updates.

- **General plan, comprehensive plan, community specific plan, or community area plan**. The community general plan, comprehensive plan, or community specific plan, or community area plan, especially the safety element of a general plan, is an appropriate document for codifying goals, objectives, and policies related to climate change adaptation and environmental justice. Other relevant policy areas in the general plan usually include land use, transportation, conservation, recreation and open space, public safety, and noise.

- **Local hazard mitigation plan.** LHMPs are an important example of a community planning process that already includes mitigation for natural hazards. These plans should be developed and updated in light of potential climate change effects, and climate change should be integrated into the assessment of hazards risk. Ideally, measures identified in an LHMP address both current hazards and future, climate change–affected hazards. However, natural hazard impacts are only one area that may be affected by climate change. Other areas include agricultural, forestry, and fisheries productivity; ecosystem structure and function; and public health. Planning in all these areas should be done in light of potential climate change impacts.

If the community has adopted an LHMP (including a multi-jurisdictional hazard mitigation plan) pursuant to the federal Disaster Mitigation Act of 2000, it is an appropriate document for codifying adaptation strategies related to the mitigation of natural or human-caused hazards such as wildfire, flooding, coastal storms and erosion, drought, and heat emergencies.

- **Zoning code and other land development codes, ordinances, and resolutions.** Adaptation strategies that affect zoning and land use can be acted on through adjustments in the regulations and procedures governing these areas.

- **Local coastal program (LCP).** Local governments in the coastal zone must prepare policies and standards for development in the coastal zone consistent with the Coastal Act and certified by the Coastal Commission. Local coastal programs contain the ground rules for future development and protection of coastal resources. Climate change issues, particularly sea-level rise and associated effects should be addressed in the LCP for both the short and long term.

- **Capital improvement plan/program.** For adaptation strategies that require capital expenditures (relocating a wastewater treatment plant, building a cooling center, etc.), the community capital improvement plan is an appropriate place to address priorities, funding, and scheduling of adaptation strategies.

- **Integrated regional water management plan.** Integrated regional water management groups (48 in the state) are collaborative efforts to address regional water resources. The regional approach supports local jurisdictions by providing coordination and information. The associated grant funding for these programs supports adaptation strategy development and implementation.

- **Emergency operations plan.** Climate analyses could affect the scope of wildfire, flood, and extreme heat events. Emergency operations plans should consider how increased frequency and intensity of climate change hazards will affect emergency response and evacuations.

- **Tribal and indigenous community plans.** Tribal plans, both sector specific and comprehensive, are appropriate plans for goals, objectives, and policies related to climate change adaptation and environmental justice. These plans ensure effective and efficient program administration and service delivery to communities and citizens.

- **Community health assessments and community health improvement plans.** Strategies that address impacts on human health, public health systems, and medical services can be integrated into a community health improvement plan (or CHIP), which is required as part of accreditation for local health departments.

- **Historic or cultural preservation plans.** Strategies that address vulnerabilities of historic, cultural, and tribal cultural resources can be included in the goals and objectives of preservation plans. Adaptation strategies can also be integrated into general plans, community plans, and specific plans.

The four phase planning process and guidance presented in this APG support integration of climate adaptation into multiple plans and programs.

COMMUNICATING THE FACTS OF CLIMATE CHANGE

Communicating the facts on climate change can be daunting, to say the least.

Climate change is inherently abstract; "climate" is the average of weather, not weather itself. Moreover, scientists predict a changing climate based on global climate models, which are quite abstract to the layperson. When scientists qualify their findings with error bars and offer various "uncertainties," people can become even more confused.

In addition, climate trends move slowly. It can take 20 to 30 years for the emissions from a tailpipe or smokestack to affect the weather. The glacial pace of climate change creates "shifting baselines," where one generation only perceives risk related to the climate they inherited and fails to perceive shifts underway over the course of a century or longer.

Climate change can also be emotionally fraught. Climate change threatens health and longevity, and the actions required to reduce emissions and prepare for climate impacts can be overwhelming since they can include significant changes and transitions, such as shifting from the fossil fuel that has traditionally powered our society to carbon free, renewable options.

Research on climate communications has basic dos and don'ts. The group ecoAmerica has published a helpful guide, 15 Steps To Create Effective Climate Communications," on discussing climate change. Climate Nexus and the George Mason University Center for Climate Change Communications also have resources to support climate change communications. In addition, OPR's Facts and Metrics webpage (http://opr.ca.gov/facts/) includes climate change facts and metrics that can be helpful in discussions and presentations.

How Is California Vulnerable to Climate Change?

Climate change is already impacting California and will continue to affect it for the foreseeable future.[17, 18] For example, the average temperature in most areas of California is already 1°F higher than historical levels, and some areas have seen average increases in excess of 2°F. Similarly, sea levels along the coast of central and southern California increased over 15 centimeters (5.9 inches) during the 20th century.[19] Current and projected climate changes include increased temperatures, sea level rise, a reduced winter snowpack, altered precipitation patterns, increases in wildfires, and more frequent storm events. Over the long term, reducing GHG emissions can help make climate change less severe.

Differences in exposure, sensitivity, and adaptive capacity affect an individual's or community's vulnerability to climate change. Exposure is the presence of people; infrastructure; natural systems; and economic, cultural, and social resources in areas that are subject to harm. Sensitivity is the susceptibility to harm and can be attributed to underlying social, economic, demographic, and physical factors. Both sensitivity and exposure are directly affected by population growth, development patterns, and success in addressing underlying vulnerabilities, including equity and social vulnerability.[20] Chapter 2 of the *Fourth Climate Change Assessment* discusses how climate change will affect people, infrastructure, and natural systems. Moreover, the *Fourth Climate Change Assessment*'s "Climate Justice" report shows that some vulnerable populations already bear a disproportionate burden of climate impacts, and the report provides strategies so that they do not bear the costs of mitigation and adaptation as well.[21]

The effects of a changing climate vary based on location. However, primary climate change effects include:

- Increases in temperature
- Increases in extreme storms/events
- Changes in precipitation
- Sea-level rise
- Ocean acidification

Primary climate change effects can exacerbate hazards seen at local and regional levels, such as wildfires and associated smoke, drought, landslides, flooding, and human health hazards.

STATE CLIMATE CHANGE IMPACT SUMMARY

The *California Fourth Climate Change Assessment* identifies the following climate change impacts of concern to the state under a business-as-usual emission scenario, also known as "representative concentration pathway" (RCP) 8.5.

Table 2 shows the historical and expected climate change effects in California as presented in the *California Fourth Climate Change Assessment Summary Report*.

- Climate change is already affecting temperatures throughout California. Annual average daily high temperatures are expected to rise by 2.7°F by 2040, 5.8°F by 2070, and 8.8°F by 2100 compared to observed and modeled historical conditions. These changes are statewide averages. Heat waves are projected to become longer, more intense, and more frequent.

- Warming temperatures are expected to increase soil moisture loss and lead to drier seasonal conditions. Summer dryness may become prolonged, with soil drying beginning earlier in the spring and lasting longer into the fall and winter rainy season.

- High heat increases the risk of death from cardiovascular, respiratory, cerebrovascular, and other diseases.[23]

- Droughts are likely to become more frequent and persistent through 2100.

- Climate change is projected to increase the strength of the most intense precipitation and storm events affecting California.

- Mountain ranges in California are already seeing a reduction in the percentage of precipitation falling as snow. Snowpack levels are projected to decline significantly by 2100 due to reduced snowfall and faster snowmelt.

- Marine layer clouds are projected to decrease, though more research is needed to better understand their sensitivity to climate change.

Representative Concentration Pathways[22]

Representative concentration pathways, or RCPs, are different scenarios for the future severity of climate change. The global scientific community usually use four scenarios: RCP 2.6, RCP 4.5, RCP 6, and RCP 8.5. The greater the number, the more severe future climate change conditions are projected to be. RCP 8.5, a "business as usual" projection assumes that global GHG emissions continue to increase until at least the end of the 21st century.

- Extreme wildfires (i.e., fires larger than 10,000 hectares or 24,710 acres) would occur 50 percent more frequently. The maximum area burned statewide may increase 178 percent by the end of the century.
- Exposure to wildfire smoke is linked to increased incidence of respiratory illness.
- Sea level rise is expected to continue to increase erosion of beaches, cliffs, and bluffs.

TABLE 2. QUALITATIVE DESCRIPTION OF HISTORICAL AND EXPECTED CLIMATE EFFECTS IN CALIFORNIA			
CLIMATE EFFECT	**HISTORICAL TRENDS***	**FUTURE DIRECTION OF CHANGE**	**CONFIDENCE FOR FUTURE CHANGE**
Temperature	Warming	Warming	Very High
Sea levels	Rising	Rising	Very High
Snowpack	Declining	Declining	Very High
Annual precipitation	No significant trends	Unknown	Low
Intensity of heavy precipitation events	No significant trends	Increasing	Medium-High
Frequency of droughts	No significant trends	Increasing	Medium-High
Frequency of intensity of Santa Ana and similar winds	No significant trends	Unknown	Low
Marine layer clouds	Some downward trends; mostly not significant	Unknown	Low
Acres burned by wildfire	Increasing	Increasing	Medium-High
Soil moisture	Decreasing	Decreasing	Low
Source: Louise Bedsworth, Dan Cayan, Guido Franco, Leah Fisher, and Sonya Ziaja (California Governor's Office of Planning and Research, Scripps Institution of Oceanography, California Energy Commission, California Public Utilities Commission), Statewide Summary Report, California's Fourth Climate Change Assessment, Publication number: SUMCCCA4- 2018-013, 2018, Table 3.			
*Over the past 30 to 100+ years, depending on the effect.			

What Are the State's Climate Resilience Efforts?

The State of California advances climate adaptation and resilience in a variety of ways. The state's current adaptation plan is *Safeguarding California*, which specifies integrated state adaptation strategies for a variety of strategic sector areas. Updating the APG is one strategy in the plan. *Safeguarding California Plan: 2018 Update* establishes a vision for the state and identifies principles, goals, and policies primarily directed to state agencies. *Safeguarding California* also establishes a "critical" role for California's local and regional government agencies.

The Governor's Office of Planning and Research administers the Integrated Climate Adaptation and Resiliency Program to coordinate regional and local efforts with state climate adaptation strategies to adapt to the impacts of climate change. The program has two components: the State Adaptation Clearinghouse and the Technical Advisory Council. The Adaptation Clearinghouse is California's centralized collection of adaptation and resiliency resources designed to guide decision-makers at the state, regional, and local levels. The Technical Advisory Council supports the Office of Planning and Research in its goal to facilitate coordination among state, regional, and local adaptation and resilience efforts with a focus on opportunities to support local implementation actions that improve the quality of life for present and future generations. The Council adopted an adaptation vision and principles in September 2017 (see text box on page 8) and approved a revised charter and a definition for vulnerable communities in April 2018.

Additional examples of the state's climate adaptation and resilience plans and programs include:

- The Governor's Office of Emergency Services manages the state's hazard mitigation activities and projects, including preparation of the State Hazard Mitigation Plan and Adaptation Planning Guide, and assists local and tribal governments with preparation and implementation of their local hazard mitigation plans.

- The California Energy Commission released Cal-Adapt (cal-adapt.org) in 2011 as a web-based tool that enables city and county planners, government agencies, and the public to identify changes to climate conditions and associated hazards in specific areas throughout California. Since that time, grant funding continues to keep the data current with California's climate change assessment process, improve flexibility of visualizations and data download options at a local level, and provide improved descriptions of visuals and data. Funding from the Strategic Growth Council now extends Cal-Adapt beyond energy-related needs. Examples of the accessible data include annual temperature and precipitation

averages, extreme precipitation events, extreme heat, snowpack, wildfire, and extended drought scenarios.

- The Office of Environmental Health Hazard Assessment's *Indicators of Climate Change in California* tracks trends for 36 indicators that show how climate change is affecting California today.

- The Climate Change and Health Equity Program's California Building Resilience Against Climate Effects Project (CalBRACE), at the California Department of Public Health, provides data, tools, and templates for local agencies to assess the health equity impacts of climate change and increase resilience.

- The Ocean Protection Council has produced guidance on sea level rise and ocean acidification with the goal of building coastal resilience. Guidance topics include sea level rise science, adaptation strategies, sound policy development, and partnership engagement.

- The state conducts comprehensive climate change assessments regularly to assess the impacts and risks from climate change and to identify potential solutions to inform state policy actions. Preparation of the assessments has been a collaborative effort of state agencies, researchers from public universities, federal agencies, and the private sector. The *Fourth Climate Change Assessment*, led by a state agency management team from the California Natural Resources Agency, California Energy Commission, and Governor's Office of Planning and Research, published in 2018, has four statewide reports: 1) Climate Justice, 2) Tribal and Indigenous Communities within California, 3) California's Ocean and Coast, and 4) Statewide Summary Report. It also includes nine regional reports, which have downscaled climate information to demonstrate the likely role of climate change in California's unique topographies. The *Fourth Assessment* has 51 technical reports on a wide range of topics as well as six unique tools, including mapping tools on urban heat and adaptation financing.

- *Planning and Investing for Resilient California*, developed by the Office of Planning and Research and a Technical Advisory Group in 2016, provides guidance for state agencies to integrate climate change considerations into every aspect of government. The guidance document offers direction on scenario selection, identification of vulnerable communities, community engagement, and fostering equity in applicable local jurisdictions.

- Finally, other state agencies, such as Caltrans and the Department of Water Resources, have prepared their own plans and resource documents for addressing climate adaptation.

STATE ADAPTATION SECTORS

Planning and implementing comprehensive resilience measures across the urban-rural divide will be critical to mitigating wildfire risk, safeguarding California's future water supplies, and preserving habitats, biodiversity, and the multitude of valuable ecosystem services that our natural and working lands provide. The *2018 Safeguarding California* organizes its policies under 11 sectors: agriculture; biodiversity and habitat; emergency management; energy; forests; land use and community development; ocean and coast; parks, recreation, and California culture; public health; transportation; and water. Five of the *Safeguarding* sectors, emergency management, energy, land use and community development, public health, and transportation, address vulnerabilities in social systems and the built environment. Five other Safeguarding sectors, agriculture, biodiversity and habitat, forests, ocean and coast, and water, address vulnerabilities in natural and managed resource systems. The eleventh sector, "Parks, Recreation, and California Culture," spans these three areas.

The Adaptation Clearinghouse website organizes its resources under these topics with some changes, including revising Parks, Recreation, and Culture to Parks and Recreation and adding additional sectors of equity and environmental justice, investing in adaptation, and plan alignment.

For consistency, the discussions of potential vulnerabilities and example adaptation strategies in the APG use these 11 key sectors as an organizing framework, with Parks, Recreation, and California Culture (refer to Figure 4 for a list of the sectors). Appendix A provides summaries of each sector and its vulnerabilities. In the APG, the issue of equity and environmental justice is not a sector in itself, but an overarching topic that is integrated into all 11 sectors as applicable.

Individual communities may choose to follow this framework, or they may organize their adaptation efforts differently. All topics may not be relevant to all communities. Regardless of the preferred organizing structure, this APG recommends an approach that integrates climate adaptation and resilience across sectors.

Figure 4. State Adaptation Sectors

EMERGENCY MANAGEMENT

ENERGY

LAND USE AND COMMUNITY DEVELOPMENT

PUBLIC HEALTH

TRANSPORTATION

AGRICULTURE

BIODIVERSITY AND HABITAT

FORESTS

OCEAN AND COAST

WATER

PARKS, RECREATION, AND CALIFORNIA CULTURE

How Is Equity Integrated into Climate Change Adaptation Planning?

Equity means that all people are justly and fairly included in society and that everyone is able to participate, prosper, and achieve their full potential.[24] It recognizes that everyone enjoys different advantages and faces different challenges, and that everyone should be treated justly and fairly according to their circumstances. Equity should be treated as a critical component of all planning, including climate adaptation planning. Equitable climate adaptation planning involves identifying persons who may be most vulnerable to climate change and ensuring that planning processes, distribution of resources, and efforts to address systemic wrongs are all conducted in an equitable manner.

First, adaptation planning should look at climate vulnerability through the lens of the adopted definition by the Integrated Climate Adaptation and Resiliency Program's (ICARP's) Technical Advisory Council. ICARP's Technical Advisory Council developed *Defining Vulnerable Communities in the Context of Climate Adaptation* to provide a clear understanding of the many elements that characterize vulnerable populations in the adaptation context. This guide provides the climate vulnerability assessment tools to evaluate climate risk and adaptive capacity, specific indicators to include in vulnerability assessment, and the following definition of vulnerable communities:

> Climate vulnerability describes the degree to which natural, built, and human systems are at risk of exposure to climate change impacts. Vulnerable communities experience heightened risk and increased sensitivity to climate change and have less capacity and fewer resources to cope with, adapt to, or recover from climate impacts. These disproportionate effects are caused by physical (built and environmental), social, political, and/or economic factor(s), which are exacerbated by climate impacts. These factors include, but are not limited to, race, class, sexual orientation and identification, national origin, and income inequality.[25]

The *Fourth Climate Change Assessment* and related research also affirm that several communities already feel the cumulative burden of climate change, environmental pollution, and historical socioeconomic disparities.[26] It is important to identify and acknowledge these communities because there is an opportunity in climate adaptation planning to address issues holistically. Communities that have long experiences with systemic exclusion and resource deprivation have developed assets, coping skills, and knowledge that can benefit overall climate resilience planning. Robust community engagement in plan development, as recommended throughout the APG, can bring these communities' wisdom into local resilience efforts.

Second, through all phases of adaptation planning, it is helpful to think of equity as multidimensional and having three objectives: 1) procedural, 2) distributional, and 3) structural (see Table 3).[27] State agencies and tribal governments have additional resources for equity and inclusion in adaptation planning, including the California Department of Public Health's Climate Change and Health Equity Program, the California Environmental Protection Agency's Office of Environmental Justice, the California Office of Emergency Services' Access and Functional Needs Section, and the Pala Band of Mission Indian Tribe Environmental Department's climate adaptation resources and templates.

TABLE 3. TYPES OF EQUITY IN ADAPTATION PLANNING	
Procedural Equity	• Create processes that are transparent, fair, and inclusive in developing and implementing any program, plan, or policy. • Ensure that all people are treated openly and fairly. • Increase the civic engagement opportunities of communities that are disproportionately impacted by climate change.
Distributional Equity	• Fairly distribute resources, benefits, and burdens. • Prioritize resources for communities that experience the greatest inequities and most disproportionate impacts and have the greatest unmet needs.
Structural Equity	• Make a commitment to correct past harms and prevent future unintended consequences. • Address the underlying structural and institutional systems that are the root causes of social and racial inequities. • Include adaptation strategies to eliminate poverty, create workforce development, address racism, increase civic participation, protect housing availability, increase education, and provide healthcare.
Source: Tina Yuen, Eric Yurkovich, Lauren Grabowski, and Beth Altshuler, "Guide to Equitable Community-Driven Climate Preparedness Planning," prepared for Urban Sustainability Directors Network, May 2017, https://www.usdn.org/uploads/cms/documents/usdn_guide_to_equitable_community-driven_climate_preparedness-high_res.pdf.	

How Is Uncertainty Addressed in Climate Adaptation Planning?

The uncertainty of the future poses significant challenges to evaluating climate impacts and developing policy. First, because climate change is driven by how much GHG is emitted into the atmosphere, climate outcomes are subject to the adoption and effectiveness of GHG reduction. The more the world acts to reduce GHG emissions, the less adaptation should be necessary. Second, for any given level of atmospheric GHGs and associated global warming, there will be impacts to natural and human systems. Despite extensive efforts to model these potential impacts, they are ultimately uncertain. Finally, the future state of technology, socioeconomic conditions, and other human systems is unknown. This is not, however, a reason for inaction. The APG has numerous techniques for addressing uncertainty through the recommended four phases of the adaptation planning process.

In addition, Appendix B provides additional information about adaptation pathways as an approach to addressing uncertainty in strategy development and implementation. Adaptation pathways are an emerging approach for communities, but best practices are still being developed. _Paying It Forward: The Path Toward Climate-Safe Infrastructure in California_ recommends use of an adaptation pathways approach for State agency infrastructure planning; however, its application and use by local communities in California is limited and not established as a best practice. Some communities, many of them coastal communities, are considering adaptation pathways as an approach to addressing sea level rise and coastal flooding, among other issues. Appendix B provides more information about adaptation pathways as an alternative or supplement to Phases 1 to 4.

Who Should Be Involved?

In addition to assembling the right resources, it is important that organizations and people actively participate in adaptation planning. In general, it can be helpful to think of four different groups of potential participants:

- **Community stakeholders.** Local people and organizations are key for gathering and analyzing local information, developing robust climate adaptation strategies, building political support, and creating a more informed and active community. This includes building support from community elected officials, civic leaders, and community-based organizations.
- **Local agency stakeholders.** Since climate adaptation affects all aspects of a community, adaptation strategies should be developed by an "adaptation team" assembled from local agency staff who can provide data, insight, and ideas. The most common government agencies and departments include planning

(land use and environmental), community development, building, engineering, public works, emergency management, police, fire, finance, public health, and environment. The level of commitment needed from the team varies depending on the level of intricacy of the plan.

- **National, state, and regional stakeholders.** National, state, and regional government agencies, including tribal governments and communities; academic and research institutions; and nonprofit organizations, preferably those located in or near the community, can provide data, guidance, and sometimes funding in support of climate adaptation planning. In addition, it is important to approach neighboring communities, including tribal communities, about collaborating on adaptation planning.

- **Partner organizations.** Regional, state, and federal networks of government agencies; academic and research institutions; and nonprofits can help support implementation efforts. These networks may be able to provide funding, case studies and best practices to help ensure success—and in some cases, temporary staff or volunteer assistance.

Engaging stakeholders is essential to adopting equitable adaptation policies and strategies and ensuring that they can be implemented efficiently. Stakeholder engagement offers the opportunity to educate and build commitment and consensus among local decision-makers and community members. Each phase of the adaptation planning process should include community and stakeholder outreach and engagement.

Communicating climate change can be challenging. Hazards created or worsened by climate change as well as other climate change–related effects affect all communities across California, but communities deal with many other issues. Sometimes other issues take precedence over climate change, like housing, transportation, immigration, and public safety. However, climate change is inextricably linked with many social issues, and taking action to adapt will also provide many other benefits.

Wrap-Up

Although climate change has the potential to significantly harm communities throughout California, local jurisdictions have many options and resources to adapt to these new conditions. The APG assists communities with this work, ensuring that adaptation planning reflects the latest best practices and information, and uses the best available science. It guides communities through a four-step process that takes a holistic approach to adaptation work, including engaging the community at large and addressing issues of equity and environmental justice. The following sections of the APG walk through each of the four steps in detail, beginning with the first phase (Define, Explore, and Initiate) discussed in the next chapter.

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PHASE
1

Define, Explore, and Initiate

PHASE 1: DEFINE, EXPLORE, AND INITIATE

Adaptation planning efforts should begin with a scoping phase to define, explore, and initiate the planning process. Phase 1 establishes the basic aspects of the planning effort, the issues it will address, and who will be involved. Making these decisions at the beginning of the process helps ensure that it will be thorough, integrated, and equitable. These scoping activities are the foundation of the adaptation planning process—a framework that informs and directs future efforts. Without this foundation, the process may not comprehensively address community need or some important topics, and climate change effects may not be adequately mitigated. The lack of a clear scope may lead to a longer, costlier, and less organized planning process. The scoping phase is essential to ensure an effective and complete adaptation planning effort and can help align the process with existing or future planning documents.

Practitioners who are new to the field may be nervous about taking on an adaptation planning effort. Adaptation planning might seem like a specialized technical analysis that differs from other planning processes in the issues it raises, the time frames involved, and the underlying science and regulations. However, it is fundamentally a planning process that ties into other processes such as general plan updates or local hazard mitigation planning. It should be approached as any other planning process and based on core planning principles. The process should be open to members of the community, with appropriate opportunities for stakeholder engagement and feedback. It should seek to improve the health, safety, and welfare of all people and address current and potential future inequities. Adaptation planning should be grounded in best available science and use established best practices as appropriate. It should comply with all applicable laws and regulations and not conflict with other adopted plans.

Phase 1 outlines steps for exploring, defining, and initiating the adaptation planning process (see Figure 5). The steps in this phase are numbered, although they do not always need to be completed in order. For example, conducting outreach and engagement for residents and community stakeholders (Step 1.4) can occur much earlier in the process to involve interested community members from the very beginning of the planning process. In some instances, it may be helpful to work on multiple steps at the same time.

Figure 5. Steps in Phase 1

STEP 1.1 MOTIVATION AND SCOPE

Clarify reasons for adaptation planning

▼

Identify desired outcomes of process

▼

Define resilience

▼

Set the geographic and time frame boundaries

STEP 1.2 TEAMS AND RESOURCES

Assess capacity and needs

▼

Assemble project team

▼

Identify tools and resources

STEP 1.3 CLIMATE EFFECTS AND COMMUNITY ELEMENTS

Identify climate effects

▼

Select populations and assets

STEP 1.4 OUTREACH AND ENGAGEMENT

Step 1.1: Confirm Motivation and Scope of the Process and Outcome

WHY IS THE COMMUNITY CONDUCTING AN ADAPTATION PLANNING PROCESS?

Communities embark on an adaptation planning process for different reasons, and it is helpful to identify what motivated the process as well as what the process will address and how it will be done. This information is helpful to all participants and stakeholders and provides transparency to the process. Some of the more common motivators are:

- **Recent event or stressor.** The community has recently experienced a climate-related disaster or has concerns about a specific future disaster.
- **Community concern.** The community is aware of long-term changes in climate, such as rising sea levels or temperatures. There is interest from residents, businesses, and other community members to address climate resiliency.
- **Regulatory requirement.** The community must comply with state law about adapting to a changing climate.
- **Opportunity.** Grants or other funding sources are available to support planning and implementation efforts.

There may be multiple reasons for an adaptation planning effort. The motivator may be informally suggested by a community member or it may be formally established by a declaration or resolution (including a declaration of a climate emergency) adopted by the community government such as a city council, board of supervisors, or tribal council. Identifying the motivator early in the process helps to identify potential stakeholders, how the community will view the adaptation planning process and its outcomes, how to implement outcomes, and how to measure success.

WHAT IS THE PLAN OR PROJECT RESULTING FROM THE ADAPTATION PLANNING PROCESS?

Scoping the planning process includes determining how to publish, adopt, and implement the results. Adaptation work typically becomes part of one of three main categories of planning mechanisms: 1) comprehensive plans, 2) focused plans, and 3) implementation programs (see Figure 6).

- The comprehensive plans establish a framework and overarching guidelines for adaptation planning and implementation.
- The focused plans set more-specific objectives based on the framework and guidelines.
- The implementation programs lay out and enact actions to achieve the specific objectives and are generally implemented on an ongoing basis.

Though adaptation planning can usually be worked into existing planning mechanisms, sometimes communities may want to develop a new mechanism (such as a dedicated climate adaptation plan) in response to the adaptation planning effort. Either way, it is important to ensure consistency across plans and programs.

The adaptation planning process presented in Phases 1 through 4 of the APG can result in one or more of the above plans or outcomes. The APG focuses on three outcomes of a local adaptation planning process: 1) safety element and/or other elements of a general plan, 2) stand-alone climate action or adaptation plan, and 3) local hazard mitigation plan. Communities are not limited to integrating adaptation planning work into these three mechanisms, and the California Government Code § 65302(g)(4) allows for any plan or document containing this information to meet the state's requirements. However, in practice, the general plan, climate action or adaptation plan, or local hazard mitigation plan are the most commonly used options to ensure that climate adaptation is addressed in a holistic and fully integrated way. The Introduction of this guide provides more information about these local planning efforts.

Coastal Hazard Resilience Planning in California: Crosswalks

Resilience Planning in California[1] ("Coastal Plan Alignment Compass") integration of various local planning initiatives in coastal communities, though the guidance can be helpful to inland communities as well. The guide includes "crosswalks" to help planners identify when local hazard mitigation plans, adaptation plans, general plans, and local coastal programs can complement and support each other and when there is a risk of inconsistency.

Figure 6.   Types of Plans and Programs

COMPREHENSIVE, OVERARCHING PLANS	FOCUSED PLANS AND GUIDANCE	IMPLEMENTATION PROGRAMS
	EXAMPLES OF PLANS AND PROGRAMS	
General Plan	Specific Plan	Zoning Code
	Local Coastal Program	
	Active Transportation Plan	Annual Budgets
Climate Action / Adaptation Plan (Strategic Plan)	Design Guidelines	
	Evacuation Plan	Building Codes
	Integrated Regional Water Management Plan	
	Sustainability Plan	Subdivision Regulations
Local Hazard Mitigation Plan	Emergency Operations Plan	
	Stormwater Management Plan	Development Entitlements
	Community Health Plans & Assessments	Capital Improvement Plan

WHAT DOES ADAPTATION AND RESILIENCE MEAN TO THE COMMUNITY?

The goal of adaptation planning is to improve community resilience in the face of a changing climate. A resilient community is one that is prepared for current and future hazard conditions and experiences less harm when disasters happen. Resilient communities can also recover more quickly and thoroughly. They rebuild in a way that accounts for continuing climate changes, rather than rebuilding the same way as before. Adjusting adaptation planning in response to new information and opportunities through ongoing learning and monitoring is important to resiliency.

Resilience is a process or ideal that a community works toward. There will not be a moment when resiliency is fully achieved and the community can stop working on adaptation. However, a vision of what resilience means for the community can act as a guidepost for adaptation planning. If the community does not have an established vision for climate change adaptation and resilience, it may help to engage all stakeholders to define resiliency, including agency staff (see Step 1.2), any advisory group or groups (see Step 1.2), external stakeholders (see Step 1.4), and decision-makers. Consider these factors when contemplating what resiliency looks like for the community:

- **Equity.** A resilient community is one in which all members of a community are able to effectively prepare for and recover from acute and chronic climate impacts. Ideally, all community members are equally resilient regardless of income, health, identity, education, and other socioeconomic factors. Removing all disparities is an aspirational goal and may be beyond what an individual community can achieve, but a resilient community should strive for confidence that all members of the community are prepared for and able to recover from climate change impacts.

- **Holistic approach.** Ensuring the health and safety of community members is critical to building resiliency, but it is not the only factor. Total community well-being depends on many different systems—built, natural, and sociopolitical. For example, if a wildfire damages a forest, the number of tourists may drop, which may result in economic hardship for communities with tourist-based economies and affect the well-being and adaptive capacity of people who own and work at such businesses. A resilient population is not possible if the systems that people depend on are not themselves resilient. Additionally, a regional approach to climate adaptation can help ensure an efficient and effective process that gets the greatest possible benefit from limited resources.

- **Future needs.** Communities are constantly changing. As buildings are constructed and torn down, people move in and out, businesses open and close, and other systems in a community change, the resiliency needs of the community change as well. For example, many older Americans want to stay in their homes or communities rather than moving to retirement homes or

assisted care facilities, which creates a different set of resiliency needs. When thinking about what resiliency means for the community, consider it from the perspective of community members of all ages and future assets, not only current ones. Additionally, some communities adopt ambitious housing plans to help bridge severe gaps between community needs for affordable housing options and current supply. These housing plans substantially influence the resilience of precariously housed low-income households and individuals currently experiencing homelessness due to lack of housing supply.

ADAPTATION AND THE EMERGENCY MANAGEMENT CYCLE

Traditionally, when planning for disasters or other negative effects, planners think of a process of harmful events and recovery known as the emergency management cycle, which has four phases:

- **Hazard mitigation.** Efforts that take place between disasters to reduce or eliminate the potential for harm caused by the negative event, with an emphasis on ensuring long-term resiliency.
- **Preparation.** Planning to ensure that activities, programs, and resources are in place to support short-term response activities when a disaster occurs.
- **Response.** Steps taken during or immediately after a disaster to minimize harm to people. Response activities often focus on short-term needs, such as ensuring that people have access to sufficient food and water, shelter, and medical care.
- **Recovery.** Actions that occur after a disaster to restore the community to a normal state, ideally more resilient than it was before. Reconstruction activities are part of the recovery phase.

Different planning mechanisms exist to support different phases of the emergency management cycle. For example, hazard mitigation plans (as expected) focus on the mitigation phase, although they will often include some preparation strategies. Emergency operations plans act as guides for the response phase, and may sometimes include directions for the recovery phase, although communities that experience significant disasters may prepare stand-alone recovery plans.

Adaptation planning efforts can address all four phases of the emergency management cycle depending on community needs and characteristics, although for many communities the largest number of strategies will likely fall into the hazard mitigation phase. The types of strategies will also depend in part on the plans and programs that will result from the adaptation planning process. Some strategies may fall into multiple phases. Adaptation planners do not need to use this process as a framework for adaptation planning efforts, but it can be helpful to think about the full spectrum of topics that these efforts can address.

COMMUNITY VISION FOR ADAPTATION AND RESILIENCE

A vision statement captures what community members most value about their community and what they want their community to become. When drafting a vision statement, it is helpful to think about how the community will be similar or different in the future (e.g., in 10, 20, 30, or 50 years or more)—how it will function, what it will be known for, who will be served by the community and its services, what it will look like, what resources will be needed, and more.

Preparation of a vision statement should be as inclusive as possible. Visioning is often the first activity of a community engagement process. The process can include a variety of activities to engage stakeholders in visioning. Ultimately, the ideas and recommendations should be compiled into a single draft vision that is vetted through the adaptation planning process.

Goals should be statements of the desired outcomes from the adaptation planning process based on the vision of a resilient community. A vision statement and goals should reflect the needs, priorities, and values of the community and of the stakeholders involved in the planning effort. Consider visions and goals that help connect local adaptation planning to State efforts, such as the ICARP vision and principles. Establishing goals early creates a common foundation for the future work of everyone involved. Participants can refer back to these goals throughout the planning process to help ensure that they are on the right track. Later in the process, after preparing the vulnerability assessment, participants prepare more-specific goals as a framework for the adaptation policies. Phase 3 of the APG provides additional guidance for drafting goals.

Resilience Defined by the City of San Francisco

Resilience describes the capacity of individuals, communities, institutions, businesses and systems within a city to survive, adapt and grow, no matter what kinds of chronic stresses and acute shocks they experience. Approaching challenges through the lens of resilience helps cities better serve their residents today and plan for the longer term. Resilience demands moving beyond reaction through proactive planning. The approach calls for considering problems systematically, seeking out departmental and conceptual relationships from which solutions can be more completely developed, and bridging the practice gaps between social justice, sustainability, disaster recovery and other areas.[2]

Example Vision with Broad Goals

Create a resilient community that can adapt to the effects of climate change.

Goals:

- A community and local economy that continues to function during extreme events and has coordinated and up-to-date preparedness, response, and recovery procedures.
- A water supply that meets the demand of residents, businesses, and visitors in spite of changing precipitation trends.
- A community that can continue to function and thrive with an increase in average temperature and extreme heat days.
- A medical and public health system that proactively addresses human health hazards and inequities in the community.
- Utilities, buildings, and infrastructure that can meet community needs during and after severe weather.
- Sustainably managed forests in coordination with federal, state, and local agencies that will not endanger communities with wildfires.

Example Vision Statement

Make San Francisco a more resilient city in the face of immediate and long-term threats of sea level rise, by taking measures to protect and enhance public and private assets, natural resources, and quality of life for all.[3]

WHAT IS THE GEOGRAPHIC AREA?

The participating jurisdictions usually define the geographic area of the plan or project. For example, a city conducting adaptation planning efforts will focus on building resiliency within its city limits or sphere of influence. Similarly, a county's efforts usually support adaptation in unincorporated areas within its boundaries. Regional governments may also conduct adaptation work for all jurisdictions in their area, and multiple jurisdictions may collaborate on regional adaptation work, creating a geographic area that spans multiple jurisdictions.

However, sometimes the planning area is not as clear cut as political boundaries. Adaptation planning for a natural resource or ecosystem—a watershed, for example—may need to cover a broad area that does not follow political boundaries. Even if the planning effort is limited to a specific area with defined boundaries (such as a state park), natural areas outside of these boundaries may need to be included to the extent possible to help ensure resiliency. Specific areas within a community, such as neighborhoods or defined frontline communities, may also be the focus of an adaptation planning effort. Frontline communities are populations that experience the impacts of issues such as environmental pollution, climate change, and the economic crisis first and most severely. They are most often communities of color and/or low-income.[4]

Planning Areas for Local Hazard Mitigation Plans

LHMPs typically follow local government jurisdictional boundaries, such as cities or counties. In some cases, natural features may define planning areas, like watersheds, or include special districts, such as fire and utility districts. Multi-jurisdictional LHMPs are an option to address cross-boundary issues and collaboration. An example is the San Diego County Multi-Jurisdictional Hazard Mitigation Plan, which includes cities, the county, fire protection districts, and water districts and includes climate change in the vulnerability assessment and strategies. If updating an LHMP, decide if previous plan boundaries are still appropriate.

Regional Collaboratives and Adaptation Planning

Although an agency or organization can create and implement adaptation plans on their own, sharing knowledge and practices with other regional practitioners can benefit adaptation planning and implementation. Climate change is a difficult topic and mutual support is often needed.

As of May 2020, multiple local and regional climate collaboratives have formed across nearly every geographic region in California, representing over 80 percent of the state's population, and others are in early stages of formation. Local and regional collaboratives can take a variety of forms but may resemble loose membership networks that can include any mix of local governments; other public agencies, regional authorities, and planning bodies; utilities; universities; nonprofit organizations; and private sector representatives. Some collaboratives formed in the early and late 2000s, such as the North Coast Resource Partnership, the Los Angeles Regional Collaborative for Climate Action and Sustainability, the San Francisco Bay Area Regional Collaborative, and the San Diego Regional Climate Collaborative. Over the last decade, the Sacramento, Sierra Nevada, North Coast, Central Coast, Santa Barbara, Inland Southern California, and other local and regional areas have also established collaboratives. In 2017, a second collaborative formed in the San Francisco Bay region, the Bay Area Climate Adaptation Network, to address the climate planning needs of local governments. The original Bay Area collaborative now focuses on broader regional solutions.

Each collaborative varies in the composition of their membership, scope of their projects, governance structure, and financial management; however, all the collaboratives offer similar types of support, such as

- Helping participants stay current on climate news, laws and policies, resources, funding, tools, and data applicable to each geography.

- Providing or identifying technical assistance and capacity building opportunities.

- Facilitating a networking space for engaging with other professionals to exchange knowledge, share best practices, build adaptation-related skills, and help define shared adaptation priorities.

- Creating opportunities to coordinate on cross-sector and cross-jurisdictional programs and projects.
- Defining regional approaches for adaptation.
- Leveraging cross-sector resources and strengths to achieve shared outcomes.

The Alliance of Regional Collaboratives for Climate Adaptation, organized by the Local Government Commission, is a statewide body representing many of the state's collaboratives and affiliate members and composed of select nonprofit, business, and academic institutions. ARCCA offers a Regional Adaptation Collaborative Formation Toolkit to support local and regional stakeholders in forming a collaborative.

Participation in regional collaboratives and ARCCA can support agencies with limited capacity and staff. For example, in 2016, the National Oceanic and Atmospheric Agency awarded the San Diego Regional Climate Collaborative a Regional Coastal Resilience Grant to help its members plan for sea level rise; develop scientific, legal, and economic resources regarding coastal resiliency; and perform education and outreach. The resources, tools, and support that collaboratives provide can help to streamline many aspects of the planning process, including data collection and research, identification of adaptation strategies, coordination with neighboring jurisdictions, and community engagement, which can deliver cost savings for resource-constrained agencies.

Building the relationships and infrastructure to support regional collaboration on climate change is especially challenging in underresourced communities. To address this disparity, Senate Bill 1072 (Leyva 2018) established the Regional Climate Collaboratives Program (RCC) at the California Strategic Growth Council. RCC will support cross-sector collaboration at the regional scale that leads to climate change mitigation, adaptation, and resilience initiatives.

WHAT IS THE TIME FRAME FOR THE PLANNING PROCESS?

Like all other planning efforts, adaptation planning requires time and effort. Local government agency staff and other stakeholders will need to commit their time, technical and financial resources, and the available knowledge of everyone involved to ensure a successful process.

The time frame for the adaptation planning process may be determined by a grant, budget cycle, direction from elected officials, community priorities, or other factors. The breakdown of the adaptation planning process in Table 4 shows the phases and steps in this guide and estimates the timing of each step. Steps may take more or less time depending on capacity, funding, scope details, and other characteristics. Following all phases could take 12 to 24 months, depending on the level of detail and resources committed to each phase. It is also possible to work on more than one step at the same time.

Considerations that can affect the time frame of the process are:

- Availability of local agency staff and other stakeholders who will lead and/or participate in the planning process.
- Need for external support from consultants, community partners, or other external partners to complete the process.
- Data availability from internal and external providers and whether any new technical studies are needed.
- Commitment to community and stakeholder engagement (beyond those who are leading the process), including types and timing of events and opportunities. As discussed in Step 1.4, providing opportunities for stakeholder engagement can be critical to ensuring the success of an adaptation planning project.
- Requirements for review and participation by external agencies. Some planning mechanisms, such as general plan safety elements or local hazard mitigation plans, require review by external agencies that can take many months.

TABLE 4. ESTIMATED TIME FRAME FOR ALL PHASES OF THE APG		
PHASE	**STEPS**	**APPROXIMATE TIME FRAME**
Phase 1	1.1 Motivation and scope	One week to one month
	1.2 Teams and resources	Two weeks to one month
	1.3 Climate effects and community elements	Two weeks to six weeks
	1.4 Outreach and engagement	One week to eight weeks
Phase 2	2.1 Exposure	Two weeks to one month
	2.2 Sensitivity and potential impacts	One to three months
	2.3 Adaptive capacity	One to three months
	2.4 Vulnerability scoring	Two weeks to one month
	2.5 Outreach and engagement	Two weeks to three months
Phase 3	3.1 Summarize vulnerability	Two weeks to one month
	3.2 Confirm vision and goals	One to two weeks
	3.3 Prepare adaptation strategies	Two to four months
	3.4 Prioritize adaptation strategies	One to two months
	3.5 Outreach and engagement	Two weeks to two months
Phase 4	4.1 Implement	Ongoing after Phase 3
	4.2 Monitor	Ongoing after Phase 3
	4.3 Evaluate	Ongoing after Phase 3
	4.4 Adjust	Ongoing after Phase 3

WHAT IS THE TIME FRAME FOR THE PLAN OR PROJECT?

Figure 6 shows the different types of plans or programs that could incorporate the adaptation planning process. Each type has a time horizon. Adaptation planning efforts should look far enough ahead to evaluate the climate change effects that may affect systems and assets over the course of their lifetimes and contain policies that can adequately protect them. The adaptation planning process's horizon should be long enough to ensure that the effort can build meaningful resiliency. For example, consider that many infrastructure systems and buildings are in use for at least 50 years, often longer.

The plan or program into which the adaptation planning will be integrated determines the time horizon though it does not need to limit or constrain consideration of long-term projections.

- **General plan.** 20 to 40 years. Projections used to inform policies can go out to 2100.
- **Climate action/adaptation plan.** Varies, but usually at least to 2050, and often to 2100.
- **Local hazard mitigation plan.** 5-year minimum, but often includes longer-term strategies.
- **Specific plan.** Varies depending on the project, but often 15 to 30 years.
- **Capital improvement plan.** 1 to 5 years.

Projects created under a plan will most likely exceed the lifetime of the plan itself. For example, imagine a general plan adopted in 2015 that expires in 2040. A subdivision constructed in 2038 will likely still be around in 2070, long after the general plan expired and possibly even longer after the standards, codes, guidelines, and policies governing its construction were written. Adaptation planning efforts should consider the lifespan of projects that will be built or implemented under that plan when deciding on a time horizon.

Step 1.2: Assemble Project Team(s) and Resources

Consider the available resources for the planning process, including financing, technical resources, knowledge, and time, and what can be reasonably accomplished with them. This helps set realistic expectations for the planning effort and identifies any critical gaps that need to be filled.

WHAT KNOWLEDGE AND TECHNICAL RESOURCES ARE AVAILABLE?

In addition to obtaining the technical resources, it is also necessary that planners and other participants have the knowledge to understand and use these resources. For example, a dataset on local climate-related hazards can be extremely helpful for adaptation planning, but planners will need to know how to analyze the dataset and interpret the results for it to be useful. Similarly, a scientific paper may provide detailed information about a relevant topic but may be written using technical jargon and academic language that is not easily understood by everyone. Determine if those conducting adaptation planning activities have the knowledge to work with the technical resources and prepare a useful end-product. If not, look at expanding the participants to include members with the necessary expertise or consider training opportunities to fill in knowledge gaps.

> Adaptation planning depends on four key resources: time, technical resources, knowledge, and financial resources. Knowing how much of each resource is available and if it is sufficient to achieve the desired goals of the adaptation planning effort is critical to building and maintaining resiliency.

It can be helpful for communities to use a simple matrix to identify their capacity for adaptation planning. The Adaptation Capability Advancement Toolkit (ADAPT-CA) is one approach.[5] It helps participants to assess their leadership and organizational culture, staffing and technical capability, stakeholder engagement and partnerships, and operations and institutionalized processes. Capacity is measured on a four-point scale, from Initiation (the lowest level of capacity) to Optimization (the highest level). Matrixes such as ADAPT-CA can also help with goal setting for adaptation planning efforts. After communities identify their current capacity for adaptation planning, they can figure out their deficits and draft goals to help them approach or achieve optimal conditions.

WHAT IS THE BUDGET FOR THE PLANNING PROCESS?

The budget should consider the needs of each phase, inclusive of the financial resources to support stakeholder engagement. Budgets should include labor costs to complete the work in addition to other costs, including equipment, meeting supplies, materials, production, transportation, training, facility rental, and food for meetings. In some cases, adaptation planning may require minimal additional financial resources if existing staff can do all the work; however, in most cases, additional expertise is needed to conduct all or parts of the process. If existing staff lead a new adaptation planning process, it is important to ensure key staff have dedicated time in their workload over the time frame of the process. If a capacity assessment determines that existing staff resources are not available to lead an adaptation planning process, the budget may need to cover hiring additional staff or external consultants, or developing partnerships with regional collaboratives, university partners, or other community-based or nongovernmental organizations. An inclusive and equitable adaptation planning process includes the participation of community members and stakeholders, and the budget should encompass the financial needs of a robust outreach and engagement process that values community-based contributions. After estimating the budget, determine if existing general funds or other dedicated internal funds are available; if not, identify options for grants or external funding sources or partnerships. Communities may also be able to receive low-cost or free assistance from experts working *pro bono* or from a local university.

WHO WILL BE ON THE PROJECT TEAM?

The climate adaptation planning team provides institutional and technical knowledge and often supports stakeholder outreach and engagement. As with any project, the team should include a mix of people from relevant agencies and organizations with a range of skills and responsibilities, but it should not be so big that management and coordination become difficult. The project team should have a primary point of contact or team leader who coordinates the process and team meetings. The team leader should be empowered to make recommendations and/or have direct access to decision-makers. If resources allow, the project team can be supported by an advisory group with a larger membership to include representatives of partner agencies and community organizations that provide subject matter expertise and credibility to the process. If a consultant team is hired to support the process, it should be involved in the project team as well.

A project team often includes members of other departments under the same organization. For example, if the planning department of a city government conducts the adaptation planning effort, consider including members of the public works, parks and recreation, police, public health, and building departments. If special districts

within the project boundaries play important roles, such as a fire protection district, school district, or water district, consider including a representative from these districts on the project team. Given the scale, pace, complexity, and uncertainty of climate change impacts, adaptation planning necessitates inclusive, collaborative planning. Significant coordination across departments, particularly for larger jurisdictions, should occur when assessing vulnerabilities and developing, vetting, and prioritizing adaptation strategies. Such coordination will not only result in a more meaningful and comprehensive adaptation plan but can also help build staff capacity and buy-in for adaptation initiatives.

Community-based organizations and institutions, such as hospitals and colleges, may be part of a core project team. The core project team should also include organizations representing or departments serving vulnerable populations in the community. It should also be selective to reflect the community and include at least one or more trusted community representatives. In some cases, it can make sense to include representatives from applicable for-profit companies, such as utility companies or major employers.

Remember that the core project team is not everyone who will be involved in the process. A larger group will be involved in other ways, perhaps participating in broad and focused community and stakeholder engagement, such as public meetings, or being on an advisory or focus group. Outreach and engagement are discussed in Step 1.4 of this phase.

When deciding who to include in a core project team, consider these questions:

- Does this person bring important information or skills, especially a person identified as a useful technical or knowledge resource?
- Does this person represent a population group that will be included in the vulnerability assessment or an agency with some responsibility or control over an included asset?
- Can this person be involved over the length of the planning process?
- Is this person empowered to make decisions in support of the process?

Teams integrating adaptation planning into local hazard mitigation planning should include a comprehensive set of stakeholders from government departments, decision-making bodies, and regional or special districts. The following stakeholders should have an opportunity to be part of the process:[6]

- Local and regional agencies involved in hazard mitigation activities.
- Agencies that have the authority to regulation development.
- Neighboring jurisdictions.
- Businesses, academia, and other private and nonprofit interests.

If possible, adaptation planning processes should not be conducted by a single person. Even communities with a dedicated resilience expert should assemble a team to conduct integrated adaptation planning activities.

Community Advisory Groups

Community advisory groups are made up of local and regional stakeholders with local knowledge about social, built, natural, economic, and cultural systems. Community advisory groups provide local expertise and can support outreach and engagement. Community advisory committee members can be ambassadors for the project and ensure that engagement includes a broad representation of interested community members in climate-adaptation planning and decision making.

For example, the Town of Mammoth Lakes created the Climate Change Action Team (CCAT) to inform the Resilient Mammoth Lakes project. The CCAT played an integral part in accurately assessing impacts and adaptive capacity, and in informing the development of adaptation measures.

Another example is the stakeholder working groups for developing the City of Long Beach Climate Action and Adaptation Plan. The City created three distinct working groups—a scientific working group, business working group, and community working group—to validate project methodology and provide input on climate-related concerns and the public engagement approach.

WHAT ARE THE AVAILABLE TOOLS AND RESOURCES?

Adaptation planning can seem overwhelming, especially for participants who have limited experience with the subject. Although it is a very broad and often complex topic, there are numerous resources to make adaptation planning easier to understand and carry out. These resources range from scientific datasets about future climate conditions and associated climate change effects, to example resiliency strategies and considerations for implementation. The Adaptation Clearinghouse is a good starting point for resources.

In recent years, many resources have emerged to help communities conduct adaptation planning activities, including guidance documents like this APG, information about climate change and its effects, support for developing adaptation strategies, and assistance with implementation. These resources may be online or hard-copy documents, data files, software packages, or other formats. Many technical resources are freely available and easy to obtain. Others may be difficult to find, such as studies and reports on very specific topics. When scoping an adaptation planning effort, consider if there are any technical resources that participants do not have access to. If there are missing technical resources, be sure to devote time in the project to locate them. Regional collaboratives, other communities that have successfully completed adaptation planning, staff at the Integrated Climate Adaptation and Resiliency Program, and regional and state experts on adaptation planning may be able to provide assistance. Reviewing neighboring jurisdictions' vulnerability assessments or adopted adaptation and resilience plans, can also help avoid duplication and maximize resources.

This guide is meant to be a "hub" between the different adaptation planning resources that are available. It is not meant to replace these resources, but to inform about how best to use them and how they relate to each other. The resources below are primary resources available to support local adaptation planning in California; however, there are many more reports, guidance documents, and toolkits available from government and nongovernmental agencies. A full description of each resource can be found in Appendix C.

Practitioners conducting adaptation planning activities should feel free to use any resource that is useful, as long as it meets some basic criteria. It should be prepared by a credible person or organization, and the assertions in the document should be clearly cited. Adaptation planning efforts should always use the most recent and best science and other studies, and practitioners should be wary of resources that disagree with the best available science or do not have credible sources.

State of California Resources

- **Cal-Adapt**. Cal-Adapt is an online resource for viewing and downloading data about projected changes in climate conditions and associated natural hazards.

- **California's Climate Change Assessment**. California's Climate Change Assessment is a series of reports looking at future climate conditions throughout the state and the consequences that may result from them.

- **California Adaptation Clearinghouse (resilientca.org).** The Adaptation Clearinghouse is an online resource with links to California-specific climate adaptation and resilience resources.

- **California Building Resilience Against Climate Effects**. CalBRACE is a project of the California Department of Public Health's Climate Change and Health Equity Program, with an online toolkit to help plan for the public health impacts of climate change and a framework for public health adaptation planning.

- **CalEnviroScreen**. CalEnviroScreen 3.0 is an online screening tool that identifies communities most affected by and vulnerable to the effects of many sources of pollution and population-based disparities.

- **California Heat Assessment Tool (CHAT).** CHAT is an online tool (https://www.cal-heat.org/) that provides detailed information about future extreme heat conditions across California.

- **California Office of Environmental Health Hazard Assessment (OEHHA).** OEHHA assesses the health risks caused by environmental hazards throughout California.

- *California State Hazard Mitigation Plan*. The *California State Hazard Mitigation Plan (SHMP)*, developed by the California Office of Emergency Services, is a summary of the threat posed by hazardous conditions in the state, strategies to mitigate hazardous events, and information about resources to support hazard mitigation.

- **MyPlan**. MyPlan, developed by the California Office of Emergency Services, is an online tool that allows users to enter a location in California, such as a city or specific address, and view the potential hazards that may affect that location.

- **Ocean Protection Council.** California's Ocean Protection Council's Climate Change Program publishes multiple resources meant to assist coastal communities with adapting to ocean-related climate hazards and building resiliency for oceanic assets. Resources include State of California Sea-Level Rise Guidance, studies and reports on ocean acidification and its effects, and opportunities for grant funding on relevant issues. The Ocean Protection Council also works on issues such as marine pollution and sustainable fisheries, which may relate to climate change resiliency for some communities.

- **California Coastal Commission.** The California Coastal Commission developed *Sea Level Rise Policy Guidance* and *Coastal Adaptation Planning Guidance: Residential Development* to provide an overview of the best available science on sea level rise in California and recommend planning and regulatory actions for adaptation.
- **Building Blocks: A Comprehensive Housing Element Guide**. The Building Blocks guide is a comprehensive resource explaining requirements, state of practice, and useful examples under state housing element law.
- **Planning and Investing for a Resilient California.** *Planning and Investing* for a Resilient California, developed by OPR's Technical Advisory Group, is a guidebook for State agencies to integrate climate change considerations into every aspect of government.
- **Sea the Future.** Developed by the Coastal Conservancy, NOAA, and the Sentinel Site Cooperative in the San Francisco Bay Area, the Sea the Future resource provides a platform that highlights all tools available for visualizing sea level rise in California.
- **From Mountains to Cities: Exploring California's Urban Connections to Sierra Nevada Ecosystems.** *From Mountain to Cities*, developed by the Alliance of Regional Collaboratives for Climate Adaptation, describes the interconnections between upstream rural communities, and downstream urban areas.

- **Climate Ready Program.** The Climate Ready Program, administered by the California Coastal Conservancy, provides grant funding to multi-benefit projects that use natural systems to assist communities in adapting to the effects of climate change.

Federal Resources

- **FEMA's** *Local Mitigation Planning Handbook* is a guidance document to help communities across the country develop hazard mitigation plans.
- **US Census Bureau's data.census.gov.** Data.census.gov is an online database hosted by the US Census Bureau that allows users to view, download, and map results from the decennial census, the annual American Community Survey, and other specialized surveys and analyses carried out by the Census Bureau.
- **US Climate Resilience Toolkit.** The US Climate Resilience Toolkit, a program of the United States Global Research Program, is a set of national resources to assist practitioners in conducting climate adaptation work.
- **Regional Resilience Toolkit.** The *Regional Resilience Toolkit*, prepared by FEMA and EPA in partnership with the Metropolitan Transportation Commission/ Association of Bay Area Governments, is a toolkit to help with regional disaster planning across multiple jurisdictions and with non-governmental partners.

Phase 1: Define, Explore, and Initiate

- **NOAA's Digital Coast** is a comprehensive platform for data, tools, and training for communities to address coastal issues.
- **Federal Highway Administration Nature-Based Solutions**. The Federal Highway Administration provides resources, pilot studies, webinars, and examples of nature-based solutions that help protect coastal highways from sea level rise, flooding, and coastal erosion.
- *Guidance for Considering the Use of Living Shorelines*. *Guidance for Considering the Use of Living Shorelines* was developed in 2015 by NOAA to provide insight on implementing a living shoreline along estuarine coasts, bays, and tributaries.

Nongovernmental Resources

- **Climate Adaptation Knowledge Exchange**. The Climate Adaptation Knowledge Exchange (CAKE) was launched in 2010 as a shared knowledge base for managing the natural and built systems in the face of climate change.
- *Guide to Equitable Community-Driven Climate Preparedness Planning*. The *Guide to Equitable Community-Driven Climate Preparedness Planning*, prepared for the Urban Sustainability Directors Network in 2017, provides guidance on how to complete an equitable climate adaptation planning process.
- *Making Equity Real in Climate Adaptation and Community Resilience Policies and Programs: A Guidebook*. This guidebook, developed by the Greenlining Institute, prioritizes the climate adaptation and community resilience needs of frontline communities and offers planning staff a step-by-step process for defining equity in measurable factors in policies and grant programs.
- *Mapping Resilience: A Blueprint for Thriving in the Face of Climate Disasters*. *Mapping Resilience*, prepared by the Asian Pacific Environmental Network, aims to raise the public visibility of the needs of frontline communities within statewide climate adaptation and resilience efforts.
- **Healthy Places Index**. The Healthy Places Index, developed by the Public Health Alliance of Southern California, is an interactive mapping tool that combines 25 community characteristics into a weighted score that ranks census tracts across California for conditions that support health.
- **Community-Driven Climate Resilience Planning Framework**. *Community-Driven Climate Resilience Planning Framework* was developed by the Movement Strategy Center and community-based organizations across the country to strengthen climate adaptation efforts through culturally relevant, democratic processes with meaningful community engagement.
- **Coastal Adaptation Policy Briefs**. The Stanford Center for Ocean Solutions developed a set of Coastal Adaptation Policy Briefs that provide engineering, financial, and legal and regulatory solutions for coastal resources.

- **Tribal Climate Change Adaptation Planning Template**. This toolkit, developed by the Institute for Tribal Environmental Professionals, contains templates and other resources to support tribal climate change efforts.

Step 1.3: Identify Community Climate Effects and Elements

WHAT ARE THE POTENTIAL CLIMATE CHANGE EFFECTS IN THE COMMUNITY?

In this phase, the goal is to compile a preliminary list of potential climate change effects to help support project scoping. The detailed vulnerability assessment is completed in Phase 2, which is when detailed climate data is accessed and analyzed. Not every community will be affected by all potential climate-related hazards and effects, and communities need to select which should be included in the adaptation planning process.

There is no comprehensive list of all climate-related hazards or other effects, but several existing resources provide lists that may be a good starting point (see Table 5). Communities should not be restricted to the lists from these and other resources. Practitioners should consider effects beyond primary climate change consequences, such as the effects on human health hazards or agriculture and forestry pests and diseases. Many consequences of climate change are compound. For example, high wind, hail, lightning, and intense precipitation can all be addressed as a single hazard called "severe weather" or something similar. Similarly, sea level rise, high tides, storm flooding, shoreline and bluff erosion, and storm surge can be collectively called "coastal hazards."

Not all natural hazards are related to climate change. For example, seismic hazards such as earthquakes are not linked to climate change in any meaningful way. However, documents such as general plan safety elements and hazard mitigation plans usually require a discussion of all relevant hazards, not only those related to climate change. If the adaptation planning effort is meant to support one of these documents, hazards that are not climate related should also be included.

Even without non-climatic hazards and secondary consequences linked to climate change, the list of potential effects in climate adaptation planning can be overwhelming, but there are ways to reduce it to a more manageable size. The easiest way to start is to exclude climate change effects that are not expected in the defined planning area. For example, a community in the high desert will probably not need to include coastal hazards. With such a diverse environment throughout California, urban and rural communities respectively face their own unique set of challenges due to climate change.

However, because climate change does not respect geographic boundaries, hazards outside of a defined planning area may still be harmful to that planning

area. For instance, a wildfire can significantly impair regional air quality, block major transportation routes, depress tourism, create refugees, and cause many other impacts that extend beyond the burned area. Communities in the region may be affected even if they have no wildfire-prone areas in their boundaries. It may be worth including hazards that could affect areas of major regional employment or other large economic drivers (such as state or national parks and forests), disrupt key infrastructure (such as roads, rails, and power lines), or affect important resources that a community relies on (such as snowpack that can affect water availability).

If the adaptation planning effort is for a special district, such as a water provider or park district, the number of climate change–related effects may be smaller, depending on the affected buildings, infrastructure, or resources. For example, ocean acidification is likely not a hazard of concern for school districts, even those in coastal communities.

HAZARD	SAFEGUARDING CALIFORNIA	CALIFORNIA FOURTH CLIMATE CHANGE ASSESSMENT	CALIFORNIA STATE HAZARD MITIGATION PLAN
Avalanche			X
Drought	X	X	X
Erosion			X
Extreme cold			X
Extreme heat			X
Flood			X
Fog		X	
Hail			X
Heat waves	X		
Hurricane			
Intense rainstorms		X	
Landslide			X
Lightning			X
Ocean acidification, hypoxia, and warming	X		
Precipitation changes	X	X	
Riverine flooding	X		
Sea level rise	X	X	X
Severe storms and extreme weather	X		
Severe wind		X	X
Severe winter weather			X
Snowpack loss	X	X	
Storm surge			X
Subsidence			X
Warmer temperatures	X	X	
Wildfire	X	X	X

Table title: **TABLE 5.   EXAMPLE LISTS OF CLIMATE-RELATED EFFECTS AND HAZARDS BY SOURCE**

Table 6 presents examples of how some communities and government agencies across California have organized the natural hazards in their climate adaptation efforts.

TABLE 6. EXAMPLES OF LISTS OF CLIMATE HAZARDS IN CLIMATE ADAPTATION EFFORTS	
CITY OF SANTA CRUZ	**SACRAMENTO MUNICIPAL UTILITY DISTRICT**
Sea level rise Flooding Severe storms and weather Coastal erosion Drought Wildfires Ocean acidification Saltwater intrusion Increased temperature Food and fuel/energy availability Coastal habitat loss Altered ecosystems Altered coastal access Altered public trust resources	Ambient temperature rise Drought Wildfires Wind patterns Hydrology Sea level rise and flooding Storm events
TOWN OF MAMMOTH LAKES	**SAN DIEGO COUNTY**
Drought Extreme heat Flooding Forestry pests and diseases Human health hazards Landslides and mudflows Severe weather Severe winter weather Smoke and ash Wildfire	Increased temperatures Precipitation pattern changes Wildfire Flooding Sea level rise

WHAT ARE THE POPULATIONS AND ASSETS IN THE COMMUNITY?

Climate change does not have the same effects in all parts of a community. Some people and physical assets will be affected much more severely than others, and adaptation planning efforts need to evaluate the full range of potential effects. Communities should select the specific populations and assets to assess in order to clearly understand how susceptible different people, places, and systems of the community are to climate change–related hazards and other effects. This allows

the community to develop adaptation policies that respond to specific climate vulnerabilities and build resiliency for the most susceptible people and assets in the community. Similar to identifying climate change effects themselves, the goal here is to compile a preliminary list of potential populations and assets to help support project scoping and the other steps of this phase. The detailed vulnerability assessment, including asset mapping, is completed in Phase 2.

What Is a Physical Asset?

An asset is any feature of a community that is not a person or group of people. Assets include the natural environment as well as the built environment, such as buildings and infrastructure systems.

Populations and assets are usually organized into a handful of categories or sectors. For consistency with Safeguarding California and the California Adaptation Clearinghouse, the APG organizes by 11 sectors:

- Agriculture
- Biodiversity and Habitat
- Emergency Services
- Energy
- Forestry
- Land Use and Community Development
- Ocean and Coast Resources
- Parks and Recreation
- Public Health
- Transportation
- Water

Communities are free to use an organizing approach that better meets local needs. For example, Placer County used the following categories in its adaptation planning efforts for identifying populations and assets:[7]

- Populations
- Infrastructure
- Buildings and Facilities
- Economic Assets
- Ecosystems
- Services

Regardless of how they are organized, virtually all people and assets in a community will be affected by climate change in some way. However, it is not usually feasible to assess the vulnerability of every population group or every asset in the community. At the same time, adaptation planners should ensure that their assessment does not exclude populations and assets that face greater harm or are critical to the community's well-being. When deciding which populations and assets to include, consider these questions:

- Is the population or asset likely to face substantive harm from climate-related effects?
- Is the population or asset likely susceptible to climate-related effects in a unique way, different from most other populations or assets in the community?
- If the population or asset is substantially harmed, are there significant negative consequences to the community? Consider both direct and indirect consequences and remember that consequences may not be evident until well after the harm occurs.
- Is the population or asset important to the community or other stakeholders?
- Is the population or asset necessary to achieve overarching resiliency goals?

If the answer to any of these questions is "yes," the population or asset in question should likely be included.

People

To help decide which groups of people to evaluate for climate-related susceptibility, focus on populations who are likely to face the most harm from climate change. These persons are sometimes said to be "socially vulnerable" or to have "social vulnerability." This does not mean that they lack resilient qualities. A person may be vulnerable to climate-related consequences but have very strong social networks and community involvement, which improve individual resiliency. It also does not mean that they are

responsible for their vulnerability or that they could have made different choices that would have improved their resiliency. Many socially vulnerable people have historically faced, and continue to face, systemic social, economic, and political marginalization and injustice. By identifying groups that are socially vulnerable, communities acknowledge the systemic discrimination that many such persons have faced and seek to correct these wrongs and build resiliency in a manner that is equitable and just.

There are many reasons why some groups of people are more susceptible to climate-related hazards—limited access to financial resources, health challenges or disabilities (physical, cognitive, behavioral, and all other forms), living or working conditions that result in greater exposure to hazard events, physical or social isolation, historical and current marginalization or deprivation of resources, and reduced agency or ability to make decisions. These are all factors that can lead to a greater potential for harm, and many people fall into more than one category.

When selecting populations for an adaptation planning effort, consider the underlying factors that contribute to a group being potentially susceptible. It may help to combine populations that have similar root issues, are likely to face similar levels of vulnerability and may benefit from similar adaptation solutions. For example, it might make more sense for a community to assess low-income households (<80 percent of area median income), very low-income households (<50 percent), and extremely low-income households (<30 percent) in one category. Other communities might benefit from evaluating these three groups separately. A group of potentially susceptible people should not be excluded simply because it represents a small percentage of the total population. However, it may not be possible to accurately assess the vulnerability of a very small number of people. If there are extremely small groups who should be included in the adaptation planning efforts, consider combining them with another group, as appropriate.

Examples of potential populations to include are:[8]

- Chronically ill persons, including those with compromised immune systems
- Foster children
- Incarcerated persons
- Linguistically isolated persons
- Low-income persons
- Persons experiencing homelessness
- Persons in designated disadvantaged communities
- Persons in overcrowded households
- Persons with disabilities

- Persons without access to lifelines
- Persons working outdoors, including farmworkers
- Persons working in industries that may be subject to transition or elimination as a result of climate change
- Renters
- Senior citizens, especially those living alone
- Single female heads of households
- Students
- Tribal communities
- Undocumented persons
- Visitors and seasonal residents
- Young children

For more guidance on selecting populations for climate adaptation planning, and to foster equity in implementation, see the Vulnerable Populations and Equity Checklist appendices of *Planning and Investing for a Resilient California* and the ICARP guide, "Defining Vulnerable Communities in the Context of Climate Adaptation."

Built Assets

There are many reasons to include built assets (buildings, infrastructure systems, developed land uses, important economic drivers, etc.) in an adaptation planning effort. Some built assets are used daily by a large percentage of the population and their damage or loss would significantly disrupt community members. Some built assets provide important services, such as delivering water or electricity. Some employ many people in the community or attract large numbers of visitors, and the community would face economic hardship if the asset had to limit its operations or close. Other built assets, such as local landmarks or historically/culturally significant locations, may not provide tangible benefits but are a source of community pride. Also, consider built assets not only for their day-to-day performance, but for their value during or after a major emergency. For example, people may not think of their local community hall or recreation center as a critical asset, but during emergency events, these buildings can be assembly points, shelters, and bases of operations for response and recovery operations.

When developing the individual categories of built assets, consider whether similar assets should be grouped together or evaluated separately. It may make sense to evaluate separately very important assets or those whose loss would be highly disruptive. For example, communities can generally group roadways into one category, but it may make sense to evaluate each major roadway or highway individually. If a handful of similar built assets face different potential harms (for

example, multiple hospitals or wastewater treatment plants in different parts of the community that are exposed to different climate-related hazards), it might also be helpful to evaluate these separately.

Consider whether it is helpful to evaluate the service a built asset provides separately from the buildings or infrastructure that provide the service. Although they seem related, the two could experience different degrees of vulnerability to natural hazards and require different adaptation solutions. For example, a drought can significantly affect water deliveries in the community, even if it causes no physical damage to the water infrastructure. A hospital might survive a severe storm event with no damage or loss of capacity, but emergency medical response service can be harmed by blocked or damaged roadways.

Examples of potential built asset categories are:

- Airports
- Bridges and tunnels
- Communication systems and service
- Community facilities (recreation centers, libraries, senior centers, etc.)
- Power lines, natural gas pipes, water lines, and related services
- Flood control infrastructure
- Goods movement
- Government offices and government continuity
- Grocery stores
- Major employers and economic sectors
- Major roads and highways, especially evacuation routes
- Medical facilities
- Parks
- Power plants
- Public safety service
- Rail lines
- Schools, including colleges and universities
- Transit stops

Natural and Managed Resource Assets

These assets include natural ecosystems as well as assets that seem natural but are closely controlled by humans, such as agricultural lands and managed timberlands. They can include the land or water itself, the plant and animal communities that

live there, and less tangible benefits such as healthy biodiversity. Paleontological or geological resources could also be included in this category, including those that are extracted for economic benefits.

There are many reasons to include natural and managed resource assets. First and foremost, many of these assets are defining characteristics of the community and the region and are considered invaluable to the people who live there. In a state with such diverse and prized natural systems, natural and managed resource assets can have tremendous symbolic value and be an enormous source of pride. In many communities, these assets directly or indirectly employ large numbers of people in recreation, tourist-serving activities, agriculture and food processing, and other economic sectors. Natural and managed resource assets can also provide critical ecosystem services, such as dunes and wetlands that help buffer coastal communities from storm surges and high tides.

Examples of potential natural and managed resource assets are:

- Beaches
- Chaparral
- Endangered, threatened, and sensitive species
- Farms, orchards, and vineyards
- Forests
- Greenbelts
- Hiking and biking trails
- Historic and cultural resource areas
- Keystone species
- Lakes and rivers
- Livestock
- Meadows and grasslands
- Metal, stone, petroleum, and other extracted resources
- Pastures
- Scenic views or ridgelines
- State and national parks, forests, wilderness areas, and other protected locations
- Timber resources
- Wetlands
- Wildlife corridors

For guidance on engaging the community in identifying assets and participatory mapping exercises, see Phase 2, Step 2.5, Outreach and Engagement.

FEMA LHMP Guidance for Identification of Community Elements

The list of example community element categories to consider in the vulnerability assessment is based on FEMA's LHMP Guidance.[9] Identification of community categories should consider both existing and planned community developments.

- **Essential Facilities.** Hospitals and other medical facilities, police and fire stations, emergency operations centers and evacuation shelters, resilience hubs and cooling centers, and schools. These facilities are essential to the health and welfare of the whole population and are especially important following climate-influenced hazard events.

- **Transportation Systems.** Airways (airports, heliports, highways), bridges, tunnels, roadbeds, overpasses, transfer centers, railways (tracks, tunnels, bridges, rail yards, depots), and waterways (canals, locks, seaports, ferries, harbors, drydocks, piers).

- **Lifeline Utility Systems.** Water, wastewater, transportation fuels, natural gas, electric power, solid waste, and telecommunication systems.

- **High-Potential-Loss Facilities.** Nuclear power plants, dams, and military installations, where damage would have large environmental, economic, or public safety consequences.

- **Hazardous Material Facilities.** Facilities housing industrial/hazardous materials such as corrosives, explosives, flammable materials, radioactive materials, and toxins.

- **Vulnerable Populations.** Non-English-speaking people or elderly people who may require special response assistance or special medical care after a climate-influenced disaster.

- **Economic Elements.** Major employers and financial centers that could affect the local or regional economy if disrupted.

- **Areas of Special Consideration.** Areas of high-density residential or commercial development where damage could result in high death tolls and injury rates.

- **Historic, Cultural, and Natural Resource Areas.** Areas that may be identified and protected under state or federal law.

- **Other Important Facilities.** Facilities that help ensure a full recovery from or adjustment to changed climate conditions. These would include government functions, major employers, banks, and certain commercial establishments such as grocery stores, hardware stores, and gas stations.

Step 1.4: Prepare an Equitable Outreach and Engagement Approach

The APG recommends integrating community outreach and engagement into all phases of the adaptation planning process. This will build trust between the core planning team and community stakeholders and develop a plan that has collective support. Outreach and engagement should be considered carefully and budgeted appropriately. The approach should include stakeholders within the organization or agency leading the adaptation planning process, and those external to the organization or agency.

Outreach for Local Hazard Mitigation Plans

LHMPs are required to include an opportunity for the public to comment on a plan during the drafting stage and prior to plan approval. A necessary characteristic of a diligent public process is inviting community stakeholders to provide input throughout the planning process and allowing for adequate time and resources to incorporate their comments.

Many resources are available to support preparation of an outreach and engagement approach.

- The *Regional Resilience Toolkit* provides guidance on principles for successful engagement and tactical tools that are applicable to the APG's adaptation planning process.
- *California's Fourth Climate Change Assessment Summary Report from Tribal and Indigenous Communities* details how to better partnership with tribal communities, provides case studies, and recognizes traditional ecological knowledge. All local agencies should conduct intentional outreach to engage or partner with tribal communities. The Governor's Tribal Advisor Office has links to numerous state agencies' policies or procedures and some additional helpful resources.
- The Government Alliance on Race and Equity has resources available to local governments to help staff to address race, equity, and justice.[10]
- The Urban Sustainability Directors Network has also developed guidance related specifically to climate risk and vulnerable populations. See Figure 7 for an example.[11]
- The Local Government Commission's guidebook *Participation Tools for Better Community Planning* provides an overview of public participation tools that can help communities plan for health-promoting land use and transportation, with a focus on lower-income, underserved communities, along with an examination of the value of resident involvement and the key principles for successful community planning.[12]
- The Institute for Local Government offers an Inclusive Public Engagement toolkit that includes tipsheets and resources to effectively plan and implement inclusive engagement strategies.
- The California Environmental Justice Alliance (CEJA) and PlaceWorks' *SB 1000 Implementation Toolkit* provides best practices for promoting meaningful community engagement throughout environmental justice planning processes, and guidance on how to develop environmental justice objectives and policies in general plans. Many of the practices presented are applicable to engaging communities on climate adaptation.
- From Community Engagement to Ownership, a project of the Urban Sustainability Directors Network, offers case studies and best practices for collaborative governance, including an expanded spectrum of community engagement to ownership prepared by the Facilitating Power and Movement Strategy Center.

As mentioned in Step 1.2, Assemble Project Team(s) and Resources, it can be beneficial to assemble a core project team with a mix of representatives from various government departments, community-based organizations, public institutions, hospitals, colleges, utility companies, and/or major employers. Team members play

a critical role in the process, providing institutional and technical knowledge and supporting external stakeholder outreach and engagement.

Additionally, it is helpful if all members of the core planning team are trained in outreach before engaging stakeholders. Topics such as cultural humility, racism, and systems of injustice are issues that some may not be used to addressing in relation to climate risk, but it is critical to understand those power dynamics when working with vulnerable populations. For example, Figure 7 shows how populations deal with underlying structural root causes, social factors, and biological factors that could contribute to increased sensitivity to climate change. Understanding these causes and factors before the outreach process helps create avenues of communication and builds trust between the project team and the community.

The Government Alliance on Race and Equity is one organization that has resources available to local governments to help staff understand race, equity, and justice and to integrate it into their work.[13]

Figure 7.   Root Causes and Factors Affecting Sensitivity to Climate Change

ROOT CAUSES

- Racial segregation
- Poverty
- Income inequality
- Lack of living wage jobs
- Gaps in educational opportunities and attainment
- Concentrated neighborhood disinvestment
- Political disenfranchisement and low social capital
- Increased neighborhood violence and crime

SOCIAL FACTORS

- Ability to afford basic necessities and resources
- Access to affordable and quality housing
- Access to reliable and affordable transportation
- Access to affordable health care
- Access to green spaces, green infrastructure, and tree cover
- Linguistic isolation
- Social cohesion
- Residential location

BIOLOGICAL FACTORS

- Age
- Chronic and acute illnesses
- Mental and physical disabilities
- Overall health status

INCREASED SENSITIVITY TO CLIMATE CHANGE

Source: Tina Yuen, Eric Yurkovich, Lauren Grabowski, and Beth Altshuler, Guide to Equitable Community-Driven Climate Preparedness Planning, prepared for Urban Sustainability Directors Network, May 2017, page 12, accessed November 2019.

After assembling the core planning team, it is essential to enlist residents, businesses, students, and other community groups because they have knowledge, information, and ideas that local governments may not know or anticipate. Community members most affected by climate issues can collaborate on solutions, which can result in more effective implementation. It is key to empower community member that they have a sense of co-ownership in the planning process.

The project team and/or consultant should prepare an approach or plan for community and stakeholder engagement, with support from the advisory group if one is assembled. The plan can be simple, brief, and flexible to adapt over time. Ideally, as noted in the *Regional Resilience Toolkit*, the outreach and engagement plan should:

- Identify stakeholders (stakeholder mapping is one method).
- Determine culturally specific outreach needs and strategies.
- Link planning and outreach messages to community values and needs.
- Develop outreach goals for each stakeholder group and the broader community.
- Establish how to engage individuals and groups best and specify objectives and roles.
- Define the specific methods to most effectively engage each group: in a meeting, via digital communications, one-on-one, or through partners or other groups.
- Detail how these activities will integrate with other planning efforts.
- Determine need, objectives, and composition for an advisory group.
- Determine the focus and purpose of each event, meeting, and input opportunity.
- Provide a schedule with objectives and roles for each activity.[14]

The *Regional Resilience Toolkit* includes a sample outline for outreach and engagement plan and tools and worksheets to support outreach tools, materials, activities, and meetings.

Institute for Local Government's Principles of Outreach and Engagement[15]

- **Inclusive.** The planning and design of the engagement process includes input from appropriate local officials as well as from members of the community.

- **Transparency.** There is clarity and transparency about public engagement process sponsorship, purpose, design, and how decision makers will use the process results.

- **Authentic intent.** The process generates public views and ideas to help shape local government action or policy, rather than persuade residents to accept a decision that has already been made.

- **Breadth of participation.** The public engagement process includes people and viewpoints that reflect the local agency's population of affected residents.

- **Informed.** Participants in the public engagement process have information consistent with the work that local governments are being asked to do.

- **Accessible.** Public engagement processes are broadly accessible in terms of location, time, translation, childcare, food, and ADA compliance.

- **Appropriate.** The public engagement process uses one or more discussion formats that are responsive to the needs of identified participant groups, and encourages full, equitable participation.

- **Feedback.** Local officials communicate ultimate decisions back to process participants and the broader public, with a description of how the public input was considered and used.

- **Evaluation.** Planners and participants evaluate each public engagement process and activity so that the process is iterative and shared lessons are applied to future engagement efforts.

PUBLIC-PRIVATE PARTNERSHIPS

Local agencies can engage with the business community to support adaptation planning and implementation. Protecting a healthy local economy is a critical part of maintaining a community's long-term resilience, and many businesses recognize the threat that climate change may pose to their activities and financial health. Businesses also can provide increased investments and other resources that may not always be available to individual communities. This creates opportunities for businesses and local governments to join or create public-private partnership to address resilience issues. Opportunities for public-private partnerships include creating an economic working group or advisory body, establishing training and capacity-building opportunities such as resilience or continuity planning workshops, and setting adaptation standards for permitting new private developments. Communities can join with local businesses as well as larger companies that may be able to meaningfully contribute to local efforts. Local governments should consider how best to use public-private partnerships to support comprehensive community adaptation efforts, because businesses may be able to bolster resilience for other stakeholders and members of the community. Local governments can consider how best to weigh the needs of businesses along with the requirements of other community members.

Investing in Our Future

The Capital Regional Climate Readiness Collaborative is exploring strategies to bring economic sectors such as agriculture, manufacturing, government, professional services, and technology into climate resilience planning efforts. Working with these businesses is essential to preserve economic vitality of the region in the face of water scarcity, heat waves, extreme weather, and other climate change hazards. The Capital Regional Climate Readiness Collaborative coordinates with local and regional businesses to plan and prepare for disasters, invest in climate-smart strategies, promote green jobs, and encourage diversity in supply chains to increase economic resilience.

STAKEHOLDER MAPPING

The engagement process should be inclusive and multidisciplinary. It should include people at varying levels of authority, including those empowered to make recommendations and decisions and representatives of governmental and nongovernmental organizations. Stakeholder identification and mapping supports an equitable outreach and engagement approach. Stakeholder mapping is the process of visualizing relationships and prioritizing engagement efforts through understanding perspectives and interests in the community. The *Regional Resilience Toolkit* includes template worksheets to do this.[16] For each stakeholder, the project team should decide who should be involved; what their role will be in the process and the plan implementation; and how, when, and how often they should be engaged (see Figure 8).

Furthermore, stakeholder mapping should list vulnerable populations to assess how they will be involved. As mentioned in Step 1.3, vulnerable populations can include chronically ill persons, foster children, incarcerated persons, linguistically isolated persons, low-income persons, persons experiencing homelessness, persons in designated disadvantaged communities, persons in overcrowded households, persons with disabilities, persons without access to lifelines, renters, senior citizens, single female heads of households, students, tribal communities, undocumented persons, visitors and seasonal residents, and young children.

Figure 8.   Regional Resilience Toolkit's Identity Stakeholder and Stakeholder Mapping

Appendix B Step 1. Engage Worksheets and Tools

1.1 Identify Stakeholders

Agency or Entity	Contact	Reason for including stakeholder
Project Team		
Comprehensive planning		
Land use		
Transportation		
Public works		
Local emergency planning/ management		
Geographic information systems		
Advisory Group		
Local Agencies		
Building code enforcement		
Fire departments/districts		
Floodplain administration		
Parks and recreation		
Public information office		
Natural and cultural resources		
Stormwater management		
Transportation (roads/bridges)		
Finance		
Economic development		
Housing		
Health and social services		
Solid waste management		
Other local agencies that may have a stake in resilience		

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Appendix B Step 1. Engage Worksheets and Tools

1.2 Stakeholder Mapping

High Influence/Impact, Low Interest: *Keep Satisfied, Targeted Engagement*	High Influence/Impact, High Interest: *Manage Closely, Engage Deeply*
Low Influence/Low Impact, Low Interest: *Monitor and Share Information*	Low Influence/Low Impact, High Interest: *Keep Informed, Consult*

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Source: U.S. Department of Homeland Security, U.S. Environmental Protection Agency, and Association of Bay Area Governments, Regional Resilience Toolkit, July 2019.

CREATING OUTREACH ACTIVITIES

Keeping stakeholder mapping in mind is important for each outreach and engagement activity. Moreover, the core planning team should determine what they are trying to achieve and help manage what the public should expect. It is helpful to think of each outreach and engagement activity as part of a spectrum. See Table 7 for the International Association of Public Participation (IAP2) Spectrum.[17, 18]

The IAP2 spectrum is a theoretical model for varying levels of participation and engagement and is not a specific recommendation for any one set of activities or goals. Local agencies and communities need to decide what level of engagement is appropriate to facilitate community participation in decision-making.

Core activities and characteristics necessary to building a diligent and robust public engagement process include:

- Providing educational opportunities.

- Soliciting community input.

- Maintaining a direct method of communication with the community specifically for the climate adaptation planning effort.

Outreach can include, but is not limited to, meetings for specific topics or geographic areas, online engagement, roundtables, forums, community festivals, workshops, or pop-up events.

TABLE 7. IAP2 PUBLIC PARTICIPATION SPECTRUM					
	INFORM	**CONSULT**	**INVOLVE**	**COLLABORATE**	**EMPOWER**
Public Participation Goal	To provide the public with balanced and objective information to assist them in understanding the problems, alternatives, and/or solutions.	To obtain public feedback on analysis, alternatives, and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision, including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
Promise to the Public	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for direct advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

Source: IAP2, Public Participation Spectrum, 2018.
Note: Also see From Community Engagement to Ownership: Tools for the Field with Case Studies of Four Municipal Community-Driven Environmental and Racial Equity Committees.

Reaching All Populations

- Understand the local capacity of residents and use their networks and expertise to make information relevant to them.

- Communicate in easy-to-follow phrases, not technical jargon.

- Use relevant publicity like ads in local radio, TV channels, social media platforms, community calendars, e-newsletters, and newspapers.

- Have various options for meeting times during the day, evening, or weekend.

- Plan meetings in places that are familiar, such as libraries, community centers, farmers markets, churches, and schools.

- Host meetings in locations that easily accessible by all modes of transportation.

- Provide childcare, kids' activities, and youth engagement as part of all outreach activities.

- Provide multilingual translation in all materials and meetings.

- Offer travel stipends, if possible, for attendees of the meeting.

- Host participatory issue forums linking relevant issues, such as the connection between affordable housing and climate resilience.

- Be mindful of the mental health effects, including anxiety and distress about the implications of climate change. Identify healing and creative practices, such as meditation and art, to interweave throughout the process to support healthy participation among community members.

- Partner with and offer a stipend to local community-based organizations to raise awareness and do grassroots organizing in their communities.

- Partner with businesses or business associations on outreach events and coordination to expand community reach, decrease outreach costs, and increase business owner and staff participation.

- Offer alternatives to in-person meetings, especially when in-person meetings increase risk of exposure to harm. Alternatives include online engagement via webinars, virtual or remote workshops, and social media, among others.

Phase 1 Wrap-Up

This initial phase of the adaptation planning effort helps establish what the adaptation work involves and why communities are conducting it. This phase also includes figuring out who will be part of the work, the tools and resources available, and the types of analyses that the community will conduct. Making these decisions at the beginning of the process helps make the rest of the work more efficient and puts all participants on the same page. With the scoping work out of the way, communities can move on to the next phase of adaptation planning, which is assessing vulnerability, as discussed in the following chapter.
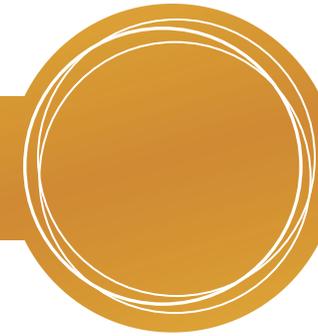
PHASE 2: ASSESS VULNERABILITY

Phase 1 developed the scope, goals, and team for building a community's resilience to climate change. Phase 2 involves a vulnerability assessment that identifies and characterizes the climate hazards and other climate effects a community faces.

This guidance uses the latest and best available knowledge from state and federal resources about designing and completing vulnerability studies. The approach is designed to ensure that the resulting vulnerability assessment meets Safety Element requirements in California Government Code § 65302(g)(4), as updated by SB 379 and SB 1035. It is also designed so that users can easily integrate the vulnerability assessment into a local hazard mitigation plan (LHMP). This approach to a vulnerability assessment mostly aligns with FEMA's risk assessment process in Task 5 of *Local Mitigation Planning Handbook*, and the APG notes when this is the case. The Phase 2 vulnerability assessment is more in-depth than in other planning processes in order to create a more comprehensive assessment of vulnerability to climate change effects.

Phase 2 has four steps for completing the vulnerability assessment—exposure, sensitivity and potential impacts, adaptive capacity, and vulnerability scoring—and a final step for outreach and engagement (see Figure 9). This phase gives a better understanding of a community's major climate vulnerabilities, and which vulnerabilities to focus on in Phase 3. Steps 2.1 to 2.4 in this phase should be followed sequentially (see Figure 10). Step 2.5 provides options for outreach and engagement that can be integrated throughout the phase or as a step at the end of the phase.

Figure 9. Steps in Phase 2

STEP 2.1 EXPOSURE

Confirm hazards

▼

Describe historical hazards

▼

Describe how hazards are expected to change

▼

Map hazards

STEP 2.2 SENSITIVITIES & POTENTIAL IMPACTS

Confirm community populations and assets

▼

Identify historical and potential future climate impacts

▼

Identify potential climate impacts of greatest concern

STEP 2.3 ADAPTIVE CAPACITY

Review documents to collect information on adaptive capacity

▼

Interview local agencies on ability to enhance adaptive capacity

STEP 2.4 VULNERABILITY SCORING

Summarize vulnerability

▼

Score vulnerability

STEP 2.5 OUTREACH AND ENGAGEMENT

Phase 2: Assess Vulnerability

Figure 10. Vulnerability Assessment Steps Defined

EXPOSURE

Presence of systems in areas that are subject to climate hazards

Example: A building located in a coastal area projected to experience flooding during 100-year storm events by mid-century

SENSITIVITY

Level to which a system would be affected by exposure to a changing climate

If floodwaters enter and remain in the building, the building floor will become damaged

POTENTIAL IMPACT

Potential effects on a system based on its exposure and sensitivity to a climate hazard

During a mid-century 100-year storm, the building may become flooded and the floor may become damaged

ADAPTIVE CAPACITY

The ability to moderate harm or exploit opportunities

The building's emergency response plan ensures that sandbags are placed around the building prior to storms

VULNERABILITY

The degree to which natural, built, and human systems are susceptible to harm

During a mid-century 100-year storm, the building is not expected to experience damage if floodwaters do not exceed sandbag heights, but once floodwaters exceed sandbag heights, the building is expected to experience flooding and flood damage

Step 2.1: Exposure

The goal of this step is to characterize the community's exposure to current and projected climate hazards. Materials prepared for this purpose include:

- A final list of climate change effects of concern.
- An overview of major historical hazard events and the consequences to the community.
- A description of how each identified climate change effect is projected to change over the analysis period.
- Map of projected change in each identified climate change effect.

Climate change–related effects will likely change as the climate warms. The impact to a community depends in part on that community's exposure.

STEP 2.1A: CONFIRM HAZARDS AND OTHER EFFECTS

Phase 1 identified a list of climate change effects. Talking to colleagues and engaging with community members can garner additional details for this list. (See Step 2.5, Outreach and Engagement, for ideas on stakeholder interviews and storytelling.) They can also validate the initial list and potentially add new effects. Tables 5 and 6 can be helpful when exploring examples of relevant climate change effects.

Describing Hazards for Local Hazard Mitigation Plans

To integrate the assessment into an LHMP, this exposure step can be integrated with the hazard descriptions in the FEMA risk assessment.

The regional assessments in the most recent *California Climate Change Assessment* have information about what effects are relevant in different communities. The different regional reports provide an overview of current and projected climate change effects throughout California and point to additional detailed studies on specific climate change effects and impacts.

STEP 2.1B: DESCRIBE HISTORICAL HAZARDS

The historical record of the hazards in a community provides context for assessing the projected changes in hazards and other climate change–related effects. It is important to describe the histories of these hazards, including when they occurred, the areas where they occurred, and their magnitude (e.g., depth of flooding, area burned, temperature). Table 8 shows an example from San Diego County's 2017 LHMP that inventories the history of wildfires in the county.

TABLE 8. EXCERPT OF WILDFIRE HISTORY FROM SAN DIEGO COUNTY'S LHMP			
FIRE	**LOCATION**	**DATE**	**ACRES BURNED**
Conejos Fire	Cleveland National Forest	July 1950	62,000
Laguna Fire	Laguna Mountains	October 1970	190,000
Harmony Fire	Carlsbad, Elfin Forest, San Marcos	October 1996	8,600
La Jolla Fire	Palomar Mountain	September 1999	7,800
Viejas Fire	Alpine	January 2001	10,353
Pines Fire	Julian, Ranchita	July 2002	61,690
Cedar Fire	Pine Hills, Ramona, Poway	October 2003	280,278
Mataguay Fire	Cleveland National Forest	July 2004	8,867
Harris Fire	Potrero	October 2007	90,440
Bernardo, Poinsettia & Cocos Fires	Rancho Bernardo, Carlsbad, San Marcos	May 2014	26,000
Source: San Diego County OES, 2017, Multi-Jurisdictional Hazard Mitigation Plan, https://www.sandiegocounty.gov/content/dam/sdc/oes/emergency_management/HazMit/2017/County-HazMit-Plan-2017-Sections-1-7-with-Appendixes-BOS-Approved.pdf.			

A historical hazard inventory is a good tool for giving the community a solid context and engaging the public to gain a better understanding of broader impacts on the community. The lived experience of community members can help build support for future adaptation actions. See Step 2.5, Outreach and Engagement, for more information.

Existing documents, such as LHMPs and previous local or regional climate vulnerability assessments, may provide enough information about historical hazard trends and events to complete this step. For greater detail, whether qualitative or quantitative, consider these sources for:

- **Coastal and storm hazards.** Sea level and storm historical data are available through the National Oceanic and Atmospheric Administration's sea level trends and storm events databases.

- **Temperature.** The U.S. Climate Resilience Toolkit's Climate Explorer has local data for both historical and projected data related to temperature trends.

- **Precipitation and snowpack.** The California Department of Water Resources provides historical data on annual precipitation and snow water equivalents by region through the California Data Exchange Center.

> ## Different Levels of Detail for Different Plans
>
> Exposure assessments have varying levels of detail. An LHMP effort should collect data for location, extent, and previous occurrences for each hazard. For other reporting efforts, such as a safety element, a qualitative description of the community's hazard history may be more appropriate.

- **Drought.** The National Drought Mitigation Center has historical records for drought events by county through the U.S. Drought Monitor.

- **Wildfires.** The California Department of Forestry and Fire Protection (CAL FIRE) has fire incident perimeter data online dating back to 1950, and historical reports on wildfire statistics.

Another helpful list of historical hazard resources for flooding and fires is in the Safety Element Completeness Checklist in OPR's *General Plan Guidelines*.

Phase 2: Assess Vulnerability

STEP 2.1C: DESCRIBE HOW CLIMATE HAZARDS AND OTHER CLIMATE CHANGE EFFECTS ARE PROJECTED TO CHANGE

Building on the historical characterization, develop projections for how each local hazard is expected to change over the identified time horizon. For each climate change effect, characterize the projected change in magnitude, frequency, seasonal timing, duration, inter-annual variability, and geographic extent.

The Step 2.1b historical inventory may reveal trends in climate hazards and other climate change effects that serve as useful context. Existing literature may also have more information about general projected trends—such as local LHMPs, previous local or regional climate vulnerability assessments, the latest *California Climate Assessment*, or resources in the Adaptation Clearinghouse.

Projection data is also accessible through Cal-Adapt. Cal-Adapt and other sources present a range of projection scenarios and climate models for different effects. Considering a range of scenarios and models can help staff think through variations in the severity of climate change effects and account for projection uncertainties. Data outside of Cal-Adapt may be more helpful for some climate change effects, such as information on heat-related public health rates, which can be accessed from the California Heat Assessment Tool (CHAT).

SELECTING CLIMATE CHANGE PROJECTION PARAMETERS

Cal-Adapt and other resources provide climate projections for an array of greenhouse gas (GHG) emissions scenarios, climate models, and time frames. These different scenarios, models, and time frames present a wide range of results. Therefore, when retrieving projections, it is helpful to select the appropriate parameters for local circumstances.

Selecting emission scenarios. GHG emissions scenarios reflect different projections for how global emissions and atmospheric GHG concentrations may change over time. The latest scenarios are representative concentration pathways (RCPs), and Cal-Adapt provides projections for a low emissions scenario (RCP 4.5) and a high emissions scenario (RCP 8.5). The Governor's Office of Planning and Research (OPR) recommends that agencies use RCP 8.5 for analyses considering impacts through 2050 because there are minimal differences between emissions scenarios during the first half of the century.[1] For analyses considering impacts beyond 2050, OPR recommends selecting warming scenarios on a case-by-case basis. For a more conservative approach to a given community element, consider using only RCP 8.5. For a less conservative approach, use both RCP 4.5 and RCP 8.5. Which approach will be most useful in selecting emissions scenarios depends on a given community element's risk and criticality.

Regional Variations in Climate Change Effects

Phase 1, Step 3 of this guide presented some of the common variations in hazards and other climate change–related effects in California communities. Climate change–related effects vary significantly throughout California, mirroring our state's diverse climate, topography, and ecology. For example, the consequences of climate change that are important for coastal communities, like sea-level rise, may not be relevant for inland communities. Communities in northern California may be less exposed to drought than those in southern California. Regional reports from the California Climate Change Assessment are helpful resources for more information about region-specific effects of climate change.

Selecting climate models. For each GHG emissions scenario, retrieve projections from a range of global climate models (GCMs), which vary based on the different modeling assumptions. The most current GCMs come from the Coupled Model Intercomparison Project, version 5 (CMIP-5), developed to support the Intergovernmental Panel on Climate Change. Though using all 32 CMIP 5 GCMs is ideal for a comprehensive assessment, there are subsets of 10 and 4 GCMs that closely simulate California's climate and can be used in studies that cannot accommodate all 32 models.[2, 3] Cal-Adapt's default settings provide outputs for these subsets of 10 and 4 models, depending on the hazard.[4] Considering a range of climate model outputs—in addition to an ensemble average—can be helpful in getting a fuller picture of potential future conditions. State guidance, including from the *Safeguarding California Plan* and the California Ocean Protection Council, recommends evaluating a range of future climate scenarios appropriate for planning decisions and respective risk aversion level. For example, high-end scenarios (e.g., H++ scenario for sea-level rise) are recommended for use with high-stakes decisions where underaccounting for projected changes could lead to significant financial or environmental impacts or public health and safety consequences.

It is also important to retrieve climate projections for the appropriate time frame. After selecting the historical baseline and future time horizon of interest, pull climate data for a multi-decade period (usually 20 or 30 years) centered on the year of interest. For example, if the year of interest is 2050, consider pulling projections for 2040 to 2060 or 2036 to 2065. Cal-Adapt uses 1961 to 1990 as the default baseline period; 1986 to 2005 is another common baseline period. Multidecade averages account for interannual variability and appropriately characterize the climate norm for the selected historical context and future time horizon.[5]

Accessing Climate Hazard Projection Data with Cal-Adapt

Cal-Adapt is an online resource that provides quick and easy access to downscaled climate project data. An array of climate models and emissions scenarios offer climate projections for the major stressors facing California, including:

- Temperature averages and extremes
- Precipitation averages and extremes
- Sea-level rise
- Wildfires
- Drought

Cal-Adapt provides users with easily accessible projections and more detailed downloadable data to support a range of needs.

STEP 2.1D: MAP HAZARDS AND OTHER CLIMATE CHANGE–RELATED EFFECTS

Mapping climate projection data helps with visualizing the populations and assets that are projected to be exposed to the effects of climate change. Depending on a community's needs and staff capacity, some mapping options are printed maps, free computer mapping tools like Google Maps, or dedicated Geographic Information Systems (GIS).

In cases where mapping is not particularly informative, other methods for visualizing climate trends can be relevant to a community. For example, consider projecting the frequency of heat waves (i.e., multiple extreme heat days over a given threshold) over the Step 2.1c time horizons, and see how this frequency changes over time. Cal-Adapt includes a variety of visualizations to inform an exposure analysis and has downloadable data to allow visualizations in other software (e.g., Excel charts).

In some cases, quantitative datasets are not available for relevant hazards. In this case, it is still useful to provide a narrative description of how (and whether) exposure varies across the community, and the degree to which community assets are projected to be exposed. For example, although there are spatial datasets showing today's inland flooding and landslide risks, there are not widely available spatial datasets related to future inland flooding and landslide risks. For these hazards, it is still useful to explain how risks may change in the future due to changes in climate.

For more detailed mapping, GIS data sources for climate hazard projections include:

- **Coastal hazards.** Sea the Future is a good resource for understanding the various sea level rise and flood visualization tools available. While there are a number of options, all with their own benefits and limitations, organizations may wish to consider two in particular. The US Geological Survey's Coastal Storm Modeling System (CoSMoS) has maps of coastal flooding under various sea level rise scenarios, storm conditions, and erosion. In the San Francisco Bay Area, the Adapting to Rising Tides (ART) program has detailed sea level rise mapping for several different scenarios. Unlike other sea level rise mapping programs, CoSMoS and ART programs provide both sea level rise and coastal storm scenarios on a simple online platform without the need for specialized software. Both also provide detailed information that is not always available from other mapping sources.
- **Temperature, precipitation, hydrologic variables, and wildfires.** Cal-Adapt's downloadable data is available in NetCDF, TIFF, and other formats.

If the planning team has GIS capabilities, it can overlay these climate change effect projections with community assets. Consider mapping climate change effects with utility assets, transportation assets, hospitals, telecommunication assets, public spaces, populations, and other assets. Another option is to map climate change effects with indices of social vulnerability—such as CalEnviroScreen and Healthy Places Index—to learn more about projected exposure in disadvantaged communities.

Step 2.2: Sensitivity and Potential Impacts

The goal of Step 2.2 is to characterize past and potential future climate impacts to community populations and assets. Materials produced in this step include:

- A final list of community populations and assets that are sensitive to the community's climate change effects.
- A list of historical and potential future climate impacts to community elements.
- A list of potential climate impacts of greatest concern.

Describing Hazards for Local Hazard Mitigation Plans

To integrate the vulnerability assessment into an LHMP, this exposure step can be incorporated into the FEMA risk assessment when identifying community assets.

STEP 2.2A: CONFIRM COMMUNITY POPULATIONS AND ASSETS

Create a list of community elements exposed to the relevant climate hazards. The community elements screening in Step 1.3 of Phase 1 should be helpful with completing this step.

Depending on the outcomes of Step 2.1, consider limiting the scope to critical community elements. A broad scope of assets can dilute the focus of the vulnerability assessment and create less-actionable outcomes. A more limited scope allows more concentrated effort on later steps—such as Phase 3 and Phase 4—that focus on mitigating impacts. Revisit Phase 1 to consider the resilience goals in identifying critical community assets. These goals can help inform criteria for identification, such as a focus on enhancing safety or mitigating impacts to the community economy.

STEP 2.2B. IDENTIFY CLIMATE IMPACTS TO COMMUNITY POPULATIONS AND ASSETS TO DETERMINE WHICH ARE SENSITIVE TO CLIMATE CHANGE EFFECTS

Projected impacts from climate hazards should be the primary concern in a vulnerability study. Climate change will exacerbate many hazards, so future climate impacts have the potential to be more severe than historical ones. Climate change will also generate impacts that may be entirely new to some communities. However, examining historical climate impacts is useful for establishing context and better understanding present-day vulnerability. As a result, in this step, consider both historical and projected impacts by collecting information on past impacts and augmenting this with more forward-looking information. Specifically:

Finding Impact Data for Specific Incidents

Impact data for some historical incidents is available through public data sources, including:

- U.S. Energy Information Administration (EIA) Electric Power Monthly for electricity outages

- CAL FIRE's Incident Reporting Collection

- Cal OES's Hazardous Material Spill Notifications

1. Conduct desk research on historical climate impacts.
2. Conduct desk research on potential future climate impacts.
3. Engage stakeholders in order to deepen understanding of past and potential future impacts, such as with stakeholder interviews and participatory asset mapping.
4. Summarize findings on potential future climate impacts.

1. Desk Research on Historical Climate Change Effects

Building on the data and analysis from in Step 2.1b, collect information on how climate-related effects have historically impacted specific community assets and the community as a whole—for example, by reviewing existing reports and databases. Publicly available data often has impact data for specific events. For example, the EIA publishes electricity outage duration, power loss, and customers impacted as part of the Electric Power Monthly reports.[6] If reports and databases are not available, stakeholders may be able to fill in historical information. Revisiting the example in Step 2.1b and Table 8, San Diego County collected information on the facilities impacted and lives lost in historical wildfire events as part of their LHMP (Table 9).

TABLE 9.	EXCERPT OF HISTORIC WILDFIRE IMPACTS FROM SAN DIEGO COUNTY'S LHMP					
HEADING	**LOCATION**	**DATE**	**ACRES BURNED**	**STRUCTURES DESTROYED**	**STRUCTURES DAMAGED**	**DEATHS**
Conejos Fire	Cleveland National Forest	July 1950	62,000	Not Available	Not Available	0
Laguna Fire	Laguna Mountains	October 1970	190,00	382	Not Available	5
Harmony Fire	Carlsbad, Elfin Forest, San Marcos	October 1996	8,600	122	142	1
La Jolla Fire	Palomar Mountain	September 1999	7,800	2	2	1
Viejas Fire	Alpine	January 2001	10,353	23	6	0
Pines Fire	Julian, Ranchita	July 2002	61,690	45	121	0
Cedar Fire	Pine Hills, Ramona, Poway	October 2003	280,278	5,171	63	14
Mataguay Fire	Cleveland National Forest	July 2004	8,867	2	0	0
Harris Fire	Potrero	October 2007	90,440	255	12	5
Bernardo, Poinsettia &Cocos Fires	Rancho Bernardo, Carlsbad, San Marcos	May 2014	26,000	65	19	0
Source: San Diego County OES, 2017, Multi-Jurisdictional Hazard Mitigation Plan, https://www.sandiegocounty.gov/content/dam/sdc/oes/emergency_management/ HazMit/2017/County-HazMit-Plan-2017-Sections-1-7-with-Appendixes-BOS-Approved.pdf						

In addition to mortality/morbidity and property damage, impacts from future climate change may include:

- Loss of service from critical utilities (e.g., energy, water, and wastewater).
- Disruptions to essential facilities (e.g., hospitals, schools, emergency services).
- Damage to facilities from coastal and inland flooding.
- Loss of housing (e.g., loss of areas available for housing, loss of existing limited housing stock, including affordable housing generally and specifically in communities experiencing significant housing shortages).
- Disruptions to a transportation system that can affect accessibility to some areas, or that can adversely affect drive or ride times (e.g., a landslide or flood that temporarily closes off access to an area; increased transit time on buses during precipitation events; floods or wildfires that shut down transit stops or lines).
- Impacts to local community health (e.g., number of hospital visits related to hazard events, air quality index ratings during wildfires, fatalities).
- Degradation or loss of natural assets, local ecosystems, and biological communities, including those that provide ecosystem services. For example, the *Karuk Tribe Climate Change Vulnerability Assessment* evaluated the impacts of high intensity fire on traditional foods and cultural use species important for health, sustenance, and well-being.

2. Desk Research on Potential Future Climate Impacts

Identify potential future climate impacts to the community by reviewing existing local, regional, and/or state reports. These might include:

- Climate vulnerability assessments that the community has conducted in the past.
- Climate vulnerability assessments produced by local colleges or universities, the Alliance of Regional Collaboratives for Climate Adaptation (ARCCA), nonprofits, or other reputable organizations.
- The most recent *California Climate Change Assessment* reports, including the regional report.

3. Interview Stakeholders on Historical and Potential Future Climate Impacts

This substep presents a good opportunity to talk one-on-one with appropriate stakeholders to explore past climate impacts and think through potential future climate impacts. The best stakeholders to engage in this substep are those most familiar with the assets, services, and resources that are most important to the community. Stakeholders may include asset managers and operators, people who run key community services (e.g., emergency services, water and wastewater, utilities, fire, police), and others. Asset and service managers often have a more detailed understanding of past climate

impacts than what has been documented in reports, and they have a wealth of knowledge around asset sensitivity and adaptive capacity.

A preliminary approach is to engage staff within the local government. However, it is also important to engage individuals outside of local government—community organizations and members, critical services not owned by local government, etc.—to create a fuller understanding of potential climate impacts and help build momentum for adaptation. Questions for these interviews could include:

Combining Interviews

Before arranging the Step 2.2b interviews, review Step 2.3b to determine whether it makes sense to combine the two interviews. If the interviewees for the two steps would be the same, it might be best to minimize the burden on interviewees and improve efficiency by combining the interviews. However, if the interviewees are not the same, are willing to be engaged more than once, and/or the project team has enough time, it may be more appropriate to keep the two sets of interviews separate.

- What services have been impacted by the climate hazard? Are these services disrupted? How might impacts to services change given projected changes in climate?

- What facilities have been damaged, destroyed, or otherwise impacted by the climate hazard? How might impacts to facilities change given projected changes in climate?

- Have populations been impacted physically or mentally by the climate hazards? How might impacts to populations change given projected changes in climate?

- Have there been additional downstream disruptions that result from the loss of critical services (e.g., electrical disruptions impacting hospital service)? How might impacts arising from interdependencies change given projected changes in climate?

- How have impacts varied across the community? Which populations have been most affected? Which populations might be most impacted in the future?

- Did the climate hazard create economic losses? How might economic losses change given projected changes in climate?

- Have community ecological or cultural resources been impacted? How might impacts to these resources change given projected changes in climate?

For more guidance on engaging stakeholders in assessing vulnerability, identifying assets, and understanding potential climate impacts, see Phase 2, Step 2.5 on Outreach and Engagement.

4. Summarize Findings on Potential Future Climate Impacts

Using the information developed through substeps 1 through 3, summarize the findings on potential future climate impacts. This summary should include information on whether existing and/or planned community assets are already exposed to climate-related hazards and/or may be exposed to them in the future. This might be a bulleted list of potential impacts and consequences or a more detailed report.

The project team may go beyond a narrative describing potential future climate impacts and develop quantitative estimates of potential future climate impacts. If a hazard or other climate change-related effect is projected to increase in magnitude or frequency and has impacted the community in the past, it could be beneficial to extrapolate data from the historical impact inventory to estimate impacts under a future climate change scenario. See Step 2.1d for recommendations on how to visualize hazard projections over time using Cal-Adapt and other tools.

Some climate change effects could impact a community in the future that have not impacted it in the past. In this case, other communities in the region that have experienced these climate hazards can shed light on their potential impacts.

STEP 2.2C. IDENTIFY POTENTIAL CLIMATE EFFECTS OF GREATEST CONCERN

The research in Step 2.2b compiled information about the historical and potential future climate impacts that pose the greatest risk to the community. That information can be used to develop a subset of priority climate impacts that are the most important to the community.

Phase 1 may have already identified these priority effects based on the community's key resilience goals and concerns. Or interviews and engagement with community stakeholders may have made them apparent. Revisiting the conclusions from Step 2.1c about how hazard conditions are projected to change and using the regional reports from the most recent California Climate Change Assessment can help identify the effects of greatest concern and inform the list of priority impacts.

The outcomes from Step 2.2b can also help determine which impacts pose the greatest risk. Consider these questions when evaluating Step 2.2b results:

- Which climate impacts might result in loss of life or significant human health impacts?
- Which impacts might create disruptions or damages to essential facilities (see Phase 1, Step 1.3)?
- Which impacts might generate significant losses for the local economy?
- Which impacts may create significant environmental impacts, such as release of hazardous materials?

- Are impacts of climate change effect short but acute, long term, or both?
- Could two or more impacts interact to result in a more severe impact (e.g., wildfires followed by extreme precipitation creating landslides)?

Answering these and other questions can help identify the specific impacts that most concern a particular community, that is, the priority climate impacts, and the vulnerability assessment can move forward.

Step 2.3: Adaptive Capacity

The goal of Step 2.3 is to characterize a community's current ability to cope with climate impacts to community populations and assets. Materials prepared in this step:

- A matrix describing the community's existing capacity to adapt to each of the priority climate impacts based on existing policies, plans, and/or programs.
- An enhanced version of the same matrix describing factors that enhance local agencies' adaptive capacity.

Describing Adaptive Capacity for LHMPs

If integrating a vulnerability assessment into an LHMP, this step can be integrated into the FEMA risk assessment when summarizing vulnerability.

Adaptive capacity is the ability to moderate the potential damages or take advantage of the opportunities from climate change. Many communities have adaptive capacity in the form of policies, plans, programs, or institutions. Understanding this adaptive capacity entails identifying existing resources and assessing the community's ability to cope with potential climate impacts. This information on adaptive capacity will feed into Step 2.4, Vulnerability Scoring.

Adaptive capacity focuses on existing capacity to cope. Phase 3 will focus on developing new adaptation strategies and building up future capacity to manage climate impacts.

Adaptive Capacity for Extreme Heat

Nearly all communities in California will experience an increase in extreme heat events in the future. Extreme heat can affect vulnerable populations, causing heat stress and respiratory illnesses, which would be considered impacts of extreme heat. Adaptive capacity looks at the existing resources available to help vulnerable populations adapt, such as cooling centers, air-conditioned schools and public facilities, and water fountains at sports fields. Larger-scale weatherization programs and other upgrades to housing can further protect populations, including vulnerable populations living and working in older buildings. These efforts increase the ability of the community to adapt to extreme heat conditions; therefore, they increase the adaptive capacity of vulnerable populations.

STEP 2.3A: REVIEW DOCUMENTS TO COLLECT INFORMATION ON ADAPTIVE CAPACITY

The goal of this step is to identify and review documents that might outline policies, plans, or programs that already help manage climate impacts or will in the future. The information reviewed could come from local, state, regional, tribal, and federal entities, including:

- Public health and safety agencies
- Environmental regulation agencies
- Fire protection agencies
- Flood protection agencies
- Offices of emergency services
- Special districts (e.g., fire protection, sewer, sanitation, water supply, electricity, parks, recreation)

Documents produced by these agencies that may have relevant information are listed below. OPR's Adaptation Clearinghouse is also a useful database to search for the latest government policies, plans, and programs that enhance adaptive capacity. The most relevant documents for review vary based on the end product of the planning process and the priority climate impacts.

Local Plans

- Climate Adaptation Plans
- Climate Action Plans
- Local Hazard Mitigation Plans
- General Plans / Comprehensive Plans
- Area and Specific Plans
- Sustainable Community Plans (SB 375)
- Local Coastal Programs
- Downtown Plans

Local and Regional Sector-Specific Plans

- Urban Water Management Plans
- Integrated Regional Water Management Plans (IRWMPs)
- Transit and Regional Transportation Plans
- Public Health and Safety Plans, such as Community Health Assessments
- Emergency Services Plans
- Fire Management Plans
- Community Wildfire Protection Plans
- Floodplain Management Plans
- Open Space and Land Management Plans

Local Nongovernment Programs

- Nonprofit adaptation-related programs
- College or university adaptation-related programs

Local Standards, Ordinances, and Programs

- Climate Adaptation Program
- Hazard Mitigation Programs
- Emergency Management Programs
- Capital Improvement Program
- Zoning Code
- Building Code
- Fire Code
- Tree Ordinance
- Urban Heat Island Ordinance
- Floodplain Ordinance
- Stormwater Management Program

Regional Strategies

- Council of Government (COG) Adaptation Plan
- Association of Government (e.g., ABAG, SCAG) Adaptation Plan

State Strategies

- Safeguarding California
- Cal OES State Hazard Mitigation Plan
- CAL FIRE California Fire Plan
- CA DWR Climate Action Plan

Federal Programs

- Building Resilient Infrastructure and Communities (BRIC) Program
- FEMA Hazard Mitigation Grant Program
- HUD Community Develop Block Grant Disaster Resilience Program

A helpful way to coordinate the information in each document is to create a matrix that summarizes:

1. Strategies that might help manage climate impacts. Is the strategy already implemented, is implementation in progress, or is it planned? Does it have components that address social vulnerability? Strategies that help manage impacts might include emergency response plans, evacuation plans, zoning requirements related to hazards and other effects of climate change, building code requirements related to hazards, asset engineering standards related to hazards, water conservation policies, etc.

2. The extent to which existing strategies manage today's climate impacts. This may require input from interviewees under Step 2.3b.

3. The extent to which existing strategies are expected to manage potential future climate impacts. This may require input from interviewees under Step 2.3b.

4. Opportunities to build on the strategies and strengthen their ability to manage present and potential future climate impacts.

STEP 2.3B. INTERVIEW LOCAL AGENCIES ON THEIR CURRENT ABILITY TO ENHANCE ADAPTIVE CAPACITY

The goal of this step is to identify and interview local agencies about their adaptive capacity. The findings from Step 2.3a may help to identify local agencies that could or do affect adaptive capacity. Arrange an interview to elicit information on their existing and planned efforts to manage climate impacts now and in the future, particularly the priority climate impacts. If appropriate, this interview can be combined with the Step 2.2b interviews.

Interview questions might include:

- Are there existing programs and policies that help the community manage climate impacts?
- How effective are they in managing present-day climate impacts?
- Based on projected changes in climate, do you think they will be effective in managing future climate impacts?
- Are there planned programs and policies that will help the community manage climate impacts?
- How effective do you believe they will be in managing present-day climate impacts? Future climate impacts?
- What are the barriers to managing climate impacts in the community? Are they related to institutional governance, attitudes and motivations, resources and funding, politics, leadership, expertise and technology, or other areas?

The findings from the interviews about adaptive capacity should be summarized in the matrix from Step 2.3a. These summaries can serve as a starting point for developing adaptation strategies in Phase 3.

Step 2.4b scores vulnerability, including assigning a score to adaptive capacity, but this can also be done as part of this step.

Step 2.4: Vulnerability Scoring

The goal of this step is to identify priority climate vulnerabilities based on systematic scoring. Materials prepared in this step are:

- A table summarizing vulnerabilities.
- A table showing the vulnerability score for each of the major climate vulnerabilities.

Vulnerability scores are based on the combination of potential impact and adaptive capacity and help identify the major climate vulnerabilities to address in Phase 3. The scoring process is qualitative, and the APG guidance ensures that the scoring process is transparent and can use inputs from multiple sources.

Although the APG discusses a quantitative scoring process for this step, it is possible to evaluate vulnerability in a more qualitative manner. Some organizations may find it beneficial to instead convene stakeholder groups and identify key priorities through facilitated discussion. This approach may be appropriate for situations where stakeholder input is particularly emphasized, where assessments need to be completed quickly, or where the information available is simply not conducive to a more systematic scoring approach.

STEP 2.4A. SUMMARIZE VULNERABILITY

For each of the climate change–related effects of concern to the community, produce a table that describes vulnerability and consequence:

- **Population and community assets.** The populations and assets associated with the potential impact and its location(s) (see Step 2.2).
- **Exposure.** The projected severity of the climate change effect in the area of the population and community assets (see Step 2.1).
- **Sensitivity and potential impact.** How the population and community assets might be affected given its projected exposure to climate change effect(s) and the broader implications for the community from the potential impacts of these effects, including consequences for public safety, human health, ecosystem services, continuity of public services, costs to the local government or borne by the public, and/or any other key metrics identified in Step 2.2 or Phase 1.
- **Adaptive capacity.** Existing ability to manage the potential impacts (see Step 2.3).

STEP 2.4B. SCORE VULNERABILITY

For each population and asset at risk for each climate change–related effect described in the table from Step 2.4a, score potential impact and adaptive capacity, then use these scores to determine an overall vulnerability score. This scoring can help clarify which effects pose the greatest threats and should be prioritized in adaptation planning. For instance, in the Los Angeles County Metropolitan Transportation Authority's *Metro Climate Action and Adaptation Plan 2019*, Metro scored the relevant climate change effects to identify the greatest vulnerabilities and prioritize transportation assets for adaptation actions.

To score potential impact and adaptive capacity, use the rubric in Table 10 as a guide, but adjust the scoring system to the circumstances. For example, if using three scoring levels is not enough, the system can expand to four, five, or more levels. Criteria can be customized to reflect the goals specific to the community, such as quantifiable metrics related to safety, costs, or other factors. Different inputs can help with the scoring process, depending on the project team's capacity and stakeholder engagement. The scoring process is based on the team's judgment, so it is a good idea to seek a broad range of inputs, including the opinions of community members and any scientific studies that assess climate change impacts.

TABLE 10. POTENTIAL IMPACT AND ADAPTIVE CAPACITY SCORING RUBRIC		
SCORE	POTENTIAL IMPACT	ADAPTIVE CAPACITY
Low	Impact is unlikely based on projected exposure; would result in minor consequences to public health, safety, and/or other metrics of concern.	The population or asset lacks capacity to manage climate impact; major changes would be required.
Medium	Impact is somewhat likely based on projected exposure; would result in some consequences to public health, safety, and/or other metrics of concern.	The population or asset has some capacity to manage climate impact; some changes would be required.
High	Impact is highly likely based on projected exposure; would result in substantial consequences to public health, safety, and/or other metrics of concern.	The population or asset has high capacity to manage climate impact; minimal to no changes are required.

After scoring the potential impact and adaptive capacity for each population and asset for the relevant climate change-related effects, use the matrix in Figure 11 to determine overall vulnerability scores based on the potential impact score and adaptive capacity score.

Figure 11. Vulnerability Score Matrix

	High	Medium	Low
High	3	4	5
Medium	2	3	4
Low	1	2	3

Potential Impacts

Adaptive Capacity

Record a description of each population and asset and the associated potential impact, adaptive capacity, and vulnerability scores for all of the climate change-related effects and associated vulnerabilities in a table such as the example in Table 11.

TABLE 11. EXAMPLE TABLE OF DESCRIPTIONS AND VULNERABILITY SCORES			
VULNERABILITY DESCRIPTION	**VULNERABILITY SCORE**		
	POTENTIAL IMPACT	**ADAPTIVE CAPACITY**	**VULNERABILITY**
Rain-induced mudflow preventing entry to emergency operations center	Medium	Medium	3
Wildfire inhibiting provision of key public services	High	Low	5

These scores will be used to determine which vulnerabilities are most pressing and should be prioritized for adaptation action in Phase 3 to help manage climate vulnerability.

Step 2.5: Outreach and Engagement

The goal of outreach and engagement in Phase 2 is to collaborate with community members both within the organization and externally to identify neighborhood strengths, assets, and climate change effects. Vulnerability assessments should be driven by community priorities and reflect knowledge from different population groups and neighborhoods. Outreach and engagement in this phase ensures that community members have opportunities to share their expertise and provide valuable, on-the-ground understanding of climate vulnerabilities.[7]

TARGETED STAKEHOLDER INTERVIEWS OR FOCUS GROUPS

As noted in Step 2.2b, stakeholder interviews are important opportunities to tap local knowledge, experience, and expertise, and understand historical climate impacts. The core planning team should identify long-standing, respected members of the community to connect with. Some examples might be heads of local governmental agencies, residents from past planning processes, leaders of environmental partner organizations, directors of youth or college programs, and managers of hospitals or public health clinics. When selecting interviewees, make sure that they are from diverse groups and can provide different geographic perspectives. Refer to "Interview Stakeholders on Historical and Potential Future Climate Impacts" in Step 2.2B.

STORYTELLING TIMELINES

Developing a historical hazard inventory through personal narratives is an effective way to engage with the community. The lived experience of community members can create social cohesion and help build support for future adaptation actions. Create an interactive timeline with drawings, written stories, and photos as an outreach activity to learn about past climate disasters and what the responses were. Find a way to summarize best practices learned from each climate disaster and future ideas on preparing for climate change. More information on creating a storytelling timeline is in the Pacific Institute's climate survivor workbook and in the *Regional Resilience Toolkit*. The *Regional Resilience Toolkit* offers a Storytelling Framework and Best Practices to Tell A Story.

PARTICIPATORY ASSET MAPPING

Participatory asset mapping can help residents understand the data behind the vulnerability assessment and projections as well as give an opportunity to realize how it will impact them. Planners can present the data through visual boards and get comments through in-person workshops, and/or present the data through GIS platforms that allow residents to map their own content via their personal computers. Co-creating asset maps helps accurately capture local organizations, places,

structures, or institutions that are vulnerable to climate change impacts and can support climate resilience. More information on setting up participatory asset mapping is in the Advancement Project's Healthy City toolkit, _Participatory Asset Mapping_.[8]

> ## Asset Mapping Example:
>
> The Map Your Future project from Bay Localize is training youth to prepare for the local impacts of climate change by helping to map climate vulnerabilities and develop resilience efforts. Youth mappers are trained to identify local impacts of climate change and community efforts that build climate resilience. The program gives preference to participants from low-income communities of color and low-income youth with barriers to employment (e.g., no high school diploma, history of incarceration, at-risk), who suffer the highest rates of unemployment.[9]
>
> Extensive facilitation guides and templates are available from Bay Localize online.[10] Additional information about the Map Your Future project is also available.[11]

COMMUNITY-BASED PARTICIPATORY RESEARCH

Partnering with an academic institution or educational nonprofit organization is another way to include students or residents as project researchers. Engage the researchers to understand the project themselves and then have them popularize technical information about local climate impacts to make it more accessible to the broader community. For example, researchers could co-create fact sheets related to natural hazards or conduct parts of the vulnerability assessments, such as interviewing several local small businesses to assess post-disaster capacity.

If funding is available, partnering with community-based organizations to do a supplemental analysis about vulnerability in lower-income communities and communities of color could be ideal. One example is _Mapping Our Future: A Work Plan for Public Engagement and Equity in Climate Adaptation Planning in the San Francisco Bay Area_. Based on survey results and a workshop with input from more than 400 residents, the report describes the local climate vulnerabilities based on income, race, health conditions, age, living conditions/location, occupation, language barriers, and related factors. This project was a way for community-based organizations to play a leadership role in climate adaptation planning.

More information is available online: http://www.baylocalize.org/files/EquityReportFinal041213v11.pdf.

When partnering with outside organizations (no matter the type), local agencies should ensure ownership of the final outputs of your project.

Phase 2 Wrap-Up

The vulnerability assessment is the process that provides participants with the details of how the community may be harmed by climate change. Through this analysis, communities can identify the most vulnerable populations and assets, and which climate-related effects may be most damaging. This can be the most technical and data-intensive phase of adaptation planning, but there are many existing reports and datasets that can help streamline the process. Community engagement during this phase can help refine the analysis and make sure it more accurately reflects specific conditions. Using the results from the vulnerability assessment, communities can develop an adaptation framework and strategies, following the process discussed in Phase 3.
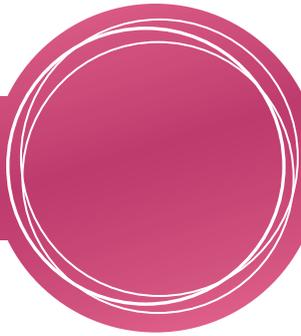
PHASE 3: DEFINE ADAPTATION FRAMEWORK AND STRATEGIES

The goal of Phase 3 is to prepare the community's adaptation framework, which identifies specific policies and implementable strategies for adapting to climate change, thus making the community more resilient. Through Phases 1 and 2, the community identified its vision, desired outcomes for the adaptation planning process, and assessed vulnerability to climate change. Phase 3 uses those findings to inform the preparation of the adaptation framework and strategies, consistent with the vision, goals, and desired outcomes of the community.

This chapter describes the steps of Phase 3 and includes examples of adaptation strategies (see Figure 12). The primary steps are: 1) summarize vulnerability, 2) confirm vision and goals, 3) prepare adaptation strategies, 4) prioritize strategies, and 5) conduct outreach and engagement.

Figure 12. Steps in Phase 3

| STEP 3.1 SUMMARIZE VULNERABILITY | STEP 3.2 CONFIRM VISION AND GOALS | STEP 3.3 PREPARE ADAPTATION STRATEGIES | STEP 3.4 PRIORITIZE STRATEGIES | STEP 3.5 CONDUCT OUTREACH & ENGAGEMENT |

Summary of § 65302(G)(4) Safety Element and Climate Adaptation

As noted earlier in the APG, California Government Code § 65302(G)(4) requires local jurisdictions to review and update their safety elements upon the next revision of an LHMP on or after January 1, 2017, or if a local jurisdiction has not adopted an LHMP, beginning on or before January 1, 2022, as necessary to address climate adaptation and resiliency strategies. The review and update should include preparation of the following:

- A vulnerability assessment.

- A set of adaptation and resilience goals, policies, and objectives based on the information identified in the vulnerability assessment for the protection of the community.

- A set of feasible implementation measures designed to carry out the goals, policies, and objectives including, but not limited to, all of the following:

  - Feasible methods to avoid or minimize climate change impacts associated with new uses of land.

  - The location, when feasible, of new essential public facilities outside of at-risk areas, including, but not limited to, hospitals and health care facilities, emergency shelters, emergency command centers, and emergency communications facilities, or identifying construction methods or other methods to minimize damage if these facilities are located in at-risk areas.

  - The designation of adequate and feasible infrastructure located in an at-risk area.

  - Guidelines for working cooperatively with relevant local, regional, state, and federal agencies.

Summary of § 65302(G)(4) (continued)

◆ The identification of natural infrastructure that may be used in adaptation projects, where feasible. Where feasible, the plan shall use existing natural features and ecosystem processes, or the restoration of natural features and ecosystem processes, when developing alternatives for consideration. Natural infrastructure means the preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, flood plain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days.

Step 3.1: Summarize Vulnerability

A helpful first step in developing the framework is to review the results of the vulnerability assessment, focusing on the major climate vulnerabilities identified in Step 2.4. The *Regional Resilience Toolkit* recommends summarizing the vulnerability assessment in "problem statements" that describe the vulnerability and its consequences.[1] The purpose of the problem statements is to provide concise, plain-English descriptions of the climate vulnerabilities so that all stakeholders, decision-makers, and members of the planning team understand the nature of the challenge. This will aid in assessing how well the community is prepared to deal with the problem now (adaptive capacity) and aid in developing new policy and strategies. Underlying data and analysis should also be preserved and made available, but the problem statements allow everyone to work from a basic, common understanding.

A problem statement should succinctly describe the specific vulnerability of assets and populations (social vulnerability). It should describe the current vulnerability and the change in vulnerability due to expected climate change and changes in the community. It might also summarize the known or hypothesized causes or contributing factors, though these are not always straightforward. In fact, identifying causes is often what underlies fundamental policy debate and action. For example, the frequency

of extreme wildfires in California is increasing, but the relative importance of causes such as climate change, increased building in the wildland-urban interface, and poor forest management will vary by community. This drives policy choices—for example, whether to focus on land use and building controls or on controlled burns and forest thinning. An example problem statement might be:

> Approximately 150 residences in the community are in a "very high" wildfire risk area that is projected to see a threefold increase in wildfire likelihood by 2050 due to climate change. The area has historically experienced a significant wildfire about every 25 years. Many of the residents (approximately 40 percent) are aged 60 and above. Recent development trends show an acceleration of new residential construction over the last 10 years, and the current zoning allows for up to 450 total residences. In addition, most of the area is serviced by only a single paved road, thus limiting emergency access.

Although this step is not essential for preparation of adaptation strategies, it will help the team organize vulnerabilities, identify applicable sectors for strategy development, reveal any relationships or patterns of vulnerability, and begin to consider the types of strategies needed to increase resilience.

After completing the assessment of climate change–related effects, summarize the findings to identify the most significant potential for harm in the community. These findings or "problem statements" will help to craft effective strategies and actions. Problem statements will help to:

- Communicate critical planning issues, for example, which critical assets are particularly vulnerable, what areas currently have repetitive losses, or how many high hazard areas are currently zoned for future development.
- Assist the community and stakeholders to prioritize and focus on the areas that have the greatest need for mitigation or adaptation based on the assessment of climate change–related effects.
- Create a clear and cogent "story" to help support decision-making by elected officials and other stakeholders.
- Provide a foundation for seeking funds to reduce the potential for harm and increase community resilience.

Step 3.2: Confirm Vision and Goals

A resilience vision and associated goals are important components of an adaptation and resilience framework.

CONFIRM VISION

The objective of this step is to confirm the community's vision for adaptation and resilience. It should engage stakeholders, the project team, and decision makers. Phase 1 included preparation of a vision or definition of what adaptation and resilience means to the community. In Phase 3, a review of the vision will help frame how to address the issues in the vulnerability assessment. If the community did not prepare a vision statement during Phase 1, this is a good time to do so.

This example vision statement for resiliency is from the City of Boulder's (CO) Resilience Strategy:

> Building on a legacy of frontier innovation, Boulder will cultivate a creative spirit to adapt to and thrive in a changing climate, economy, and society.

DRAFT GOALS

Goals provide direction for achieving a vision and act as guideposts throughout the planning process and implementation. As noted in the *Regional Resilience Toolkit*,[2] establishing resilience goals assists in:

- Building transparency into the process at the outset so that all participants understand the breadth of priorities and topics to cover.
- Engaging the project team and stakeholders early in deciding what shared outcomes they will work cooperatively to achieve and providing an opportunity for input and feedback on the project direction.
- Providing a foundation upon which future project decisions can be made and help in evaluating how well mitigation actions will meet established community values and expectations.
- Connecting to metrics and tracking and monitoring progress of the project through implementation.

Goals may be driven by a desire to protect:[3]

- Physical areas (e.g., new development along the shoreline, natural resource areas or assets)
- Asset classes (e.g., infrastructure, natural resources)
- Social values (e.g., protecting parks because beauty and recreation are highly held values)
- Economic values (e.g., protecting major economic drivers like large businesses)
- Character, history, sense of place (e.g., protecting historic structures or neighborhoods)
- Existing functions/activities (e.g., emergency services)
- Specific communities (e.g., vulnerable populations)

To get started, group the problem statements from Step 3.1 by themes, such as climate change effects, populations and assets at risk, or sectors. Several problem statements or groups may lead to a single adaptation goal. The APG uses 11 sectors (see Figure 4) to support organization of example strategies, which are defined in Appendix A. Communities can use the same sectors or follow an organizational approach that best fits their implementation needs.

When drafting goals, it is important to start with a review of existing goals in the community's planning documents—e.g., general plan and LHMP—and state plans such as Safeguarding California and the State Hazard Mitigation Plan. This review will help the project team determine if existing community goals support the vision, respond to the vulnerability assessment and will support integration and alignment of adaptation and resilience goals.

Goals that respond to the vulnerability assessment, such as those that seek to increase adaptive capacity, protect assets, and reduce impacts from hazards and other climate change effects, help other stakeholders see how resilience fits with existing community priorities. Goals should be clear and accessible to all stakeholders, and they should reduce or avoid long-term vulnerabilities. The goals will be supported by strategies developed in Step 3.3.

The General Plan Guidelines (2017) define a goal as a "general direction-setter." It is an ideal future end related to the public health, safety, or general welfare. A goal is a general expression of community values and may be abstract in nature. It may not be quantifiable or time dependent.[4]

The FEMA Local Mitigation Handbook describes goals as general guidelines that explain what the community wants to achieve with the plan. They are usually broad,

policy-type statements that are long term, and they represent visions for reducing or avoiding losses from the identified hazards.[5]

Goals should be designed with consideration to how progress can be tracked or monitored. Some communities may prepare one or more "objective" statement for each goal. These objective statements are meant to be specifically measurable in some way that shows progress toward the goal. For example, a goal to reduce community vulnerability to wildfires might have objectives for the percentage of homes that meet defensible space best practices. Whether specific objective statements are prepared or not, the goal and strategy development process should proceed with consideration to developing specific indicators of progress that can be monitored.

Step 3.3: Prepare Adaptation Strategies

The project team and community should collaborate to prepare adaptation strategies after the review of vulnerabilities, development of problem statements, and confirmation of the community's vision and goals for adaptation and resilience. Use the Vulnerability Assessment prepared in Phase 2 to identify priority areas for action and develop a framework for how those areas should be addressed.

WHAT IS A STRATEGY?

Climate adaptation strategies should be developed within a policy framework appropriate to the outcomes of this adaptation planning process, as identified in Phase 1 and confirmed in Step 3.2—that is, a general plan safety element, climate action or adaptation plan, local hazard mitigation plan, or another plan or project. The terminology should be consistent with the policy/planning document where the strategy will reside.

Each plan type or program has a defined set of terms and approaches for strategies (the APG uses the term "strategy" generally to refer to a policy, program, project, measure, or action meant to increase resilience). Some plans and policy documents use a traditional goal–objective–policy–strategy/implementation program hierarchy for organizing strategies; others focus only at the strategy level. The level of detail may also vary.

What Is a Policy?

The General Plan Guidelines[6] states that a policy is a specific statement that guides decision-making and indicates a commitment of the local legislative body to a particular course of action. A policy is based on a plan's vision and goals and helps implement them. For a policy to be useful as a guide to action, it should be clear and unambiguous. A policy is carried out by implementation strategies. An implementation measure is an action, procedure, program, or technique that carries out policy. Programs can be short- or long-term groupings of projects or services that help achieve policy goals.[7] The FEMA Hazard Mitigation Handbook does not define policy; however, it defines actions as specific projects and activities that help achieve the goals.[8]

Levels of Detail in Adaptation Strategies

Some strategies look like general statements of policy preference or desired direction, and others are highly detailed and contain specific implementation direction. The following strategies are from the Town of Mammoth Lakes Safety Element, updated in 2019.

General Statements:

- Establish public outreach and education programs to inform residents, businesses, and visitors of air quality alerts.
- Support sustainable and feasible forest thinning by product economies and markets to create a revenue stream for mechanical treatments required to meet wildfire mitigation and protection needs.
- Increase the groundwater recharge potential within the Town boundaries and surrounding areas.
- Encourage a drought tolerant and fire-resistant landscaping demonstration garden to encourage public participation in water conservation and fire preparedness efforts.

Detailed Implementation Direction:

- Expand the Mammoth Lakes Mosquito Abatement District to include all areas within the Town boundary.
- Encourage Mammoth Community Water District (MCWD) to add water wells to increase water supply reliability during drought years.
- Improve wildfire management coordination between the Town, the Great Basin Unified Air Pollution Control District, Cal FIRE, and U.S. Forest Service (USFS), to mitigate economic impacts of prescribed or managed fires.
- Work with Mammoth Lakes Fire Protection District to create a Land Inventory using GIS to identify fuel reduction status and points of contact.

HOW TO DRAFT A STRATEGY

Each goal drafted in Step 3.2 should have a set of strategies to support its achievement. Strategies will be actions that respond to the problem statements prepared in Step 3.1. As part of strategy development, the project team should answer these questions:

- Who will be responsible for the strategy?
- How it will be achieved?
- How it will be assessed?
- What is needed to accomplish it?

Similar to the process for drafting goals, it is helpful to review existing plans and programs for strategies that could address specific vulnerabilities identified in Phase 2 before drafting new strategies.

Strategy development is iterative, especially in an inclusive and transparent process with the community. The initial round of strategy development could be a brainstorming activity that results in lists of ideas that can be revised later in response to more stakeholder feedback, and to fit the structure and requirements of the implementation mechanism. Developing strategies with agency and community stakeholders identifies opportunities to integrate adaptation planning into multiple community programs and plans.

For example, increased vulnerability of infrastructure to wildfire could be addressed through updates to a general plan safety element or an LHMP. Increased vulnerability of people to extreme heat may require coordination with local public health officials. Strategies that will be integrated into a general plan should be consistent with the current community general plan structure and the *General Plan Guidelines*.[9]

Strategies that are developed for a safety element should follow the specifications in Government Code § 65302(g)(4) (see text box above). Strategies that will be part of an LHMP should be consistent with FEMA's guidance (see text box on following page). Strategies may not fit neatly into the plan because each plan type has different objectives, organizational structure, and time frames.

It is common to categorize strategies to respond to different options for implementation. The *Regional Resilience Toolkit*[10] provides examples of strategy categories or types that have been incorporated into the example strategies in Appendix C. These categories include operational; programmatic; plans, regulations, and policy development; capital improvement/infrastructure projects; education, outreach, and coordination; and evaluation.[11]

- **Programmatic.** Strategies to expand or create new programs, activities, and initiatives.
- **Plans, regulations, and policy development.** Strategies to develop or revise policies, plans, regulations, and guidelines.
- **Capital improvement/infrastructure projects.** Strategies designed to address physical and functional deficiencies and needs in the built and natural environment.
- **Education/outreach/coordination.** Strategies related to initiating or expanding partnerships and relationships, communicating and sharing information, and expanding awareness.
- **Evaluation.** Strategies to improve feedback, input, and data and information or conduct further or new analyses.

The *Regional Resilience Toolkit* has worksheets and tools to support strategy development. These worksheets provide sources for and examples of strategies that address common hazards and assets.

FEMA LHMP Guidance for Mitigation Actions

LHMPs are required to have mitigation goals, actions, and a plan for implementation, which provides a framework to identify, prioritize, and implement actions to reduce the potential for harm from climate change–related effects. FEMA suggests considering vulnerability assessment findings, outreach findings, community goals, and state hazard mitigation goals when developing hazard mitigation measures.[12]

FEMA suggests the following types of mitigation actions to address long-term vulnerability:

- Local plans and regulations
- Structure and infrastructure projects
- Natural system protection
- Education and awareness programs[13]

Uncertainty

Given the inevitable margin of uncertainty in future impacts and societal conditions, communities should develop policies and strategies consistent with several principles. The "low/no regrets" principle suggests that actions taken would still have value even if future conditions are different from those projected (for better or worse). For example, conserving additional land in flood-prone areas gives a community an open space benefit even if worse flooding does not materialize. Conversely, seawalls can help protect coastal areas, but they cause more rapid erosion elsewhere and are not an effective long-term adaptation strategy, so the resources to implement this action could have been better spent elsewhere.

The "low/no regrets" principle is good for short- and mid-term decision making but as timeframes extend and uncertainty increases potential "regret" becomes more difficult to determine. The Center for Ocean Solutions[14] suggests using a "triggers approach" derived from the adaptive pathways model. The idea is to identify the general conditions under which a policy may fail. For example, a seawall to mitigate sea-level rise may fail when sea-level rise reaches a certain point or coastal storms change in frequency or intensity. This identification can then be used to establish "triggers" or "thresholds" when modified or new mitigation strategies would be required. The establishment of triggers or thresholds can be integrated into Phase 4.

The "triggers approach" can be extended by developing adaptive pathways (see Appendix B for an overview of the adaptive pathways approach, examples, and additional resources.) Adaptive pathways begin by developing future scenarios of climatic and social conditions to identify when a policy may fail. The idea is then to develop strategies that are either robust for any future scenario or can be modified or changed without significant cost or effort (and to identify in advance how these changes would be implemented). It may be the case, though, that future conditions would require a shift to a very different policy approach. For example, increased levels of sea level rise could trigger a policy shift from coastal armoring to coastal retreat. The adaptive pathways approach is a way to tease out these future possibilities to potentially inform current policy development. It is a novel and advanced approach that some communities may want to consider.

EXAMPLE ADAPTATION STRATEGIES

In support of Phase 3, Appendix D provides example adaptation strategies that can be implemented on a local or regional level to address many potential climate impacts. These are not intended as a comprehensive list of strategies but as thought starters to help the project team draft adaptation strategies tailored to the community's circumstances. Adaptation strategies are organized by sector and respond to climate hazards common in that sector. Appendix D examples include a description of the climate change effect and strategy, factors to consider, the category or strategy type, sector overlap if applicable, potential responsible agency types, possible funding sources, and examples and/or sources for the strategy itself. Strategies will require adjustment or greater specificity for application in a community. Communities should expect to go beyond these strategies to address all their high-priority adaptation needs. This may include bolstering programs that are already locally effective or developing innovative strategies based on particular characteristics.

Climate change impacts often interact, and some adaptation strategies may address multiple climate impact areas. The discussion of each strategy notes overlaps with other climate impact areas. Also, an adaptation strategy is easier to implement if it has co-benefits—that is, if it addresses other community needs in addition to climate change adaptation.

Strategies can direct budgeting and capital spending, education and outreach, program delivery, operational changes, project review, and regulations and permitting, among others. Strategies can be mandatory or voluntary, perhaps with incentives or disincentives. Local governments should look at all the strategy implementation powers, tools, and partnerships they possess to move their community to a more resilient future.

Co-benefits

A co-benefit is an additional beneficial result of an action to increase resiliency, such as greenhouse gas reduction or increased open green space. When evaluating adaptation strategies, the project team should consider additional purposes they could serve:

- Cost savings
- Air quality improvement
- Water quality protection
- Stormwater management
- Increased public safety
- Recreation, open space, and tourism
- Greenhouse gas emissions reduction
- Public health improvement
- Enhanced or restored natural systems
- Economic continuity

Ideally, all strategies will have one or more co-benefits. In some cases, the co-benefit may be more compelling than the primary adaptation benefit. For example, identifying land to preserve as open space as a wildfire buffer has a co-benefit as a community amenity. Clearly showing co-benefits of strategies is effective for communicating to the public and decision-makers the value of doing climate adaptation planning. Co-benefits can be linked to other community planning goals and thus support the principle of integrating climate adaption across all community plans and policies.

Example: Gateway Cities Climate Action Planning Framework

The Gateway Cities Council of Governments prepared a regional Climate Action Planning Framework to help its member communities advance their goals for economic development, public health, air quality, climate resiliency, equity, and job creation while planning for the impacts of climate change. The Framework includes a GHG Reduction Measure Toolkit and a Climate Change Adaptation Toolkit. The Climate Change Adaptation Toolkit provides cities with baseline information on climate hazards and adaptation measures to help prepare them for the potential impacts of climate change. It includes Climate Adaptation Model General Plan Language to help cities integrate climate change adaptation into their climate action plan, general plan, and/or LHMP, and meet the requirement of State legislation (i.e., SB 379).

Additional Resources for Adaptation Strategy Development

- California Climate Adaptation Clearinghouse: https://resilientca.org/

- *State General Plan Guidelines*, Appendix A Example Model Goals, Objectives, and Policies and Programs: http://opr.ca.gov/docs/OPR_Appendix_A_final.pdf

- U.S. Climate Resilience Toolkit, Appendix B: https://toolkit.climate.gov/

- Climate Adaptation Knowledge Exchange (CAKEx): https://www.cakex.org/

- Georgetown University Adaptation Clearinghouse: https://www.adaptationclearinghouse.org/

- Urban Sustainability Directors Network's *Guide to Equitable, Community-Driven Climate Preparedness Planning*: https://www.usdn.org/uploads/cms/documents/usdn_guide_to_equitable_community-driven_climate_preparedness-_high_res.pdf

- NAACP's Our Communities Our Power: Advancing Resistance and Resilience in Climate Change Adaptation Action Toolkit: https://live-naacp-site.pantheonsite.io/wp-content/uploads/2019/04/Our-Communities-Our-Power-TOOLKIT-FINAL.pdf

- Local and Regional Government Alliance on Race & Equity's Racial Equity: Getting To Results https://www.racialequityalliance.org/wp-content/uploads/2017/09/GARE_GettingtoEquity_July2017_PUBLISH.pdf

- The Greenlining Institute's *Making Equity Real in Climate Adaptation and Community Policies and Programs: A Guidebook* https://greenlining.org/publications/reports/2019/equitable-building-electrification-a-framework-for-powering-resilient-communities/

ADDITIONAL CONSIDERATIONS FOR STRATEGY DEVELOPMENT

Equity

Vulnerability has underlying historical roots that should be considered when developing strategies. The Movement Strategy Center, an organization that supports visions and relationships necessary to move from incremental change to transformation, describes vulnerability as a consequence and not a condition.[15] For example, a community that has been underserved by health care may be more vulnerable to health impacts from extreme heat events. Cooling centers are a common strategy to deal with the immediate impacts of heat, but strategies aimed at improving overall public health should be considered as well.

The Asian Pacific Environmental Network's *Mapping Resilience* report identifies numerous principles for more equitable planning:[16]

- Ensure meaningful and active engagement with the most impacted communities.

- Practice both adaptation and mitigation simultaneously.

- Promote equity by prioritizing and protecting the most vulnerable populations.

- Encourage actions that provide multiple benefits.

- Consider unintended consequences and avoid maladaptive practices that cause harm.

- Maximize transparency and accountability.

- Drive decision making through strong scientific evidence and local knowledge.

- Create adaptive processes that provide flexibility and opportunity for revision.

- Advance a just transition toward a diversified and regenerative economy.[17]

Additionally, the Climate Justice Working Group has 10 guiding principles for adaptation strategy development (see text boxes later in this section). Similarly, ICARP has 7 principles (see ICARP box in the Introduction). These principles focus on helping frontline communities, collaborating with multiple stakeholders, avoiding maladaptation (adaptation strategies that are actually harmful for the community) and promoting co-benefits in strategy development.

Climate Justice Working Group

The Climate Justice Working Group offers the following vision, principles, and policy and funding recommendations to guide California's adaptation efforts through 2025.

Vision
By 2030, we envision a resilient California where our most vulnerable communities are ready to respond to the physical, environmental, economic and health impacts brought on by climate change, and thrive after climate events. California must proactively bring public and private investments into vulnerable communities to foster robust and thriving communities that are engaged, healthy, just, economically viable, and safe from environmental threats.

Guiding Principles
1. Actively engage frontline communities in research, planning, implementation, education, and decision making about potential climate change impacts and about the development, funding, implementation, and evaluation of adaptation and resilience policies. Create enabling conditions for frontline communities' early, continuous, and meaningful participation in the development of adaptation policy and funding decisions. Partner with local leaders and community-based organizations to enhance the effectiveness of adaptation research and innovation, education, decision making, and policy implementation. This overarching principle applies to all of the subsequent climate justice principles and recommendations.

2. Identify and reduce frontline communities' vulnerabilities to climate change, with a focus on physical, economic, and quality-of-life factors.

3. When planning for infrastructure investments, prioritize actions that increase the resilience of essential facilities and associated services that provide health care, food, drinking water, evacuation routes, and emergency shelter for frontline communities. Reduce community health and safety risks from potential damage to sensitive facilities such as water treatment plants, hazardous waste facilities, and power plants and transmission lines.

Climate Justice Working Group (continued)

4　Promote adaptation policies, funding decisions, and implementation actions that increase training, employment and economic development opportunities among frontline communities. Where applicable, prioritize opportunities that advance a "just transition" from dependence on fossil fuels and further enhance community resilience to the impacts of climate change.

5. Promote and support regional and local adaptation efforts that generate multiple benefits across sectors.

6. During planning and implementation of land use and community development decisions, consider and avoid negative consequences of actions, including displacement, that could inadvertently increase frontline communities' and individuals' climate vulnerability.

7. Promote adaptation co-benefits of toxic chemical and greenhouse gas reduction policies by supporting those that also reduce frontline communities' climate vulnerability and enhance their resilience.

8. Ensure that adaptation policies, funding decisions, and implementation actions comply with relevant laws and policies that are designed to protect and advance civil rights and environmental justice.

9. Promote local, regional, and state agency transparency, accountability, and adaptive management by developing and applying easy-to-understand climate justice metrics, data and information resources, and annual reporting protocols.

10. Identify needed funding, establish needed funding mechanisms, and allocate adequate funding to support adaptation policy development, implementation, and evaluation in frontline communities.

Source: The Climate Justice Working Group, Advancing Climate Justice in California: Guiding Principles and Recommendations for Policy and Funding Decisions, 2017, Accessed August 2019, https://www.healthyworldforall.org/en/ express-img/17081516-3570-img1.pdf.

Step 3.4: Prioritize Adaptation Strategies

In Step 3.3 the project team and community developed adaptation strategies based on the vulnerability assessment and community engagement (see Section 3.5, Conduct Outreach and Engagement). In this step the project team should prioritize those adaptation strategies. This will aid in making decisions about complex issues, and it will make the strategy development process transparent and easier to communicate to community staff and residents. Prioritization of strategies should consider several factors:

- **Vulnerability Score (from Step 2.4).** Which strategies will be effective at addressing assets or systems with the highest vulnerability?
- **Administrative Operability.** Who will implement the strategy and what is their organizational capacity?
- **Cost.** How much will the strategy cost to implement?
- **Funding.** What resources are available to pay for implementation?
- **Bond funding.** (e.g., LA County's Measure W, California Prop 68), tax programs (e.g., Bay Area's Measure AA, tax-increment financing), public-private partnerships, and others as summarized in Phase 4.
- **Effectiveness/Benefit.** How effective is the strategy at addressing the problem and/or what is the benefit? What future losses might be avoided?
- **Efficiency.** How do the costs compare to the effectiveness/benefit? (What is the benefit-cost ratio?) What are direct and additional indirect benefits of the strategy?
- **Co-benefits.** What are the co-benefits of the strategy?
- **Environmental Performance.** What are the potential environmental impacts or considerations of implementing the strategy? Does the strategy support nature-based approaches and natural systems?
- **Equity.** Who pays the cost and who receives the benefits (including co-benefits)?
- **Legality.** Is the strategy consistent with applicable laws?
- **Responsiveness/Appropriateness.** How responsive or appropriate is the strategy to the needs and conditions of everyone in the community, especially those on the frontline?
- **Timing.** When will implementation begin and how long will it take?
- **Monitoring.** How will the strategy be tracked and monitored for effectiveness? Is there a key performance indicator?

Yurok Tribe and Climate Change: An Initial Prioritization Plan

The Yurok Tribe in northern California prepared a Climate Change Adaptation Plan for Water & Aquatic Resources (2014–2018) using a similar multiphase adaptation planning process. Step 3 of the process was "Identify and Prioritize Solutions." A particular focus were the importance of traditional knowledge derived primarily from interviews with elders and the adoption of holistic thinking in all phases of the process. From these was derived a set of four criteria for evaluating potential strategies (Section 8.2):

1. Address important areas of concern [identified in the vulnerability assessment].

2. Are in line with the Yurok holistic world view on the inter-connectedness of all things.

3. Provide benefits across multiple habitats and species.

4. The degree of benefit provided and whether they might cause harm in some way.

As an example, one strategy that came from this approach was: "Continue to reinvigorate traditional Yurok values and practices." The plan states: "Traditional Yurok values and practices are a form of resilience that have helped Yurok survive and thrive amidst the numerous challenges they have experienced (Ch. 1). '[These values] have carried Yurok throughout time,' notes Joe Hostler, with the Yurok Tribe Environmental Program, and will help Yurok in a future with climate change as well" (Section 8.2).[18] The strategy then details specific actions to implement the strategy and address climate change.

Cost/Benefit Assessment for Adaptation Actions

The two resources below illustrate ways in which communities can assess and balance the benefits associated with adaptation actions and the costs. Balancing these is critical to communities to achieve the most effective and implementable outcomes.

- Using a NOAA framework, the San Diego Regional Climate Collaborative compared the trade-offs (cost vs. benefits) of various coastal adaptation strategies. This assessment evaluated the utility of the NOAA Framework and demonstrated the outcomes for two southern California cities. The outcomes balanced costs of the strategies against the potential losses associated with various scenarios.[19]

- In *Economic Analysis of Nature-Based Adaptation to Climate Change: Ventura County, California*, the Nature Conservancy assessed the potential costs and benefits of engineered measures (coastal armoring) compared to nature-based adaptation measures. The Nature Conservancy's publication summarizes the evaluation methods and the findings as an example to other jurisdictions. This type of analysis gives a community insight into the reasoning behind actions to address sea level rise.[20]

The *Regional Resilience Toolkit* suggests looking at four "frames" when prioritizing strategies:[21]

- **Society and equity.** Effects on communities and the services on which they rely, with specific attention to disproportionate impacts due to social, political, or economic inequality.
- **Economy.** Economic aspects that may be affected, such as costs of physical infrastructure damages or lost revenues during recovery periods.
- **Environment.** Environmental aspects that may be affected, including ecosystem functions and services and species diversity.
- **Governance.** Factors such as organizational structure, ownership of assets, management responsibilities of assets, jurisdictional mandates, regulations, or funding options that affect how a community can respond to a hazard.

The *Regional Resilience Toolkit* includes an Evaluation Criteria Worksheet (Appendix B, Step 3.3, pages 3.8 to 3.9) that places these frames into a scoring matrix to help evaluate and prioritize which strategies to implement. The considerations listed above can be used to effectively evaluate the strategies. The project team, advisory groups, and key stakeholders who would have a role in implementation should be involved in scoring and prioritizing strategies. It is important to get feedback from a variety of stakeholders outside of the core project team, especially those representing frontline communities, because they will most likely evaluate the strategies differently. To develop an effective implementation plan, it is essential to get input on who could assist and what could possibly hinder the implementation of a strategy.

Each strategy can be scored by whether it meets the criteria, does not meet the criteria, or has a negative effect. Higher scores typically demonstrate a higher priority and feasibility of implementation. Based on these scores, the strategies can be grouped under Very High Priority, High Priority, and Important. Multiple scores can be averaged across worksheets.

The Adapting Rising Tides (ART) Program offers an online ART Portfolio, which includes reports, resources, examples, how to guides, and supplies to support climate adaptation planning. ART Supplies includes a helpful *How-To Guide*, "Developing Evaluation Criteria," which provides more information and guidance to support preparation of an evaluation worksheet.

Step 3.5: Conduct Outreach and Engagement

There are many creative, easy, and affordable ways to involve stakeholders in brainstorming and drafting adaptation strategies. This outreach is meant to build on the information about climate change effects and the involvement with the vulnerability assessment to now develop solutions.

OUTREACH TO DEVELOP ADAPTATION STRATEGIES

Several methods of engagement may be appropriate to gather ideas from community members, including:

- Pop-up booths at community events
- Design charrettes
- Focus groups
- Interactive workshops
- Online and mobile engagement
- Open houses
- Surveys
- Tours

What is important for any engagement activity is that it be well prepared and smoothly facilitated. The *Regional Resilience Toolkit* is a good resource for meeting logistics and a workshop checklist if templates are needed to help plan a successful event.[22]

Figure 13. Example Templates and Worksheet from the Regional Resilience Toolkit

Source: U.S. Department of Homeland Security, U.S. Environmental Protection Agency, Association of Bay Area Governments, Regional Resilience Toolkit, July 2019, Appendix A and Appendix B,

A few reminders when planning events:

• Partner with community-based organizations to conduct outreach (and provide stipends when available).

• Do preparation work to train community members to be ambassadors on the planning process and lead aspects of the outreach.

• Hold events at local, frequently visited locations that are easily accessible by transit (like libraries, schools, or recreation centers).

• Use culturally appropriate materials in relevant languages and approach outreach in ways that are culturally familiar to the community.

• Use arts, music, and storytelling to engage youth and a broader audience.

• Provide childcare services and/or kids' activities.

- Provide assistive technologies (products, equipment, and systems) to help people who may have difficulty speaking, typing, writing, remembering, pointing, seeing, hearing, or learning.

OUTREACH TO PRIORITIZE ADAPTATION STRATEGIES

Once stakeholders have brainstormed adaptation strategies, the project team should categorize and prioritize strategies before seeking additional feedback from the community. One way to help with this would be to summarize and visually illustrate aspects of each strategy, which could include:

- A cost or feasibility estimate
- A list of co-benefits, including equity implications
- Downsides to adopting the strategy
- Potential barriers or challenges
- Implementation needs
- Case study or example
- Other important information from Step 3.4

Graphically or visually presenting this information for each strategy makes it easy to review and assess through online surveys, in-person workshops, or other types of engagement. An example of how adaptation strategies could be presented to the community is taken from the Long Beach *Climate Action and Adaptation Plan* workshops and shown on Figure 14.

Figure 14. Long Beach Adaptation Strategy
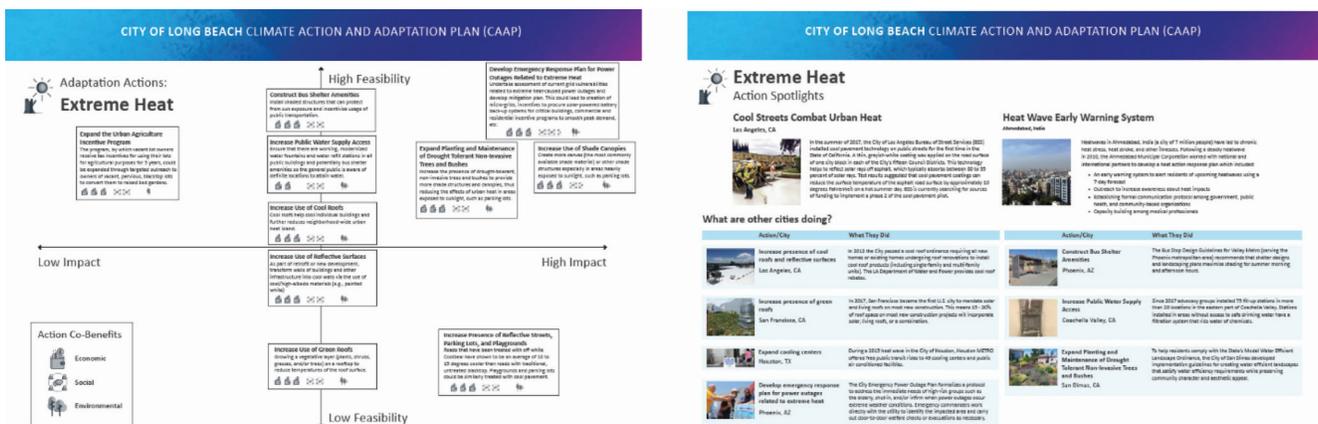
Source: [City of Long Beach, Climate Action and Adaptation Plan, 2019](#), accessed August 2019.

To take strategy review and prioritization a step further, some government agencies have developed games to engage residents in developing adaptation strategies. For example, the County of Marin created "Game of Floods" (see Figure 15) to educate the community about sea level rise vulnerability and adaptation. The game allows players to design collective solutions that protect airports, wastewater treatment facilities, individual properties, and more. Players work around the board collaboratively and discuss adaptation strategies, considering their effectiveness, impacts, uncertainty, and relative costs.

### Figure 15. Example Game to Engage Residents
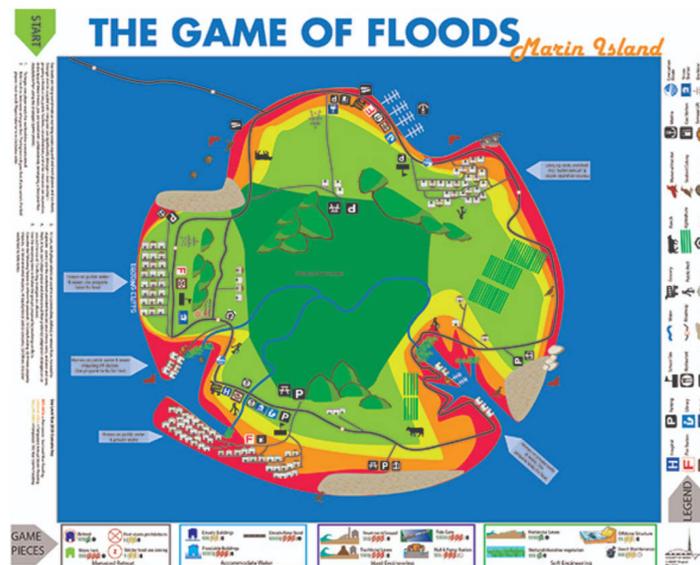
Source: County of Marin, Game of Floods, 2019, https://www.marincounty.org/depts/ cd/divisions/planning/csmart-sea-level-rise/game-of-floods.

The project team should be prepared to receive extensive feedback on the adaptation strategies and to interpret how community members understand and value each of the strategies presented. It is helpful to develop a method for capturing and incorporating feedback through sticky notes, sticky dots, photos, video recordings, or online analysis. The entity leading the outreach process should also post the outcomes of the voting and workshop summaries online or in other publicly accessible locations for transparency.

ENSURING EQUITABLE ADAPTATION STRATEGIES

During the development of adaptation strategies, the project team and community members should think about how strategies can be aligned with equity principles and how they can be transformative, addressing social inequities as well as climate change impacts. Figure 16 shows an example approach to developing adaptation strategies and achieving equity.[23]

Figure 16. An Example of Community Adaptation Solutions and Transformative Actions
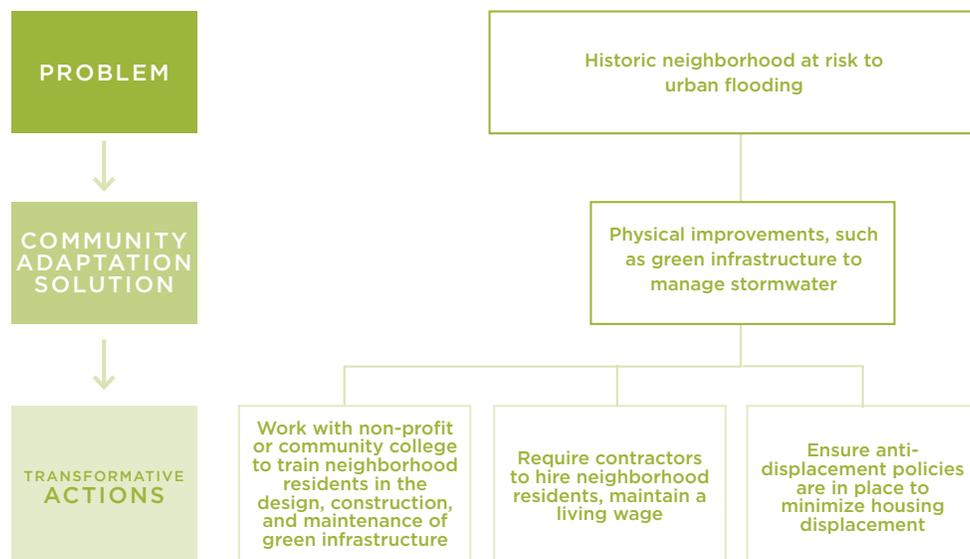
Source: Tina Yuen, Eric Yurkovich, Lauren Grabowski, and Beth Altshuler, Guide to Equitable Community-Driven Climate Preparedness Planning, prepared for Urban Sustainability Directors Network, May 2017, page 43, accessed November 2019.

As the adaptation strategies are refined, it is good to take a step back and reflect if the strategies are realistic and equitable. Table 12 shows a set of questions developed by Greenlining Institute in *Making Equity Real in Climate Adaptation and Community Resilience Policies and Programs: A Guidebook*.[24] The questions are partly based on the "Resiliency Guidebook: Equity Checklist" developed by the California Governor's Office of Planning and Research.[25] For consistency with the guidance and terms used in the APG, Table 12 uses the term "strategy" instead of "program or policy," which is the term in Greenlining's original version of this table.

TABLE 12. QUESTIONS TO ENSURE EQUITY IN ADAPTATION PROCESS	
TOPIC	**QUESTIONS**
Identifying vulnerable populations	Which vulnerable populations may be impacted by or could benefit from the strategy? How has the community identified these populations?
Targeted Funding	Does the strategy have dedicated set-asides for vulnerable communities?
Accessibility	Are the benefits of the proposed strategy broadly accessible to households throughout the community, particularly communities of color, low-income populations, housing-insecure households, people with disabilities, people experiencing homelessness, tribal and indigenous communities, and immigrant communities?
Engagement	Have you designed a process to collaborate with vulnerable populations that engages and empowers them in a meaningful, authentic and culturally appropriate manner? Which best practices for community engagement are you implementing?
Assured Benefits	What mechanisms will you use to assure particular benefits to vulnerable populations? (e.g. provide technical assistance or capacity building, provide jobs, provide extra financial resources or investments)
Disproportionate Impacts	Does the strategy generate burdens (including displacement and increased costs), either directly or indirectly, on vulnerable populations? If yes, how will you address and mitigate them?
Capacity Building	How will the strategy provide for local capacity building? (e.g. through funding, expanded knowledge base or other resources?)
Relationship Building	Does the strategy help foster the building of effective, long-term relationships and trust between diverse communities and government? Does the strategy align with and support existing community priorities, creating an opportunity to leverage resources and build collaborative partnerships?

TABLE 12. QUESTIONS TO ENSURE EQUITY IN ADAPTATION PROCESS	
TOPIC	**QUESTIONS**
Shared and Multiple Benefits	How may the strategy decrease inequality in income or wealth? How does the strategy increase adaptive capacity and/or reduce exposure climate change effects in frontline communities? Can the benefits of the strategy be targeted in progressive ways to reduce historical or current disparities? How may the strategy ensure safety and improve health outcomes for vulnerable populations?
Economic Opportunity	Does the proposed strategy support vulnerable communities through workforce development, affordable housing, or contracting opportunities?
Accountability	How will you evaluate the equity impact of the strategy? Does the proposed strategy have appropriate accountability mechanisms to ensure that vulnerable communities will equitably benefit and not be disproportionately harmed?
Adaptive Management	If data shows you are not on track to meet the equity outcomes, do you have a plan to adjust and correct course?
Communication	How will you communicate progress to stakeholders?

Phase 3 Wrap-Up

Communities have a wide range of potential strategies to improve resilience to a changing climate. These strategies can take the form of new programs or initiatives, policies, regulations, physical construction projects, and evaluation efforts, among others. Strategies should be feasible and appropriate for the community with its available resources. They should be responsive to the issues identified in the vulnerability assessment, address overarching issues such as equity, and provide co-benefits to the community. They should also be flexible enough to accommodate the inherent uncertainty in climate change planning. Once a community has identified and prioritized the adaptation strategies, the community can move into the fourth phase of adaptation planning, Implement, Monitor, Evaluate, and Adjust.

PHASE 4: IMPLEMENT, MONITOR, EVALUATE, AND ADJUST

In Phase 3, the project team and community built an adaptation framework of the community's vision, goals, and priority adaptation strategies. Phase 4 uses the adaptation framework to prepare an implementation program.

This section summarizes the most important step of adaptation planning, implementation. To ensure that implementation of each strategy is effective and continues to be effective, communities should monitor, evaluate, and modify strategies as needed based on their observed effectiveness, local changes, and new science. This section divides the Phase 4 process into four steps, shown in Figure 17.

- Prepare an implementation program to put adaptation strategies into action.
- Create a monitoring program to track implementation and ensure the monitoring program can be adjusted as needed.
- Establish an evaluation processes to assess how well and how long the vulnerability assessment and adaptation strategies serve the community; ensure that the evaluation process can be adjusted as necessary.
- Adjust adaptation strategies as monitoring and evaluation input is received.

Figure 17. Steps in Phase 4

STEP 4.1 IMPLEMENT	STEP 4.2 MONITOR	STEP 4.3 EVALUATE	STEP 4.4 ADJUST

Outreach and Engagement

Community and Stakeholder Engagement in Phase 4

Long-term implementation cannot be effective without close collaboration with the community. Outreach and engagement should be conducted through all phases of adaptation planning and should continue through implementation. Beginning with the scoping of the adaptation planning efforts (Phase 1) and continuing with the vulnerability assessment (Phase 2) and development of strategies (Phase 3), close collaboration bolsters community understanding and support for implementation. Implementation should actively and meaningfully involve community members and provide transparency in the monitoring and evaluation of effectiveness. This is particularly important in frontline communities who are disproportionately vulnerable to climate change, including tribal communities. This ensures that community members are partners if the results of monitoring and evaluation require a change in adaptation strategy. Involving the same representative groups formed during the previous phases can help with this objective.

In all the phases, equity is a critical component of these efforts. This means including opportunities for meaningful involvement from members of frontline communities and vulnerable populations who are disproportionately impacted by climate change and often underrepresented in community decision-making processes. Tribal communities are also often underrepresented in local government processes and should be intentionally engaged or partnered with, especially when a project impacts tribal resources. (Note: If the plan or project resulting from the adaptation process is a General Plan Amendment or otherwise subject to the California Environmental Quality Act, the lead agency must follow state regulations for tribal consultation and assessment of potential impacts to cultural resources as early as possible in the project.) It is important to rely on frontline, vulnerable, and tribal community representatives for their local expertise and to determine adaptation planning strategies and implementation options.

When community members understand the frequency and severity of climate-related hazards is linked to the effectiveness of GHG reduction and climate change adaptation strategies, it prepares them for the necessity of adjusting approaches to adaptation over time. Fostering this understanding and including the groups formed in assessing monitoring data and choosing next steps is critical to ongoing effectiveness. Each step of Phase 4 incorporates outreach and provides a list of sample actions. These outreach actions are primarily taken from the *Guide to Equitable Community-Driven Climate Preparedness Planning* by the Urban Sustainability Directors Network.

Step 4.1: Implement

In Phase 1, Step 1.1, the project team identified the end product or plan of the adaptation planning process. Phase 1 also presented the types of plans, programs, and implementation mechanisms common in adaptation planning. In Phase 3, the project team developed and prioritized adaptation strategies. Development of

adaptation strategies likely included identification of a potential lead department and/or partners tasked to implement a strategy, a time frame for implementation, and potential cost estimates. When starting Phase 4 and implementation, the first step is to prepare an implementation program and to confirm the implementation mechanism and responsible department of entity needed for each adaptation strategy. Some strategies will be implemented upon adoption of the plan prepared as a result of the adaptation planning process, while others will need to be further developed and/or be integrated into other plans or programs.

All adaptation strategies have temporal components that include time to implementation, timing of necessary action, and duration of effectiveness. These elements of time must be considered for all strategies and when devising the method of measure delivery.

For implementation strategies that will be further developed or implemented, the team should identify the planning document or other mechanism best suited to drive strategy implementation, as well as any documents that should be amended to ensure consistency. The answers to two questions can help clarify the choice of mechanism:

1. Which mechanism most closely overlaps the intent and topic area of a strategy?
2. Which mechanism is next slated for update or revision?

Regardless of how they are implemented, adaptation strategies tend to be in more than one plan, such as the general plan, local hazard mitigation plan (LHMP), climate action or sustainability plan, integrated regional water management plan, and capital investment plan. Other possible mechanisms for adaptation strategies are discussed in Phase 1.

- **General plans.** In 2017, OPR released updated General Plan Guidelines. These guidelines are a resource for understanding where climate adaptation strategies are best integrated into a general plan. Climate adaptation influences content in all chapters of a general plan; however, the element that often holds the most adaptation content is the safety or comparable element. Other elements of the general plan, including optional elements such as an "equitable and resilient communities" element, may also have adaptation content.[1]
  - The **safety element** is the primary location for addressing climate-exacerbated hazards and climate change impacts. This includes identifying community vulnerabilities associated with climate change (see the vulnerability assessment described in Phase 2) and developing strategies to address these vulnerabilities (Phase 3). The safety element should include a vulnerability assessment or a reference to where it is in another document. This element in particular must be consistent with the LHMP if the community has one. It also needs to be consistent with other elements of the general plan, such as land use, circulation, housing, conservation, air quality, and environmental justice.

- The **land use element** includes the planned future pattern of all community land uses and can include policy language that reduces the vulnerability of existing and new development.

- A **circulation element** can include policies ensuring appropriate ingress and egress for all neighborhoods and that major circulation corridors are not endangered by climate impacts and addressing other mobility-related vulnerabilities.

- **Housing element** policies ensure that all residential land use by type, location, and building standards are resilient to heat, poor air quality, and all other potential climate impacts. These policies can also address the availability of housing and the vulnerabilities of persons who are susceptible to climate change due to their living situation. The California Department of Housing and Community Development (HCD) has an abundance of technical assistance available to local governments.

- The **conservation** and **open space elements** include strategies to protect vulnerable ecosystems (habitat, sensitive and endangered species, other flora and fauna). They may also include policies to reduce vulnerabilities from hazards in natural areas (e.g., fire).

- The **air quality element** can address vulnerabilities from climate-influenced pollutants. For example, this optional element could address vulnerabilities from increased ozone due to warmer temperatures, and issues from increased particulate matter associated with drought or fire.

- The **environmental justice element** or content can specifically acknowledge that some subpopulations in a community are disproportionately vulnerable to climate impacts, particularly with respect to health outcomes. This element or content area relates to many other elements in the general plan.

City of Hermosa Beach General Plan and Climate Change

The City of Hermosa Beach General Plan, adopted in 2017, has a section in the safety element focused on climate change impacts and adaptation. This section addresses sea level rise, extreme heat, and other potential impacts, such as public health, precipitation, water, biological resources, agriculture, marine resources, and energy. The plan includes potential impacts of projected climate change and strategies to ensure the city is prepared for them.[2]

- **Local hazard mitigation plans.** LHMPs include both long-term and short-term hazard mitigation planning. They can include discussion of emergency preparation and response, such as notification systems and available resources for emergency response activities. These plans also should ensure that communities are prepared for escalating climate vulnerabilities. The LHMP should be consistent with a community's general plan safety element.

- **Climate action plans/sustainability plans.** Climate action plans (CAPs) or sustainability plans are broad strategic plans to address climate change or sustainability. They do not have a standard structure or form, unlike other mechanisms such as general plans. Climate change adaptation is often a component, although some may focus only on greenhouse gas reductions. They may include or refer to a vulnerability assessment (Phase 2). Some of their strategies often overlap with the general plan, LHMP, and other plans such as a bike and pedestrian plan. Many CAPs and related documents discuss implementation issues, including assigning responsible entities, funding, and indicators for monitoring.

City of Santa Cruz Local Hazard Mitigation Plan

When the City of Santa Cruz updated its LHMP for 2017–2022, it specifically included a section that addresses hazards such as wildfire, flooding, drought, coastal erosion, and landslides. The assessments in the "Climate Change Considerations" section relied on data from Cal-Adapt and other resources.[3]

San Diego County Multi-jurisdictional Hazard Mitigation Plan

In 2017, San Diego County, its incorporated communities, and three special districts adopted a multi-jurisdictional HMP. The plan includes a vulnerability assessment, a section on emerging hazards posed by climate change and sections on existing hazards including analysis of how climate change may exacerbate these issues. As the plan was being developed, planners held a series of workshops to specifically discuss the effects of climate change. Regional organizations such as academic and institutional agencies were key partners in developing the plan.[4]

- **Integrated regional water management plans.** Integrated regional water management (IRWM) plans address water concerns at a regional level. SB 1672 (2002) requires IRWM plans that address water supply and quality, flood protection, and other matters. The California Department of Water Resources' IRWM planning guidelines require the inclusion of climate change considerations in IRWM planning analyses. In an effort to assist practitioners, the Department of Water Resources developed a listing of climate change documents relevant to IRWM planning. The regional-level assessment, oversight, and strategies can deliver higher value investments and balance priorities among multiple jurisdictions. This is particularly important in settings such as the California Delta Ecosystem or the Salton Sea, where watershed issues fall under the authority of several local, regional, and state agencies.

- **Capital improvement planning.** A local government's capital improvement plan is an annual or biennial plan for financing community projects and is typically what funds community assets or infrastructure, such as bridges, water treatment facilities, or community centers and smaller projects such as new bike lanes or sidewalks. These projects may be directly vulnerable to climate hazards, may serve as shelters or gathering places or may provide evacuation routes during emergency situations. Having local community facilities and infrastructure that are climate resilient bolsters local adaptive capacity. In addition, integrating adaptation into the planning and design efforts for public projects nearly always saves a community money through avoided losses, even if the up-front costs of a new location or additional structural measures are slightly higher.[5] Climate-resilient features may also reduce regular maintenance and operation costs of some facilities (such as rooftop solar panels).

Adaptation strategies, regardless of the plan or program that contains them, need to be implemented to achieve their intended outcome. This requires assigning staff, developing programs or other measures, securing funding, and engaging the public. Many of these choices are described in Phase 3. It is important to confirm the remaining details to implement the strategy. This process builds on the prioritization of adaptation needs and strategies in previous phases, and outreach and funding are covered in subsequent sections. The way to implement adaptation actions will vary by location and jurisdictional context. Things to consider when developing the implementation approach are:[6, 7]

- **Build on existing processes.** Building on actions already proven effective in a community is a great place to start. Ideally, pursuit of this concept began in Phase 3, but further implementation includes integrating strategies into programs already in place from another plan, such as the general plan or LHMP. Bolstering or altering existing programs builds on internal strengths. Staff may already be

familiar with a particular type of policy or program, cutting down on training, the startup time, and associated costs.

- **Assess cost-effectiveness.** The project team should evaluate each implementation method for cost, down to the department and staffing requirements. This process also begins in earlier phases, such as Phase 3, but has a role here. In situations where multiple implementation options can achieve the same adaptation goal, cost/benefit assessment is a way to compare measures to determine the most cost-effective option or a sequence of measures that starts with the most fiscally feasible but potentially lower adaptation benefit in the short term. At its simplest, such an assessment looks at whether or not an action can be funded on an ongoing basis through the general fund. This case can be bolstered in when implementation yields future cost savings, offsetting the implementation cost. Strategies such as altering the building code for cooler (lighter color) roofs is an example that does not impose high costs directly on the local government. Other actions may be funded with establishment of a new fee system. Larger, structural projects are often funded through bonds. The measures that are more difficult to implement rely most on external funding or financing. In many cases, this is the most feasible option, but also the most tenuous.

City of Chula Vista Cost Effective Measures

Chula Vista, through use of the Climate Change Working Group (CCWG), adopted adaptation actions in 2011. The CCWG was made up of residents, businesses, and community representatives. In collaboration with city staff, this group brainstormed a lengthy list of potential measures, which it ultimately trimmed to 11 based on factors such as local jurisdictional authority and cost considerations. These considerations resulted in nearly all of the 11 actions being implemented. One such success was cool roofs. The CCWG recommended and city staff implemented a new cool roof ordinance. The measure was estimated to cost less than $30,000, an amount deemed feasible for the city budget.[8, 9]

- **Leverage community and private sector alliances.** Aligning strategies with local community groups and private sector entities is a good way to ensure ongoing effectiveness. It also is a way to limit cost burden by delegating aspects of implementation to an external entity. This can be formally established with an MOU or a similar formal partnership agreement. The following section describes outreach specifically, a critical part of ensuring that adaptation benefits are shared in all parts of a community and that the actions bolster social equity.

- **Establish partnerships regionally.** Geographic boundaries should not constrain adaptive actions, and some adaptive actions require regional collaboration. Regional compacts or less formal partnerships with regional entities can assist communities with technical assistance and potential funding. Regional partnerships also are a good way to engage in peer-to-peer learning with communities that share similar challenges. The Alliance of Regional Collaboratives for Climate Adaptation provides the context for many parts of the state to foster learning, allow for collaborative pursuit of funding opportunities, and develop private sector adaptation support.[10]

City of Oakland, Oakland Climate Action Coalition

The Oakland Climate Action Coalition (OCAC) formed in 2009 with 30 organizations, including those addressing issues such as sea level rise, environment, public health, and social justice. OCAC started with the intention of elevating voices seen as missing from Oakland's initial climate actions, and it has matured into a leading organization that provides a platform for the community promoting and supporting climate action. It has also been part of partnerships with regional and international entities (e.g., BCDC and the Kresge Foundation).[11, 12]

IMPLEMENTATION OUTREACH

When the adaptation planning is complete and the plan is approved, the transition to implementation can be celebrated with a fun, public event. Such an event is an opportunity to honor stakeholders and their role in the process and is the next step of implementation. The event should be planned with those already engaged in the process, but this is also an opportunity to identify stakeholders that have not been involved and could be important voices and partners during implementation. This includes communities most likely impacted by one or more points of vulnerability or affected by the strategies that have been prioritized for implementation.

Implementation strategies can and should build on the actions recommended in Phase 3. In this case, rather than asking community members to help brainstorm adaptation measures, community members can be asked for help supporting and bolstering implementation and supporting monitoring. During engagement, the project team can share ongoing progress of adaptation actions and their resulting benefits. Communities can be sought in the following roles:

- Collaborators in education.
- Participants and facilitators of tours of adaptation projects as they are implemented.
- Recipients of surveys to assess effectiveness and social acceptance.
- Receptors or generators of online updates of adaptation progress.
- Participants or leaders of pop-up booths at locations illustrating adaptive action or community events.

Communities can ensure ongoing support for adaptation by maintaining outreach efforts. Climate adaptation requires ongoing, long-term commitment despite the changes in elected leaders. When people are informed about and involved in adaptation strategy development, implementation, and monitoring, they are more likely to call on local leadership to continue support for that. In the best cases, local agency staff and local organizations are partners during the implementation process.

City of Oakland Community-Based Climate Adaptation Planning

The Pacific Institute report conducted in collaboration with OCAC, *Community-Based Climate Adaptation Planning: Case Study of Oakland, California*, identifies methods of engaging frontline communities in the implementation process—from the way that climate change is discussed to the methods that communities use to participate in implementation.[13] Two of these methods are: 1) an appointed task force of stakeholders from throughout the community who make recommendations about implementation, and 2) a community-initiated coalition, that is, a coalition of community groups who make recommendations collaboratively.

IMPLEMENTATION FUNDING

Strategies must be funded regardless of how they are implemented, or the planning mechanisms used. Funding and financing sources can include local general funds, bonds, taxes, assessments, fees, grants, private sector partnerships or investments, non-profit grants and partnerships, among others. The state has many grant programs to support location adaptation actions funded through cap-and-trade. The Adaptation Clearinghouse's "Investing in Adaptation" web page lists many funding opportunities by adaptation sector and has guidance on conducting fiscal analyses of adaptation strategies.[14] It is regularly updated as funding sources evolve. The California State Library also lists funding opportunities resulting from recent legislation.[15] *Climate Adaptation Finance and Investment in California* also has guidance on funding adaptation measures intended for local government staff. The *Regional Resilience Toolkit* includes steps for identifying and gathering adaptation funding sources.[16] Some federal sources, such as FEMA's Hazard Mitigation Grant Funding (HMGP) and Building Resilient Infrastructure and Communities (BRIC) programs can be used to fund and finance adaptation actions. Many communities across California have historically used federal funding for these activities. Non-profit funding sources may also be available.

Local agencies often rely on their general fund for partial or full funding of implementation since they control it and using it does not rely on local ability to receive grant funding or raise new capital. However, local agencies often have limited general funds and competing needs for its use.

In cases where a community does not have general funds, staff, or other funding resources to implement all adaptation strategies, it can be helpful to rank strategies by how important it is to enhancing climate resilience and by the local capacity to fiscally support implementation (refer to Task 1.2). Strategies can be classified based on whether current support of a strategy would require 1) no budget adjustment, 2) reallocation of funds, or 3) new and/or external funding.

City of Goleta: Coastal Hazards Vulnerability Assessment and Fiscal Impact Report

The City of Goleta's Vulnerability Assessment includes a fiscal impact report that not only details ways in which climate change may affect Goleta, but also specifically assesses the impact of climate change and adaptation measures on economic and fiscal resources. This includes the value of threatened assets and the expense associated with various adaptation measures and estimated city liability for vulnerabilities. This evaluation provides critical transparency to all community members. The report also includes identification of potential sources of funding to support the adaptation measures identified.[17]

Moulton Niguel Water District: Long Range Financial Plan Report

This assessment covers future water availability and the fiscal considerations needed to ensure water supply—from debt management, to changes in the cost of water, to future demand—and available funding sources such as the general fund and CIP financing. These considerations include assessments reaching 10 years into the future. Similar to Goleta, this report transparently addresses the provision of water for the community relying on the Moulton Niguel Water District.[18]

Blue Lake Rancheria Tribe Climate Change Adaptation and Mitigation

The Blue Lake Rancheria Tribe, located in Humboldt County, is rural and geographically isolated. Local climate change effects include heavy rains, high winds, flooding, and landslides across key transportation corridors, in addition to large wildfires. These hazards create vulnerabilities in the energy supply network, as the community connects to the larger PG&E grid and obtains diesel fuel from outside of the region, which can both be disrupted from climate change hazards. The Blue Lake Rancheria Tribal government determined that developing a microgrid system to service their community would be a high priority project to increase energy resilience in the community. The tribe partnered with the Schatz Energy Research Center and PG&E and received funding from the California Energy Commission Electric Program Investment Charge, to complete a low-carbon community microgrid powered by a 500-kilowatt solar photovoltaic array with associated battery storage. When the surrounding regional energy network goes down, the microgrid allows the tribal government offices, economic enterprises, supporting infrastructure, and certified American Red Cross Center to continue functioning as needed.[19]

OPR's *Climate Adaptation Finance and Investment in California* includes a chapter on funding and financing implementation with guidance for local governments regarding options for bonds and taxes. It also includes grant programs by sector. It is intended to provide a survey of issues, considerations and sources of funding that can help guide strategies and tactics for investing in adaptation and resilience in California.[20]

In times of economic downturn or limited local budget, collaboration with regional partners can result in joint planning and resource sharing activities, as well as cooperative purchasing agreements to support implementation. The Alliance of Regional Collaboratives for Climate Adaptation (ARCCA) provides ways for communities in many parts of the state to collaborate, limit costs, and achieve effective adaptation measure development and implementation.

AECOM partnered with Resources Legacy Fund to produce *Paying for Climate Adaptation in California: A Primer for Practitioners*, a report that synthesizes information local decision-makers need when thinking about funding and financing climate adaptation. The report offers a foundational understanding of existing constraints

and opportunities and recommends ways cities, counties, water districts, utilities, state agencies, private companies, and other entities can make adaptation and resilience investments.[21] The AECOM report categorizes funding opportunities into:

- **Grants and assessments.** Grants, such as planning grants that help fund acceleration of affordable housing production and streamline housing approvals, can be obtained for entities at all levels of government, and assessments rely on property owner. Both of these require high local capacity.
- **Taxes.** Taxes primarily require payment by property owners. Different taxes are subject to various rules and requirements but may be a good option for certain adaptation strategies.
- **Fees.** Fees rely on users to generate the funds to support adaptive measure implementation. In many cases, there are strict rules regarding where such funds may be spent.
- **Private involvement.** There are a variety of ways in which the private sector can be involved; however, there is less consistency between examples save for a common private investment for public benefit.

Resources such as Blue Forest Conservation's *Forest Resilience Bond*, the CEC's *Characterizing Uncertain Sea Level Rise Projections to Support Investment Decisions*, *Finance Guide for Resilient By Design*,[22] *Transit Resiliency Funding Opportunities*,[23] and others all provide guidance, suggestions, and ideas to guide funding to support adaptation strategy implementation. Funding is a dynamic component of adaptation planning. Many of the foundational funding sources are familiar, such as general funds; others, such as new grant programs or green bond financing, emerge on an ongoing basis. Many of the websites and resources summarized in this section, particularly from the State of California, such as the Adaptation Clearinghouse, allow communities to track the emergence of these resources.

Example: San Francisco Bay Restoration Authority Nine-County Parcel Tax

This tax of $12 per year per parcel provides $25 million annually for 20 years to support restoration of San Francisco Bay habitats. The tax passed in 2016 with 70 percent support to address sea level rise and extreme storms, bay access, habitat restoration, and wildlife protection.[24, 25]

In cases where an adaptation strategy requires construction of a physical asset typically included in a capital investment plan, the asset can be included in the annual or biennial planning process, which are better equipped for financing larger projects. An effective way to support implementation—whether using the capital investment plan or local general fund—is to demonstrate the fiscal benefits from loss avoidance and improved public safety. It is almost always less costly to address climate impacts or hazards ahead of time rather than responding after they happen.

Step 4.2: Monitor

Climate conditions continually change, as do science, community characteristics, regulations, technology, and other factors that affect adaptation needs. Monitoring is critical to ensure that the chosen strategies to address community vulnerability continue to be as effective as planned. For each adaptation strategy, one department should be designated as the responsible agency for carrying out monitoring activities, including storing monitoring data. In many cases, this also requires designation of a dedicated funding source for monitoring activities. The responsible agency can be a jurisdictional department, regional entity such as a council of governments, or a community group. If a community group, a specific memorandum of understanding should be established between a jurisdictional department or regional entity and the community group to ensure ongoing data collection and data quality. There should also be a designated department that gathers and compiles all the monitoring data from all the monitoring entities to conduct an overall assessment of effectiveness.

Monitoring is the easiest and most cost-effective when using an indicator that is already collected as part of day-to-day operations. During strategy development and prioritization (Phase 3), the indicator to be monitored should be identified. It should reflect the impact being addressed, the desired outcome, and the specifics of the individual strategy. Identified indicators should be collected at a prespecified interval—at least annually, although more frequent collection rates may be necessary (such as event frequency or tide height). Example indicators include signals of the impact being addressed, such as beach width, mean high tide, flood frequency and peak flow, or fire frequency and intensity; the desired outcomes, such as asthma rates, days missed from work or school, air quality, or climate hazard losses; and specifics of the strategy, such as structural condition of mitigation or days and frequency of closure or service disruption (roads or other assets).

MONITORING AND OUTREACH

The results of monitoring efforts should be reported regularly to the public to maintain awareness of effectiveness and local adaptation needs. Communities can publish a regular adaptation report to the public, place the information on an interactive website that is regularly updated, or report the results through other means. The cities of Encinitas, Burlingame, and Richmond all provide examples of municipal efforts for communicating implementation progress. This type of transparency is critical to keeping the community engaged in the ongoing challenge of adaptation. In particular, this data should be available and communicated to community members who are expected to be most susceptible to climate-related issues. Some sample actions are:

> ### Example: City of Arcata King Tide Community Observation
>
> The City of Arcata has developed a website where community members can participate in the collection of visual data on water levels during "king" tides. The website asks community members to take photographs of the bay, creeks, and streams and upload them to the website, creating collective visualization of high water levels.[26]

- Document lessons learned during the planning process and ensure that future planning processes take the lessons into consideration.
- Have a community advisory board lead monitoring and review of the plan, or partner with a university or college program to do this.
- Identify mechanisms for holding agencies and departments accountable.
- Use "open data" online platform approaches to sharing climate, project implementation, and equity information with community members.

Step 4.3: Evaluate

Strategies are evaluated because the increasing severity of climate change and changes in community characteristics cause continually changing levels of effectiveness. Monitoring is the first step in adjusting to these changes. The monitoring data should be analyzed and evaluated to identify if and how a strategy no longer meets community needs. This evaluation should focus on what the community sees as the goal of the adaptation strategy, so that effectiveness can be assessed based on community need. When a strategy is identified as losing effectiveness, a series of steps are needed to plot a path forward. State legislation may also trigger a re-evaluation of the vulnerability assessment and adaptation strategies.

When a strategy loses effectiveness, the vulnerability and susceptibility of the people, resources, assets, or operations it affects should be reassessed. It is most practical to keep the focus of the reassessment as narrow as possible—a new, comprehensive vulnerability assessment is not always necessary. When updating a vulnerability assessment—whether individual scores or the entire analysis—the first priority is to review any scientific updates and changes to community characteristics. The Intergovernmental Panel on Climate Change updates its periodic summary of climate science and global adaptive needs every five to seven years.[27] The state issues an updated *Safeguarding California Plan* periodically with updated science and state conditions, and conducts a new *Climate Change Assessment* every few years.[28] There are also many regional assessments emerging from universities and regional agencies or nongovernmental entities. All these reports may have updated science and other useful information.

Another source for new or improved data is datasets or studies prepared in the aftermath of climate-exacerbated hazards, such as fire or flooding. These resources often combine local social conditions and context with bio-geophysical factors that contributed to the experienced hazard event.

As community planners know, community characteristics change over time. When an adaptation strategy loses effectiveness, it is critical to assess whether or not changes in the community have altered the experienced climate change effects, increased the vulnerability of any populations or assets, or made any additional community members or assets susceptible. For example, if a growing community has increased its level of development and associated impervious surfaces, it may have also increased its flood risk. The community should assess if the escalating risk disproportionately affects any specific populations or locations. County health departments are a key community ally in identifying changes to the population characteristics and to overall health indicators.

California Adaptation Planning Guide

EVALUATION AND OUTREACH

Community outreach and education programs about evaluation can be a very effective way to engage community members in efforts to shift course in adaptation strategies. Include the public by, at a minimum, disclosing evaluation outcomes transparently. This leads to a better understanding of the finite nature of any single adaptation strategy. It is also possible to include community organizations or committees in the assessment and evaluation of monitoring data. More direct participation fosters better understanding across more of the community, and it should include disproportionately affected or frontline communities in these efforts. Some sample actions are:

- Define and regularly measure a series of equity-related indicators.
- Develop a reporting system (e.g., online) to communicate results for the equity-related indicators through time.
- Ensure clear avenues for recourse and accountability of project implementation.

Step 4.4: Adjust

Evaluation of monitoring data following measure implementation may reveal the need for adjustment, which could trigger the strengthening of a strategy or an entirely new approach to the vulnerability. Each strategy should be evaluated carefully to assess the extent to which it can be bolstered to address increasing impacts of climate change and the extent to which it precludes strategies that may more effectively address the impacts. Such assessments should take place during the first couple of years of implementation of any strategy so that potential strengthening and compatibility with other strategies are known from the outset, making for smoother adjustments based on indicator evaluation. For example, strengthening a sea wall or flood wall may make retreat or accommodation strategies more difficult to pursue; however, in many cases, initially bolstering a physical barrier can give a community time to set up strategies that accommodate higher sea or flood levels. Once those are in place, the physical barrier should give way to the accommodation strategy (see Table 13). Evaluation of monitoring data can help communities determine when such transitions should take place.

Strengthening a strategy varies widely by strategy, from changing the speed of implementation, to altering its location, to revising the implementation mechanism. The changes to strengthen a strategy should be identified as part of the initial implementation, and the indicator being monitored should be tied to pre-identified points where strengthening may be required.

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As well as evaluating strategies for the extent to which they can be strengthened, they should be evaluated for their compatibility with potentially more effective strategies. In many cases the strategies that are potentially more effective take longer or cost more to implement, making them better suited to be a longer-term strategy that can be implemented after priority strategies are put into effect. Choosing when to shift to the longer-term strategy is more easily managed when specific triggers for the shift are identified ahead of time (see Table 13).

TABLE 13. EXAMPLE OF BEACH EROSION ADAPTATION OPTIONS			
RISK	**ACTIONS**	**LEAD TIME**	**ADAPTATION OPTIONS**
Beach Erosion	Protect	5–10 years	Beach and dune nourishment
		10–15 yrs	Raise and Improve sea walls
		15–20 yrs	Sand retention strategies
	Accommodate	5–10 yrs	Elevate structures
	Retreat	15–20 yrs	Relocate public infrastructure

Source: Environmental Science Associates, City of Del Mar Sea-Level Rise Adaptation Plan, prepared for the City of Del Mar, August 2016, updated May 2018, https://www.delmar.ca.us/DocumentCenter/View/3580/Revised-Adaptation-Plan-per-Council-May-21.

ADJUSTMENT AND OUTREACH

Communicating with the community and inviting its collaboration throughout the implementation process, both before and during adjustment, are critical to sustaining ongoing adaptation. A community should not be surprised by changes in approach, which should be communicated consistently as a normal part of long-term climate adaptation strategy implementation. Without appropriate inclusion of the community throughout the process, changing a strategy could be viewed as abandoning it or as a failure of implementation rather than as a successful outcome of good monitoring and evaluation. Sustained engagement with the community and transparency in monitoring and evaluation can help avoid such misunderstandings, which can lead to community dissatisfaction with adaptation actions. Additionally, community inclusion can supplement the selection process for the new or bolstered strategy.

Some sample actions are:

- Ensure that lessons learned and outcomes from review and monitoring of implementation are publicly available.
- Use data to inform plan updates and/or make any needed course corrections.
- Develop materials allowing for pop-up events to solicit feedback and ideas for strategy adjustment when needed.
- Collaborate with the community to update strategies and program implementation based on lessons learned from monitoring.

Phase 4 Wrap-Up

Adaptation planning work does not end when the plan is finalized. Communities must implement the plan, monitor and evaluate its effectiveness, and adjust the plan in response to feedback and changing conditions. It is important to determine funding, timing, and responsibility as part of this work. And as with all other phases of adaptation planning, community engagement is critical. Adaptation planning is a cyclical process, and the adjustment work in particular involves revisiting or redoing previous phases. With a robust and ongoing adaptation planning effort, communities position themselves to better resist a changing climate so that they can continue to thrive.

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DEFINITIONS

Adaptation (Climate Change): Making changes in response to current or future conditions (such as the increased frequency and intensity of climate-related hazards), usually to reduce harm and to take advantage of new opportunities.[1, 2] Climate change adaptation describes actions that address the projected impacts on all aspects of community function that may result from climate change. This can include impacts related to hazard events (flood, wildfire, drought, severe storms), as well as slow changes that affect agricultural, forestry, and fisheries productivity; ecosystem structure and function; and public health.[3]

Adaptive Capacity: The "combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities". The ability to adjust to potential damage, to take advantage of opportunities, or to respond to consequence.[4]

Climate Change: Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use.[5, 6]

Climate Justice: Climate justice is defined as "the concept that no group of people should disproportionately bear the burden of climate impacts or the costs of mitigation and adaptation".[7]

Climate Scenarios: A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as the observed current climate.[8, 9]

Community Asset: A valued feature of a community that may be harmed by climate change. Community assets may include buildings and facilities, key services, ecosystems, economic drivers, and infrastructure.[10]

Community-Based Organization: A group of individuals organized by and for a particular community of people based on shared interests and/or attributes. The community could be defined geographically (e.g. a neighborhood), could contain

members from diverse backgrounds, and/or could be defined on the basis of something like religious beliefs or a shared condition. Members may include various stakeholders, such as the public, elected officials, advocacy groups, and business leaders.[11, 12]

Disadvantaged Communities: Areas disproportionately affected by environmental pollution and other hazards that can lead to negative public health effects, exposure, or environmental degradation, or with concentrations of people that are of low income, high unemployment, low levels of homeownership, high rent burden, sensitive populations, or low levels of educational attainment.[13, 14]

Environmental Justice: The fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation and enforcement of environmental laws, regulations, and policies.[15, 16]

Equity: Equity is just and fair inclusion into a society in which all can participate, prosper, and reach their full potential.[17, 18]

Equity (Climate): The central equity challenges for climate change policy involve several core issues: addressing the impacts of climate change, which are felt unequally; identifying who is responsible for causing climate change and for actions to limit its effects; and understanding the ways in which climate policy intersects with other dimensions of human development, both globally and domestically.[19, 20]

Evapotranspiration: The process of transferring water through plants by evaporation from the land to the atmosphere.

Extreme (Climate) Event: When a weather or climate variable exceeds the upper or lower thresholds of its observed range.[21, 22]

Exposure: The presence of people, infrastructure, natural systems, and economic, cultural, and social resources in areas that are subject to harm.[23]

Frontline Communities: These communities experience the impacts of issues such as environmental pollution, climate change, and the economic crisis first and most severely. These communities are most often communities of color and low income.[24]

Hazard: An event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural losses, damage to the environment, interruption of business, or other types of harm or loss.[25]

Hazard Mitigation: Sustained action taken to reduce or eliminate the long-term risk to human life and property through actions that reduce hazard, exposure, and vulnerability.[26] Hazard mitigation can one component of climate change adaptation.[27]

Impact: In the context of climate adaptation, the effects (especially the negative effects) of a hazard or other conditions associated with climate change. Impact is often considered the combination of exposure and sensitivity.[28] Impacts are sometimes discussed in terms of direct or indirect impacts. Direct impacts on physical assets or immediate operations can lead to more indirect impacts on the broader system or community.[29]

Maladaptation: Adaptation efforts that worsen a situation, or transfer the challenge from one area, sector, or social group to another.[30]

Mitigation (Climate): Climate change mitigation refers to "a human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks."[31, 32]

Probability: The likelihood of hazard events occurring. Probabilities have traditionally been determined from the historic frequency of events. With changing climate and the introduction of non-climate stressors, the probability of hazard events also changes.[33]

Resilience (Climate): The capacity of any entity—an individual, a community, an organization, or a natural system—to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience. (Rodin, 2014) Adaptation actions contribute to increasing resilience.[34, 35]

Resilience (Community): Community resilience is the ability of communities to withstand, recover, and to learn from past disasters to strengthen future response and recovery efforts. This can include but is not limited to physical and psychological health of the population, social and economic equity and well-being of the community, effective risk communication, integration of organizations (governmental and nongovernmental) in planning, response, and recovery, and social connectedness for resource exchange, cohesion, response, and recovery.[36]

Risk: Risk for the purpose of hazard mitigation planning, is the potential for damage or loss created by the interaction of hazards with assets such as buildings, infrastructure, or natural and cultural resources. For natural hazards, risk tends to be calculated based on evaluation of the probability (likelihood) of a hazard event occurring, vulnerability, and the event's potential consequences. This method uses data from the past to establish the probability and, in the case of climate change, includes future projections of probability.[37]

Sensitivity: The level to which a species, natural system, or community, government, etc., would be affected by changing climate conditions.[38]

Social Vulnerability: Social vulnerability is "the susceptibility of a given population to harm from exposure to a hazard, directly affecting its ability to prepare for, respond to, and recover."[39, 40]

Susceptibility: A person or population's potential for vulnerability due to demographic, socioeconomic, and geolocation characteristics.

Vulnerability: Climate vulnerability describes the degree to which natural, built, and human systems are susceptible "…to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt."[41] In hazard mitigation planning, for buildings and other structures, vulnerability means susceptibility to damage given the inherent characteristics of a particular structure. Its broader meaning is the level of exposure of human life and property to damage from natural and human-made hazards.[42] Vulnerability can increase because of physical (built and environmental), social, political, and/or economic factor(s). In the case of climate change, vulnerability is often defined as the combination of impact and adaptive capacity as affected by the level of exposure to changing climate.1 Notably, impact is often determined by the combination of exposure and sensitivity, and vulnerability is considered a function of exposure, sensitivity, and adaptive capacity.[43]

Vulnerability Assessment (Community): For climate change, it is an analysis of how a changing climate may harm a community and which elements—people, buildings and structures, resources, and other assets—are most vulnerable to its effects based on an assessment of exposure, sensitivity, the potential impact(s), and the community's adaptive capacity.

Vulnerable Communities: Vulnerable communities experience heightened risk and increased sensitivity to climate change and have less capacity and fewer resources to cope with, adapt to, or recover from climate impacts. These disproportionate effects are caused by physical (built and environmental), social, political, and/or economic factor(s), which are exacerbated by climate impacts. These factors include, but are not limited to, race, class, sexual orientation and identification, national origin, and income inequality.[44]

Vulnerable Populations: Vulnerable populations include, but are not limited to women; racial or ethnic groups; low-income individuals and families; individuals who are incarcerated or have been incarcerated; individuals with disabilities; individuals with mental health conditions; children; youth and young adults; seniors; immigrants and refugees; individuals who are limited English proficient (LEP); and Lesbian, Gay, Bisexual, Transgender, Queer, and Questioning (LGBTQQ) communities, or combinations of these populations (HSC Section 131019.5, CNRA 2018).[45, 46]

APPENDICES
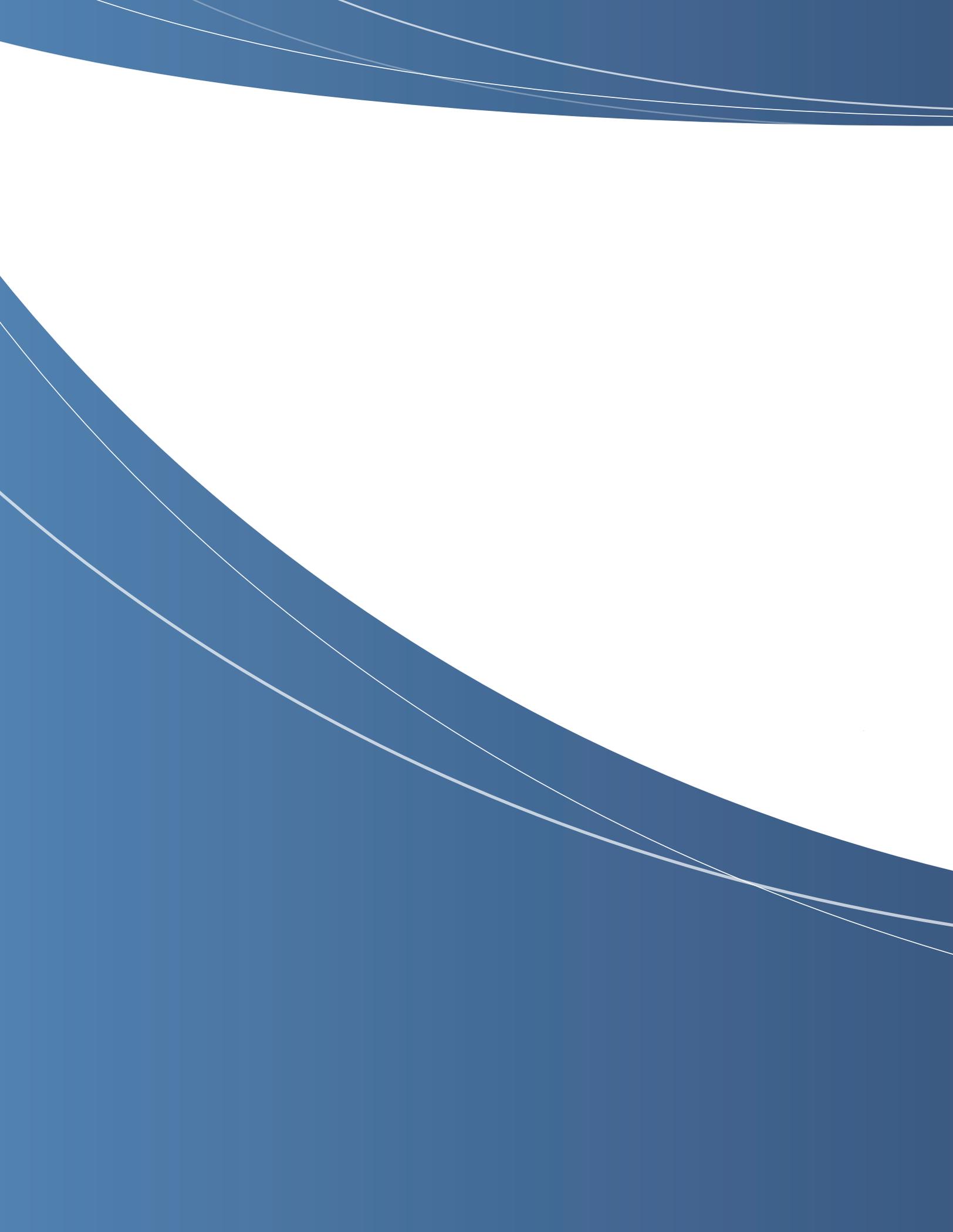
APPENDIX A: SECTOR SUMMARIES

Agriculture

Agriculture Sector

DEFINING THE SECTOR

Agriculture is any activity that involves growing plants or fungi or raising animals to provide a product. Most agriculture produces food, but other agricultural products include ornamental plants, fibers such as cotton and wool, and medicinal plants. Agriculture often includes processing crops or livestock into a final product, such as converting grapes to wine.

Agricultural activities usually require specialized land uses, such as fields, orchards, vineyards, greenhouses, and pastures. Processing and sales of products may require additional uses, such as farm stands, wineries and tasting rooms, commercial kitchens, or small-scale manufacturing facilities. Practices that take place on natural forest lands or tree plantations, such as harvesting trees for timber, are discussed in the Forests section of this guide. Practices that involve raising seafood, including fish, shellfish, aquatic plants, and related products, are discussed in the Ocean and Coast section of this guide.

California is by far the largest agricultural production state in the country. In 2017, California produced over $50 billion in agricultural products, almost twice that of the

Agriculture in California

Agricultural activities take place in all 58 counties of California, although the largest agricultural centers are in the Sacramento and San Joaquin Valleys. California produces over 400 different agricultural products and is effectively the only US producer of several products, including figs, garlic, olives, and walnuts. The state's largest products are dairy, grapes, almonds, strawberries, and beef.

next most productive state.[1] Agriculture varies widely across California and is found in most parts of the state, from citrus orchards near Riverside to the rice fields of the Sacramento Valley, and from small-scale farms to cattle ranches covering hundreds of thousands of acres. Most agricultural land is in unincorporated areas, although some incorporated communities, even in major urban areas, may have agricultural uses.

The primary climate change concern for agricultural activities is ensuring that they can remain economically viable in the face of changing temperature and precipitation patterns. Many communities depend on agriculture as a major employment sector and a key part of their economy. Some agricultural areas are prime tourist attractions, such as the wine-producing regions of Northern California and the Central Coast. The agriculture sector employs many members of frontline communities, including migrant and undocumented workers, so there are significant equity issues in this sector as well.

MAJOR VULNERABILITIES

Many crops require a particular range of temperatures at different points in the year to be highly productive. If temperatures shift outside of this range, the plants may not be as productive, or the crops may not be as high in quality as buyers expect. For example, many nuts and stone-fruit trees require a specific number of hours each winter (called "chill hours") where the outdoor temperature is below 45 degrees to help the flowers and leaves fully develop. Without enough chill hours, the trees produce fewer crops that are often of lower quality.[2] On the other hand, some crops, such as rice and tomatoes, are susceptible to very high temperatures, and increases in the frequency and intensity of extreme heat events can cause crop loss.[3]

Changes to precipitation patterns are expected to affect crop growing throughout the state. Very wet years and floods caused by a rapidly melting snowpack can cause farmers to delay crop planting, and floods may wash away young plants and leach nutrients out of the soil. Shifts in precipitation patterns can cause significant harm to crops that are grown without irrigation, and even irrigated crops can suffer during intense drought conditions if not enough water for irrigation is available.

Livestock such as cattle and chickens are also susceptible to climate change. Very high temperatures can cause illness and mortality in livestock. During droughts, there may not be enough wild food, such as grasses in pastures, forcing ranchers to purchase feed that may be expensive or available in limited quantities. Heavy floods, especially flash floods, can drown large numbers of livestock.

Both plant crops and livestock are at risk of increased disease activity due to climate change. Warmer temperatures and wetter conditions can increase the population of many disease organisms and vectors, and warmer temperatures in the spring and

autumn can cause them to stay active for a larger part of the year. Waterlogged plants, or plants and animals weakened by drought or high temperatures, often have less resistance to diseases and so may suffer greater harm from infections.

People working in the agricultural sector face harm from climate changes. Most agricultural work is outdoors, increasing workers' exposure to extreme heat, poor air quality, and some disease vectors such as mosquitoes. Physical stress, such as lifting heavy loads or repeatedly bending over to pick crops, can exacerbate the risk of adverse health impacts. Many farmworkers are also low income, migrant, and/or undocumented, which can escalate their susceptibility to harm. Loss of agricultural activity can lead to fewer available jobs, and many agricultural workers have challenges finding jobs in other industries. A weaker agricultural sector can also cause more widespread economic harm in communities where agriculture is a significant industry.

Agricultural lands are not open space, but they do provide some of the same ecosystem benefits as open space. These benefits include promoting groundwater recharge, reducing flooding, improving water quality, sequestering carbon, and providing habitat to local wildlife (especially in agricultural buffer areas). If agricultural lands are damaged or become in some way less viable because of climate-related effects, these benefits may be lost. This is particularly true if economic conditions result in agricultural land being converted to developed areas.

Appendix C presents adaptation strategies as examples of ways that communities can support a more resilient agricultural sector as part of adaptation planning effort. These strategies are generalized approaches that can be refined for the specific agricultural activities in a community.
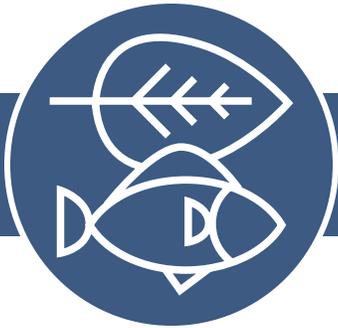
Biodiversity and Habitat

Biodiversity and Habitat Sector

DEFINING THE SECTOR

California is one of the world's biodiversity hotspots and has the greatest number of native and endemic plant species of any US state.[4] The state's unique mix of habitats include the Joshua trees of the high desert, the redwood forests of the Northern California coast, the salt marshes of the San Francisco Bay Area, the annual grasslands ringing the Central Valley, and the bitterbrush sage ecosystems of the Basin and Range region, among many others. For example, the CALVEG vegetation classification system recognizes over 200 different types of ecological groups in the state, not including agriculture, oceanic ecosystems, or urban areas.[5] However, climate change threatens California's habitats and their high level of biodiversity by creating temperature and precipitation changes that may no longer support these ecosystems.

California's habitats and the biodiversity they support are critical for several reasons. Protecting natural systems is a core value for many Californians, and the health of the natural environment is a major contributor to community well-being. Preserving the state's biodiversity is often a climate justice issue

What Is Biodiversity?

Biodiversity is a measure of the number of different species in an area. Areas with a large mix of species, such as a tropical rainforests or coral reefs, have high biodiversity. Areas with only a few species, such as a large farm field with only a single crop growing, have low biodiversity.

What Is a Biodiversity Hotspot?

A biodiversity hotspot is a small area of Earth's surface that is home to many endemic plants and animals (species that do not live anywhere else). Biodiversity hotspots cover only about 2 percent of the Earth's surface, but collectively, these areas are home to about half of all endemic plant species and 35 to 43 percent of all endemic mammals, birds, reptiles, and amphibians.

because these ecosystems are a cultural resource for some communities, including many tribal communities. Many of these ecosystems are iconic symbols of California that attract large numbers of visitors every year, helping to support local economies throughout the state. Productive natural ecosystems provide beneficial services such as sequestering carbon in soil and plant matter, improving water quality, supporting recharge of the state's groundwater basins, and buffering developed areas from floods and storm surge. These ecosystems are also home to animals that provide important benefits, such as pollinating agricultural crops or controlling the number of pests or disease-carrying organisms.

This sector focuses on terrestrial and freshwater biodiversity and habitat. Saltwater ecosystems, including coastal and open ocean habitats, are discussed in the Ocean and Coast section of this guide. This section includes discussion of forestry ecosystems, although additional discussion of forestry ecosystems and related issues are in the Forests section of this guide. Discussion of the recreation issues associated with natural lands is in the Parks and Recreation section of this guide.

MAJOR VULNERABILITIES

Ecosystems are suited to specific temperature and precipitation conditions. Climate change threatens to alter these conditions outside of their optimal range in some places, forcing these natural communities to migrate to maintain their ideal conditions. Depending on future climate conditions, between 21 and 56 percent of California's natural areas will be marginal or unsuitable for their current ecosystems by 2100.[6] Some specific ecosystems may lose much more of their suitable range. For example, up to 69 percent of pinyon-juniper woodland, 81 percent of Pacific Northwest conifer forest, and 97 percent of freshwater marsh area may no longer be suitable for these habitats by the end of the century.[7] The Sierra Nevada foothills, the desert areas, and the south coast are expected to be most affected by ecosystem loss due to climate change.[8]

Even if an ecosystem can remain in its existing area or shift easily to a new area, climate change can still create hazardous conditions for biological communities. Areas that are susceptible to wildland fires, including forests, shrublands, and chaparral areas, are expected to face more frequent and intense fires. Although fire is a regular feature of these ecosystems and many species have adapted to it, changes to the fire regime may exceed optimal conditions for these biological communities. If fires become frequent and/or intense enough to prevent ecosystems from effectively recovering, the existing ecosystem may be replaced by another. Extreme heat and drought conditions may also damage habitat areas and cause an ecosystem transition.

More subtle changes can also harm California's biodiversity and habitat. For example, many plant and animal species have evolved together to meet each other's needs, such as plants flowering at the same time that butterflies emerge from their chrysalises. In this instance, the flowers provide food for the butterflies in exchange for pollination. Shifts in temperature and precipitation patterns may alter the timing of these events, potentially throwing their life cycles out of sync. Changes in life cycles or other behaviors caused by climate change can lead to a long-term decline in the species. If the species involved is a keystone species (a species that many others in an ecosystem depend on, and whose removal would cause a significant change to the ecosystem), the overall habitat may decline.

Climate change may threaten the biological integrity of ecosystems by promoting pests and diseases that attack native species. Warmer temperatures during a wider portion of the year can encourage the spread of these organisms and pathogens, especially during wet years. Stresses from other climate-related effects can also make species more susceptible to pest and disease infestations. For example, stresses from the 2012–2017 drought and warm temperatures weakened trees throughout the Sierra Nevada foothills and left them more susceptible to bark beetles. The warm temperatures also created a larger bark beetle population than normal, because cold winters normally control the beetle's numbers.

Although protecting these ecosystems for their own sake is important enough, it is also important to remember that harm to biodiversity and habitat has a significant effect on California's human population. Damage to an ecosystem that is a major tourist attraction can lead to a decline in visitors, causing economic harm to nearby communities. Ecosystem services such as flood protection could decrease or disappear if the ecosystems providing these benefits are harmed, exposing people, buildings, and infrastructure to the risk of serious harm. If ecosystems provide important natural resources to communities, including drinking water, damage to the ecosystem can decrease the availability or quality of this resource, in turn affecting all those who depend on it. Ecosystems can also serve as cultural resources for some populations, creating a risk of damage to cultural heritage if the natural communities are damaged.

Appendix C presents examples of ways that communities can support more resilient natural habitats and biodiversity as part of an adaptation planning effort. These strategies are generalized approaches that can be tailored to the specific natural systems in a community.

Levels of Implementation for Ecosystem Adaptation

When developing adaptation strategies related to natural systems, it can be helpful to think of implementing each strategy at four levels. Each successive level requires more human intervention in the natural system and potentially a greater commitment of resources. As climate change–related effects become more harmful and as ecosystems experience more severe impacts, greater implementation levels may be needed. This approach is helpful to explore the full range of potential implementation actions associated with an adaptation strategy, recognizing that some implementation actions may fall into multiple levels.

- **Resistance.** Attempt to make the ecosystem more impervious to climate change, so that the overall degree of potential impacts is reduced and current conditions in the biological community are maintained.

- **Resilience.** Manage the ecosystem so that it can "absorb" the effects of climate change and more easily recover from damage, accepting that some short-term disturbance of the habitat is likely.

- **Response.** Through management efforts, help transition selected elements of the ecosystem to a new condition to avoid or reduce the most harmful effects.

- **Realignment.** Accept that substantial ecosystem disturbance is likely and allow the biological community to transition to a "new normal" that includes a substantially altered but healthy natural system.[9]

Emergency Management

Emergency Management Sector

DEFINING THE SECTOR

The emergency management sector focuses on hazard mitigation to reduce risk from climate effects and natural hazards. This sector encompasses emergency operations equipment and personnel, evacuation routes, and at-risk populations with access and functional needs. The four basic phases of emergency management include mitigation, preparedness, response, and recovery.[10]

- **Mitigation.** Sustained action taken to eliminate or reduce the severity of long-term potential for harm to human life, property, and the environment from the impacts of future disasters. Note that this emphasis on long-term harm distinguishes hazard mitigation from actions geared primarily to emergency preparedness and short-term recovery.[11]
- **Preparedness.** Activities conducted in advance of an emergency to develop operational capabilities and improve response to disasters and/or emergency events. Preparedness differs from hazard mitigation by its focus on immediate post-disaster action.
- **Response.** Activities conducted to respond to an event or disaster to save lives and prevent harm to the public, property, animals, and the environment during an emergency. It includes actions such as rescuing survivors, providing for mass evacuation, feeding and sheltering victims, and restoring communications.[12]
- **Recovery.** Activities that restore vital life support systems to minimum operating standards after an emergency and support the return of communities to a (new) state of normality. It includes such actions as restoration of essential transportation, utilities, and other public services; repair of damaged facilities; provision of both temporary and replacement housing; restoration and improvement of the economy; and long-term reconstruction that improves the community.[13]

Mitigation and preparedness go hand in hand. In situations where time or financial resources preclude long-term hazard mitigation in the natural and social environment, it becomes very important to undertake plans and actions to prepare for emergencies, making it easier to respond to and recover from them.[14]

Extreme Weather

As summarized in Safeguarding California (2018), climate change affects emergency preparedness, response, and recovery; therefore, it is critical to ensure community resilience against its effects.

According to the United Nation's Intergovernmental Panel on Climate Change (the international body for assessing climate change and science), climate change will continue to increase the frequency and severity of extreme weather events.[15] Extreme weather is defined as events, such as droughts or floods, that have historically occurred on average only once in 100 years and vary from "the norm" in severity or duration. California is currently experiencing unprecedented impacts from extreme weather. Severe drought, which started in 2011–12, was intensified by the driest four years on record (2012–2015) and the smallest and second smallest recorded Sierra snowpack (2015 and 2014). Further, 2014, 2015, and 2016 were the warmest years on average.[16] In contrast, 51 out of 58 counties declared states of emergencies during the 2017 winter storms for flooding, which resulted in three federal disaster declarations.[17] Record-breaking wildfires also continue to impact California with increasing frequency, size, and devastation. Two of the three largest wildfires in California's history have been in the past five years, burning a total of 529,225 acres.[18] In 2015 alone were two of the top ten most destructive wildfires in California's history.[19] Climate change is anticipated to increase and exacerbate these and other hazards—including extreme heat events, sea level rise, tsunamis, and flooding associated with atmospheric rivers, like those experienced in the 2017 winter storms—as well as slower onset changes like rising temperatures, which have additional impacts (e.g., increasing the severity of extreme heat events and wildfires).

MAJOR VULNERABILITIES

Emergency management systems, such as public safety, emergency medical services, and emergency operations, are typically prepared for natural and human-made disasters in communities. However, with the increase in intensity and frequency of climate change effects, these systems can become overwhelmed and may not be able to meet the needs of the community. For example, during an extreme heat event, hospitals could become overwhelmed with emergency room visits for heat stroke, dehydration, and respiratory illnesses. Emergency medical services may not be

able to reach those in need due to flooding, landslides, or severe weather that blocks roadways or makes driving dangerous. At-risk populations, such as persons without access to lifelines, persons with chronic illnesses, and persons with disabilities, can be overwhelmed by one or more climate-related hazard events, causing evacuation fatigue that prevents them from evacuating.

Other key components of emergency management systems are evacuation routes and emergency shelters. These components are essential in response to a disaster to move people away from the hazard-affected area to a centralized location for emergency supplies and information. Evacuation routes can become blocked by wildfires, flooding, and landslides, making evacuation efforts nearly impossible. Some evacuation routes, such as those in mountainous areas, may not have enough capacity to effectively move residents and visitors away from the hazard-affected area in a timely manner. Emergency shelters and operation centers are also vulnerable to damage or destruction by climate-related hazards, which could occur simultaneously with a disaster that requires their use.

Emergency communication systems can be knocked out or disrupted during extreme weather events or wildfires. This can disable evacuation notifications that are essential to getting people out of harm's way. The telecommunication systems may also not be effective at reaching all sectors of the population, such as linguistically isolated populations and persons with disabilities that require alternative forms of communication.

Appendix C provides examples of ways that communities can support a more resilient emergency management sector as part of adaptation planning effort. These strategies are generalized approaches that can be refined for the specific emergency management activities and programs in a community.
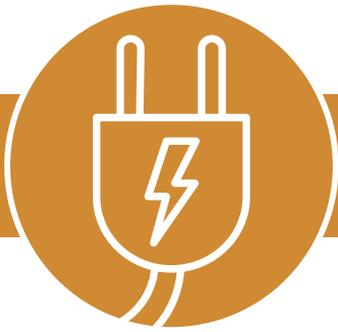
Energy

Energy Sector

DEFINING THE SECTOR

California's energy system is a complex network designed to make sure that people across the state have access to the energy they need to provide light, operate equipment and appliances, maintain comfortable indoor temperatures, and for numerous other activities. For the purposes of the APG, energy use is divided between energy use in buildings and energy use in vehicles and mobile equipment.

Most energy used in buildings is in the form of electricity and natural gas (primarily methane), which is produced and distributed through statewide infrastructure systems operated by public and private utilities and overseen by state agencies and regulators such as the California Public Utilities Commission and the California Energy Commission. However, in some areas, especially rural communities and remote parts of the state, buildings may use other fuels, such as propane and wood for heating. Vehicle fuels in California are mostly petroleum-based gasoline and diesel fuels produced at refineries and delivered to retail fueling stations by road, rail, and ship. Other fuels, in particular electricity, are becoming more popular as vehicle fuels.

Where Does California's Energy Come From?

California has an abundance of energy resources and can produce a large amount of the energy it uses in the state. California often generates between 65 and 70 percent of the electricity it uses, and the rest is imported.[20] California is the fourth-largest petroleum producer in the United States, and in-state refineries produce most of the state's gasoline and diesel fuels, which are subject to stringent air pollution requirements. California does have some methane production, but it imports about 90 percent of the natural gas it consumes. States in the Southwest and Rocky Mountain regions, as well as western Canada, supply most of California's natural gas.[21]

Most of the electricity used in California is generated at large power plants throughout the state and elsewhere. The electricity is transported along high-voltage power lines called transmission lines, which can carry the energy for long distances. Facilities called substations convert the power to lower voltages and send it to local buildings through smaller power lines, called distribution lines. Collectively, this system of power lines and substations is called the "grid" and is owned by public and private utilities. However, some buildings can reduce their dependence on the grid by generating some or all the electricity they need on-site, often through solar panels or wind turbines.

Currently, natural gas power plants generate the plurality of electricity consumed in California.[23] Natural gas is extracted from the ground, processed, and pumped into large transmission pipes that carry it to different areas of the state. The gas is then pumped through smaller distribution pipes to individual buildings. Along the way, various facilities help ensure that the gas is flowing under safe conditions. Fuel derived from petroleum, such as gasoline, diesel, and natural gas, are produced at large industrial facilities and distributed to retail outlets throughout the state.

What Are the Sources of California's Electricity?

In 2018, approximately 35 percent of California's electricity came from natural gas, 31 percent came from renewable sources (mostly solar and wind), 11 percent came from large-scale hydroelectric facilities, 9 percent came from nuclear facilities, and the remainder came from coal, oil, and unspecified sources.[22] California is moving toward obtaining all its electricity from renewable and other carbon-free sources.

MAJOR VULNERABILITIES

California's energy supplies and transmission/distribution networks are susceptible to climate change in several ways. Most notably, the state's electricity grid is highly vulnerable. Almost all of the power lines in California are above ground and can be damaged or destroyed by high winds, downed trees and limbs, wildfire, floods, and landslides. Substations are often more resilient, but they too can be harmed by these hazards.

Damage to the electrical grid can cause widespread power outages, and downed power lines, contact with vegetation, and conductor slap can spark wildfires. Notably, some transmission lines and distribution networks feeding remote communities run through forested areas, heightening the risk of wildfire ignitions. Fallen power lines also

create a public health hazard, posing a risk of electrocution. Natural gas systems are primarily underground and so are more insulated against natural hazards, but pipelines can still be damaged by landslides and other events. In some coastal areas, natural gas pipelines are at risk of being exposed to salt water as sea-level rises, which can increase corrosion. Above-ground natural gas facilities, as well as other energy facilities such as power plants and refineries, are also susceptible to being harmed by many climate-related hazards.

Even if the transmission and distribution infrastructure of the energy network is not harmed, there is still the potential for loss of service. High heat events cause power lines and other grid infrastructure to operate at reduced capacity, limiting the amount of energy that the system can transport. At the same time, electrical demand increases during high heat events as more people turn on cooling systems, and this is likely to become more frequent due to climate change. This combination of reduced capacity and increased demand places stress on the electrical grid, increasing the possibility that the system will fail and cause power outages. Natural gas is also susceptible to extreme heat events because very high temperatures can harm the electrical equipment used to maintain safe conditions in the pipelines.

Some climate-related events can reduce the ability of power plants and other facilities to generate energy even if they do not damage the facility itself. Hydroelectric power plants are perhaps the most obvious example. During long-term drought conditions, the amount of water available to run these facilities drops, decreasing the electricity generated. For example, in 2011, hydroelectric facilities supplied 15 percent of the state's electricity, but during the peak of the 2012–2017 drought in 2015, these facilities met only about 6 percent of California's needs. Increased levels of air pollution, such as smoke from wildfires, result in less light striking solar panels and lower levels of power output. Ash and other particles can also settle on solar panels, reducing capacity until they are cleaned off. Potential changes in wind patterns from climate change are not yet well understood; they may mean less wind resources available for power

Defining Adaptation for Energy Utilities in California

The California Public Utilities Commission defines climate change adaptation for energy utilities as the "adjustment in utility systems using strategic and data-driven consideration of actual or expected climatic impacts and stimuli or their effects on utility planning, facilities maintenance and construction, and communications, to maintain safe, reliable, affordable and resilient operations"[24]

generation. As we increase our knowledge, it will be important to understand potential changes to magnitude and distribution of wind resources for power generation.

Fuels that are transported through the state's existing freight system, such as roads and rails, are also vulnerable to disruption. This includes most gasoline and diesel fuels as well as some building fuels such as propane and kerosene. If roads or rails are damaged, destroyed, or blocked by climate-related hazards, deliveries of these fuels may not be able to get through, causing shortages. This is a particular risk for rural communities that may only have one central access road. Since these fuels are usually distributed at retail outlets such as gas stations, any climate-related hazard that damages these retail outlets can lead to fuel shortages.

Other forms of fuel transportation can also be vulnerable. Pipelines that transport liquid fuels (natural gas and petroleum) can be susceptible to landslides and scouring from flooding. Seaports are also a major shipping hub for some fuels, and coastal flooding and sea level rise can disrupt operations at these facilities, affecting energy supplies that pass through them.

This section of the guide focuses on the energy system itself, but the indirect effects from energy shortages or outages are also important when considering strategies to improve energy resilience. Energy supplies, including back-up generation, are needed for vital activities, including operating hospitals and other medical facilities, fueling emergency response activities, water and wastewater services distribution, and operating cooling equipment during extreme heat events. Loss of energy, particularly during another hazard event, can have serious effects on community health and well-being. Many types of economic activities are also difficult or impossible during energy outages, and long-term disruptions can cause economic harm.

Forests

Forests Sector

DEFINING THE SECTOR

The Forests sector encompasses forested lands, which cover approximately one-third (32 million acres) of California and are managed by the federal government (58 percent), State and local governments (3 percent), and private landowners (39 percent).[25] Major considerations in this sector include the wildlife habitat, carbon storage, and water filtration that forests provide human and biological communities throughout the state. The forestry industry and sustainable forest management is also a key component of this sector, because it supports many communities in northern and eastern California. The primary goals of this sector are to encourage restoration and protection of forest ecosystems, support community resilience, and foster creative solutions to fuel reduction activities.

MAJOR VULNERABILITIES

Historically, forest management practices have varied. In particular, the practice of suppressing any and all fires in forested areas has led to overgrown forests, with high densities of small trees competing for resources and stunting tree growth, leading to less carbon sequestration and less resiliency to climate change hazards.[26] Other practices have degraded forests and caused loss of older trees, simplified forest structures, and fragmented forests, all of which leave forests vulnerable to climate change hazards such as pests and diseases, drought, extreme heat, and wildfire.[27] Severe drought and extreme heat increase stress in trees and leave them more susceptible to diseases and pests such as bark beetles, which have devastated 129 million trees since 2010.[28] Years that fall within a multiple-year drought cycle and extreme heat conditions exacerbate these diseases. Weakened trees are more susceptible to frequent and severe wildfires and less able to recover from them, as forest ecosystems have in the past.

The habitat and biodiversity of forest areas is also vulnerable to climate change effects. As temperatures continue to warm, forests are beginning to regenerate at higher elevations. Warmer temperatures can cause a complete loss of the ecosystem if trees are unable to find suitable habitat to grow. Fragmented forests make conditions more difficult for the ecosystem to survive, as these ecosystems may not have the

ability to move if the temperature and precipitation are not suitable at their current location.

A devastated forest ecosystem can leave the communities that live within or near them more vulnerable as well. Not only are these communities at a higher risk for wildfires, they may also be vulnerable to economic losses and damage from weakened forests. Communities living within the wildland-urban interface have a higher risk of damage from wildfires if the surrounding forest systems are weakened. This can cause devastating impacts because entire neighborhoods or bordering agricultural lands could be lost to wildfires. Timber harvesting and forestry management economic drivers also depend on forests to continue operations, and therefore are vulnerable to the pests and diseases, drought, extreme heat, and wildfire that threaten forests.

Bark Beetle

Extreme heat and drought in conifer forests has increased tree vulnerability to bark beetles. Between 2010 and 2017, approximately 147 million trees died from bark beetle infestations.[29] Warming temperatures year-round promote the survival of bark beetles through winter and cause them to fly earlier in spring, increasing their reproductive frequency. Forests that have high tree mortality rates from bark beetle may experience more frequent and intense wildfires in the future.[30]

Appendix C provides examples of ways that communities can restore and protect forest ecosystems, support community resilience, and foster creative solutions to fuel reduction activities. These strategies are generalized approaches that can be refined for the specific forest programs and forestry activities in a community.

Land Use and Community Development

Land Use and Community Development Sector

DEFINING THE SECTOR

The land use and community development sector plays a foundational role in how communities can prepare for and respond to impacts related to climate change. This sector includes the development patterns, land conservation and protection, and land management decisions made in local communities throughout California. Land use decisions are typically made based on a general plan land use element and zoning code, which have guidelines for where and how communities will develop in the future. This sector includes plans and programs that provide communities with a healthy and safe environment, affordable housing, and accessible public amenities.[31] Key principles that define the land use and community development sector include: equity, sustainability, and choice; economic development; location and connectivity; resilience in new and existing development; innovation; community-led capacity; awareness and responsiveness; collaboration; and improved data.[32]

MAJOR VULNERABILITIES

The land use and community development sector is based on safety documents such as general plan safety elements and local hazard mitigation plans, which can govern development patterns and provide hazard mitigation measures to prevent loss of life and property. However, many safety elements are out of date and may not address current or future climate-related effects.

This sector is also primarily vulnerable to physical climate change effects based on the location of development. Buildings and populations living in hillside and mountain communities are especially vulnerable to damage or injury from landslides, wildfires, severe weather, and flooding. Coastal communities face similar challenges, because sea level rise and coastal flooding cause inundation and damage to essential infrastructure and homes. Damage from these physical hazards can also devastate local economies because businesses could close, residents could leave permanently after evacuations, and the local tax base could virtually disappear.

Existing land use patterns create vulnerabilities for the people living and working there. Some neighborhoods are not walkable, lack access to transit, and are not

close to resilience hubs, which could prevent seniors and those without access to lifelines from reaching resilience hubs or cooling centers during extreme heat conditions. People experiencing homelessness are often overlooked as a population that requires assistance, and therefore may not know about or have the means to travel to resilience centers. Neighborhoods beyond urban limits may also not have access to resilience centers or community activities that can build social capacity (interpersonal relationships, a shared sense of identity, and a shared understanding) within a community. Many neighborhoods are within the wildland-urban interface and highly vulnerable to wildfires, or in landslide-prone areas. These neighborhoods typically have many single-access roads, which can be blocked or damage during emergencies, leaving those living on them isolated or trapped.

Many communities also have inequalities between neighborhoods, which can put vulnerable populations at higher risk of being affected by climate-related effects. Communities that have large impervious areas that lack vegetation, typically in areas with disadvantaged communities, are subjected to higher temperatures from the urban heat island effect and may have poor drainage during flood events. In the event of a climate hazard event, residents and business owners in these neighborhoods may live in unhealthy conditions, face great financial hardships due to recovery costs, or be permanently displaced if housing is unaffordable. Linguistically isolated populations, undocumented persons, and other marginalized persons may have limited access to community amenities or lack a voice in their communities, which means that community development policies and programs are less likely to consider their needs. This could make preparation, response, and recovery efforts difficult or impossible for vulnerable populations.

Appendix C provides examples of ways that local governments can support a more resilient land use and community development sector as part of adaptation planning effort. These strategies are generalized approaches that can be refined for the specific land use and community development.
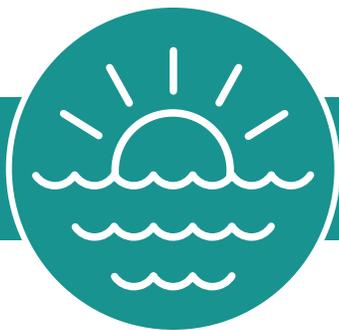
Ocean and Coast

Ocean and Coast Sector

DEFINING THE SECTOR

The Ocean and Coast sector encompasses the 1,200 miles of California shoreline that include marine habitats, beaches and coastal recreation areas, ports, and bays throughout the state. Nearly 75 percent of California's population lives in coastal cities or counties, and this sector sustains approximately 500,000 jobs and $19 billion in salaries and wages. These areas contain both diverse coastal communities and unique ocean habitat and resources. Major considerations in this sector include marine ecosystems, livelihoods and economies, public access to the coast, recreation, and the well-being and safety of coastal communities. This sector also fosters multiagency coordination between the California Coastal Commission, Department of Parks and Recreation, Ocean Protection Council, State Coastal Conservancy, State Land Commission, and the San Francisco Bay Conservation and Development Commission.

MAJOR VULNERABILITIES

Ocean and coast areas across California are directly exposed to sea level rise, ocean acidification, and increased frequency of coastal storms. This creates vulnerabilities in both natural and human-made systems that depend on stable and healthy coastlines.

Marine ecosystems, including coastal and tidal habitats, are at risk of damage from coastal storms, changing pH levels due to ocean acidification, and increased algal blooms that cause hypoxia (the absence of oxygen), affecting coastal plants and animals. Coastal wetlands are being damaged by sea level rise and saltwater intrusion that is changing the chemical composition of the ecosystem. Sea level rise is causing coastal wetlands to migrate inland, which is difficult or impossible in areas that have been developed to the shoreline.

Coastal economies are closely tied to the health of marine ecosystems. Marine fisheries and shellfish industries are already witnessing damage to the shells of shellfish due to ocean acidification. Marine fishing economies are vulnerable to damage from increased coastal storms and harmful algal blooms. Coastal tourism is vulnerable to losses from shrinking beaches, bluff and dune erosion, and coastal flooding, which damage important park and recreational facilities.

The built environment in coastal communities is not only vulnerable to economic hardships, but to damage in infrastructure and buildings that support residents and businesses. Rising tide levels and storm events can increase the vulnerability of essential buildings and infrastructure that are commonly located on coastlines, including airports, bridges, highways, cargo and passenger rail, ports, and wastewater treatment plants. Damage to these facilities could prevent residents from evacuating during emergencies or contaminate drinking water supplies. Additionally, storm surge and high winds during coastal storms have eroded bluffs and dunes, leaving buildings and infrastructure vulnerable to damage from ground failure and slope destabilization.

Sea Level Rise vs. Coastal Flooding

Sea level rise is the long-term rise of mean high tide levels along the coast, which can occur over years or decades. Coastal flooding, on the other hand, is the short-term rise in sea levels due to a coastal storm or "king tide" event. These events can create a temporary increase in sea levels of approximately 28 to 30 inches or higher depending on the size of the storm. Higher sea levels caused by sea level rise can give a boost to smaller floods that, during normal conditions, would not have been large enough to flood dry land.[33]

Appendix C provides examples of strategies to support a more resilient ocean and coast sector as part of adaptation planning efforts. These strategies are generalized approaches that can be refined for the specific ocean and coastal programs in a community.

Parks, Recreation, and California Culture

Parks, Recreation, and California Culture Sector

DEFINING THE SECTOR

The Parks, Recreation, and Culture sector provides places for gathering to increase social cohesion; yield public health benefits such as cooling, clean air, and space for exercise; and creates opportunities to educate the public about climate change.[34] This sector frequently overlaps with the biodiversity and habitat, forests, ocean and coast, and water sectors, because parks and recreational areas are closely tied to natural ecosystems. This sector supports approximately 700,000 jobs in urban and rural areas across the state and recognizes that recreational play, family vacations and daytrips, educational opportunities in parks and historic sites, and routine interactions on neighborhood playgrounds and in community spaces bring people together around treasured places that are a vital part of California's culture.[35] Historic and cultural resources also play an important role in the Parks, Recreation, and Culture sector, because these resources often protect California cultural and tribal cultural heritage, while attracting visitors to local communities to support tourism. The goal of this sector is to prepare for and respond to climate effects to parks and recreation along the coast, inland, in the mountains, and in urban areas so that these resources are accessible to communities and provide opportunities for enriching experiences.

MAJOR VULNERABILITIES

Vulnerabilities in the parks and recreation sector vary widely depending on the location throughout the state.[36] In the coastal region, trails, beaches, state parks, parking lots, piers, campgrounds, and other park facilities are vulnerable to damage and inundation from sea level rise and coastal erosion. In inland areas, drought can reduce water availability at reservoirs and campsites, compromising water recreation activities and leaving campsites without water. In mountain areas, drought and warmers temperatures are reducing snowpack, which is leading to shorter winter sport seasons and loss of recreation-dependent jobs in rural communities. Communities that depend on winter and/or summer recreation may lose important park facilities, forcing people to look elsewhere for work.

Parks and recreation vulnerabilities also differ based on urban and rural community settings. In urban areas, unshaded bike paths and trails become less attractive during extreme heat conditions, and high temperatures can make outdoor recreation dangerous for children, seniors, and people with chronic illnesses. In rural areas, wildfires and trees made hazardous by pests and diseases deter hikers and bicyclists and close campgrounds, parks, roads, and trails, which in turn impacts local economies. Warmer temperatures can also increase the temperature of freshwater habitats, leading to toxic algal blooms that make fishing and other water recreational activities dangerous. Both local and urban areas are vulnerable to flooding that can wash out trails and roads, cutting off recreation areas and facilities.

Historic and cultural resources are uniquely vulnerable because their locations are often significant as well, and therefore they cannot be moved. In some cases, historic buildings adapt naturally to extreme heat and severe weather conditions through architectural features such as raised foundations, overhangs, recesses, wall materials, and other site and design features. However, historic buildings and sites can be damaged or become inaccessible due to sea level rise, coastal storms, wildfires, and flooding, and they can require extensive repairs that interfere with visitors to these sites. Tribal cultural resources, such as native fisheries, gathering places, and traditional sources of food and medicine are essential for tribal culture throughout California. These resources are threatened when droughts affect salmon populations, more intense wildfires burn through important forested lands, and sea level rise and extreme heat make the land uninhabitable, forcing tribal nations to relocate.

Appendix C presents examples of ways that communities can support a more resilient parks and recreation sector as part of adaptation planning effort. These strategies are generalized approaches that can be refined for the specific parks and recreation activities and programs in a community.

Public Health

Public Health Sector

DEFINING THE SECTOR

The Public Health sector aims to promote and protect the health of people where they live, work, and play.[37] This sector focuses on preventing people from becoming sick or injured due to climate change-related effects that impact human life support systems such as water, air, food, shelter, and security. Public health includes healthcare facilities and programs and encompasses health equity issues, because climate change effects do not affect everyone equally. The goal of this sector is to ensure all community members, including those with fewer resources or capacities, can prepare, respond, and recover from short-term and long-term health effects worsened by climate change.

MAJOR VULNERABILITIES

There are several diseases and illnesses linked to climate change that have the potential to appear throughout California. Some illnesses, such as Lyme disease, West Nile Virus, Zika, dengue, and chikungunya, are carried by animals such as mice and rats, ticks, and mosquitoes. Some of these vectors have already become more numerous in California due to climate change. Outdoor workers, people experiencing homelessness, children, seniors, persons with chronic health conditions, and pregnant or nursing women are among those who are highly vulnerable to these illnesses because they are either more exposed or have weakened immune systems that may not be able to overcome vector-borne illnesses. People experiencing homelessness are particularly vulnerable because they lack permanent, and often temporary, shelter, leaving them more exposed to extreme events such as extreme heat or flooding. Economically disadvantaged persons may also be unable to afford medical insurance, which would make treatment for these illnesses expensive and difficult. Education, outreach, and emergency alert systems may already exist to help combat these illnesses; however, linguistically isolated persons might not receive adequate emergency warnings or attend educational events due to communication barriers.

Public health infrastructure, such as hospitals, clinics, and public health departments, may not be prepared for an influx of patients from climate-related effects. This leaves

the entire health system vulnerable, not only to disease outbreaks, but to health impacts created by wildfires, poor air quality, and extreme heat. Mortality accounts for the greatest share of economic impacts of climate change, resulting in billions of dollars of losses each year in California.[38]

Climate change effects can also produce secondary health impacts, such as asthma from wildfire smoke and poor air quality, heat-related illnesses from extreme heat, and cardio-pulmonary diseases from mold and mildew growth after flooding. Worsening air quality (ozone, particulate matter, criteria air pollutants, and allergens) and heat stress can cause cardio-respiratory health problems such asthma, chronic obstructive pulmonary disease, and allergies in those who do not have adequate shelter or living conditions, such as persons working outdoors, people experiencing homelessness, children, and households in poverty. Smoke from local or regional wildfires can force outdoor workers to choose between their health and financial stability if they cannot afford to stop work for a day or two. Additionally, low-income households and renters are more likely to live in areas subject to flooding, poor air quality, extreme heat, or landslides, which can create hazardous living conditions or destroy housing, increasing individuals' susceptibility to human health hazards. Moreover, experiencing extreme weather events can lead to mental health challenges.

Appendix C provides examples of ways that communities can support a more resilient public health sector as part of adaptation planning effort. These strategies include preventing people from becoming sick or injured due to climate change–related effects and addressing underlying causes, such as living conditions, that make people more vulnerable to climate-related threats. In addition to traditional public health services and approaches, the strategies address systemic causes of inequity to improve living conditions, to ultimately lead to long-term health improvements and resilience. These strategies are generalized approaches that can be refined for the specific public health programs in a community.

Transportation

Transportation Sector

DEFINING THE SECTOR

The transportation sector covers a wide range of infrastructure assets, including roadways, rail lines, bike paths, sidewalks and walkways, airports, and ports, and transportation vehicles themselves. It also includes personnel needed to construct and maintain these systems and provide transportation services. Virtually everyone in California is dependent on the transportation sector, not only for getting around, but for transporting the goods and services they use.

Roadways are perhaps the most obvious element of California's transportation sector. They range from interstate freeways that carry tens of thousands of vehicles per hour through major urban areas to quiet neighborhood streets and remote rural roads. Designated highways are usually managed by the California Department of Transportation (Caltrans), and local governments are responsible for other roads. Roads on state and federal land, such as military bases or national parks, are typically managed by those agencies. These systems carry personal cars, heavy commercial trucks, buses, and many other vehicle types.

California's primary rail network is another key part of the state's transportation system. The rail system is used primarily for moving freight throughout California, and in some areas provides key public transit service. This includes regional commuter rail such as Caltrain and the Altamont Commuter Express in the Bay Area and Metrolink in the Los Angeles region; medium-distance Amtrak California trains such as the Pacific Surfliner and San Joaquin; and long-distance Amtrak trains that connect California to other states. Most of California's primary rail system is maintained by rail lines such as Union Pacific, although some sections of track are owned by local and regional governments.

Transportation also includes public transit—both buses and rail systems—which are generally owned and operated by local transit agencies. Transit provides an essential service to many communities. In large cities, it provides a critical transportation option in densely populated areas where there is simply not enough capacity to handle all the car traffic if everyone drove instead. In both cities and less urban areas, transit (particularly buses) provides an essential service to transit-dependent populations,

which may include students, low-income individuals, the elderly, the disabled, and other populations that cannot or choose not to own cars.

Airports and seaports provide more specialized transportation services for both travelers and freight and can be critical economic centers. Major airports such as Los Angeles and San Francisco International Airports are among the busiest in the United States and connect millions of travelers to destinations across the world. However, a number of smaller airports throughout California provide travel within California and to nearby states. These regional airports support public safety activities such as aerial firefighting and air medical services and provide a base for recreational flyers. Some of California's airports are also key nodes in global air freight services.

Seaports are primarily freight centers, the largest of which receive hundreds of millions of tons of goods annually. California's seaports are critical trade centers, handling imports and exports between the United States and other Pacific nations. However, seaports and related facilities can serve as docking areas for recreational cruises and personal water vessels. In some communities, port facilities can support ferries and other forms of water transit.

This sector also includes networks that support active transportation such as walking and biking. This includes bike lanes and sidewalks that are tied to roadways but may also include entirely separate rights-of-way such as bike paths and trails. Such networks provide access for people who are unwilling or unable to drive, including children, senior citizens, and those who do not own a personal vehicle. In some communities, these networks provide important recreational benefits, provide vital access for those commuting to and from work or school, and are contributors to the local economy.

This section focuses on transportation infrastructure and the services and economic activities that are enabled by these infrastructure systems. The fuels needed to power the transportation sector are discussed in the Energy section of this guide. Recreational and emergency management activities that rely on transportation systems are discussed in their respective sections of this guide.

MAJOR VULNERABILITIES

Climate change is likely to increase the risk of transportation networks being damaged, destroyed, or blocked by a natural hazard event, preventing movement of people and goods. This can be a minor incident, such as a tree being knocked over by high winds and falling onto a roadway, or a major event such as a bridge on an interstate freeway being destroyed by a flood. In some cases, the damage can be severe enough to block access for weeks or months. For example, a landslide in Montecito in January of 2018 closed US Route 101 in the area for about seven weeks. The previous winter, landslides along the Big Sur coast of Central California

caused parts of State Route 1 to be closed for a year and a half. Notably, populations dependent on public transportation or specific transportation infrastructure may be disproportionately affected by climate impacts to that infrastructure.

Floods, landslides, severe winds, and wildfires are the major hazards to transportation systems now. These natural hazards could increase in frequency and severity over time with climate change. In the long term, sea level rise could inundate transportation assets along coastal areas, causing them to close temporarily or permanently. Extreme heat can also be problematic for transportation systems, melting the asphalt on roadways, buckling rail lines, requiring vehicles to travel at slower speeds, or closing roads or rail lines.

In some cases, a closed section of a transportation network is the only way in or out of an area, which can create significant hardships until the network is reopened and creates greater risks during evacuation and emergency response situations. While this is often thought of as a rural issue, it can also affect parts of more urbanized areas (for example, some residential areas in the canyons of the Los Angeles region).

Some transportation activities depend on a single piece of infrastructure, such as a rail line or ferry terminal, and damage to these facilities can cause a complete shutdown of the service. Even if alternative routes or services are available, the closure often causes significant congestion as the people and goods that normally traveled the closed route are forced onto other parts of the transportation network. In addition to increasing travel times, this can place increased stress on alternative routes, which will require more maintenance. Damage to pieces of transportation infrastructure that help to move goods can cause widespread disruptions to supply chains, which may have major economic impacts that affect international trade as well as the local economy.

Transportation networks also rely on vehicles such as cars and trucks, rail trains, ships, and aircraft. Damage to these vehicles affects transportation services, even if the underlying network is unharmed. This is mostly a concern for economic activities and community services that depend on a vehicle fleet, such as vehicles used for public transit or goods delivery. These fleets are usually stored in centralized yards when not in use, creating the risk that a climate-related event such as a wildfire or flood could damage or destroy most or all of the vehicles. This can cause long-term service disruption, especially if the vehicles are custom built, such as rail trains.

Extreme heat can create problems for the transportation sector even without doing damage to physical systems. During very high temperatures, electrical equipment operates at reduced effectiveness, which can increase the risk of failure for vehicles that are powered by electricity. Similarly, power outages are more likely during extreme heat events, affecting electrically powered rail transportation systems. In particularly extreme heat events, air becomes less dense, sometimes to the point that it cannot provide enough lift for some aircraft to take off.

Water

Water Sector

DEFINING THE SECTOR

The water sector covers fresh water in all its forms. Fresh water is the lifeblood of the state, affecting every activity, person, and ecosystem. This sector includes the timing, form (snow or rain), magnitude or absence of precipitation events, and the quality of the water available to ecosystems and for use by people. California has always had a variable hydrological system with periods of heavy rain, snow, and drought. The timing of these events and our ability to harness at least some of the resources or rein in some of the impacts influences the availability and quality of drinking water, viability of agriculture, health of ecosystems, and safety of communities.

Heavy rainfall and rapid snow melt result in flooding. Floods pose a direct public safety threat to all homes, businesses, utilities, and communities in or near a floodplain. They also result in erosion events and altered water quality. Floods occur based on regional weather patterns, existing river conditions, geology, and the patterns of human development.[39] Every county in the state has been declared a federal disaster area due to flooding in the last 30 years.[40] Flooding threatens lives and assets totaling billions of dollars. In the future, climate change may result in large atmospheric river events that deliver substantial precipitation in very short periods of time, further impacting California communities[41]. Human development has worsened flood risk due to activities such as encroachment on floodplains and introduction of impervious surfaces such as roofs, roads, and parking lots, which increase runoff. In coastal areas, ocean waters can cause inundation. This impact is covered in the coastal sector.

California has a long history of flooding, but it also has a legacy of recurring droughts. Droughts are prolonged periods of little or no precipitation, whose extreme conditions impact the state. Besides threatening drinking water supplies and water available for natural systems, droughts particularly distress the agricultural sector, which must rely more heavily on a dwindling groundwater supply during drought events. This combination of drought and greater reliance on irrigation stresses groundwater supplies. Groundwater levels have been dropping in California for decades, and the rate increases with each dry period. The Sustainable Groundwater Management Act was passed in 2014 to limit unrestricted groundwater withdrawal and establish

a long-term, sustainable balance between groundwater withdrawal and recharge. Further complicating the groundwater supply is a history of industrial and agricultural water pollutants entering this supply, making groundwater use more challenging without treatment.

The quantity of available water is only part of the challenge in many parts of California. Water quality also inhibits use by communities, industry, and ecosystems. One often-overlooked water quality impact is temperature—increasing temperature in waterways is associated with lower dissolved oxygen and other negative impacts to species such as salmon. Other water quality challenges are due to past land uses that left a legacy of water pollutants in both surface and groundwater such as industrial and agricultural uses. Currently, pollutants of concern are nonpoint sources that include fertilizers and pesticides from agricultural and residential areas; oil, grease and toxic chemicals from urban runoff; and sediment from improperly managed construction site, and crop and forest lands. Drought and increased rates of evaporation caused by warmer temperatures serve to condense pollutants in water, making the resulting water quality more detrimental to its eventual users.

The rise (rainfall and snowmelt) and fall (drought) of water availability in California means water providers in the state should identify ways to ensure a consistent, ongoing supply of clean water regardless of rainfall or snowmelt. The snow that accumulates in the Sierra is a primary source of the state's water, both for drinking and for irrigation.[42] How long the snowpack stays in the mountains before it melts in spring, when rainfall rates begin to drop, is critical to balancing water supplies and assuring that groundwater use does not surpass recharge rates.

Aquatic ecosystems rely on the same water that serves communities, agriculture, and industry. The impacts on these ecosystems is covered in the biodiversity sector.

MAJOR VULNERABILITIES

Climate change causes the weather to become more variable with longer and more frequent droughts, as well as increased periods of heavy rain and snow events. This results in an intensification of impacts on all water-related or dependent activities and systems. Addressing the threat of climate change to California aquatic and water systems is a state priority, as noted in declarations such as Executive Order N-10-19.[43]

Climate change slowly alters seasonal patterns of rainfall and temperature and makes extreme events such as drought and heavy rainfall more severe and frequent. Less snowpack that melts earlier, and more precipitation falling as rain rather than snow threatens state water supplies. Changes in temperature and water availability also alter water quality by increasing evaporation rates and decreasing total precipitation levels, concentrating water contaminants in the remaining water. All of these effects

can affect water supplies, groundwater levels and associated land subsidence, water quality, and erosion. They also interact with other climate effects to affect the water system. With higher temperatures, people and plants dry out faster, resulting in higher water demand from both households and agriculture. Higher temperatures also change the rate of chemical reactions in water and reduces water's ability to hold oxygen. These factors reduce the viability of water to support wildlife and ecosystems. Communities that rely on smaller water treatment systems may be especially affected, as these systems may not be able to effectively treat heavily contaminated water.

In coastal areas, sea level rise combined with groundwater withdrawal results in sea water intrusion, making coastal aquifers less suitable for human uses, including agriculture. Sea level rise also increases flood risk for coastal areas by expanding the width of floodplains at the outlet of rivers and streams and backing up stormwater systems that drain to the ocean. Together these changes increase flood risk and drought impacts and impair ecosystem health.

Flooding—from extreme rainfall events and/or rapid snowmelt and changed land use patterns—already places billions of dollars in assets and the lives of millions of Californians at risk.[44] Climate change will increase the severity and frequency of flooding. Locally, this means that communities will face rising flood risk with expanding floodplains and increased frequency. The growing risk demands action at all levels of government. Local governments should adjust their disaster management and local hazards plans to prepare for worsening risk to both structures and community members. Floods also impact aquatic ecosystems through erosion and water quality shifts. Increased intensity and frequency of extreme rainfall also means that local stormwater systems should be evaluated for their ability to accommodate larger events due to climate change as well as changing land use patterns. Without adjustment of stormwater systems, localized flooding will occur with greater frequency. In coastal areas, rising sea levels further exacerbate the challenges for local stormwater systems because higher sea levels have the potential to back up stormwater into city streets.

Climate change is projected to increase the frequency and severity of drought events. This places more pressure on groundwater, which already supplies 40 percent of California's water.[45] The past reliance on groundwater during times of drought is not sustainable—groundwater levels have been dropping for decades and now have state protection.[46] Further complicating the challenge of water supply is the projection of reduced snowpack. Less precipitation in the Sierra Nevada, or more rain than snow, diminishes the spring snowmelt, which is a primary source of the state's water supply. Reduced snowpack, reduced precipitation, and increased drought threaten water supply for drinking, agriculture, and ecosystems. To shore up supply for drinking and

agriculture, communities should work with water providers and rural landowners to develop strategies for drought years.

Aquatic ecosystems such as streams, rivers, and lakes will also be affected by climate change, as will any ecosystem that relies on water. Water levels in streams and rivers will change with altered seasonal precipitation patterns. High flows will be higher and low flows may be lower. This results in alteration of habitats, water temperature, and other water quality indicators. These changes affect all species residing in these aquatic ecosystems. Industries from hydropower to fisheries to recreation will also be affected by the increasing variability introduced by climate change. Vegetation is responsive to altered precipitation rates, which has tremendous impact on habitats and terrestrial ecosystems (covered in the Biodiversity sector).

Appendix D provides examples of ways that communities can support a more resilient water sector as part of adaptation planning effort. These strategies are generalized approaches that can be refined for the specific activities in a community.

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APPENDIX B: ADAPTATION PATHWAYS: AN OVERVIEW

One of the challenges of pursuing adaptation strategy development is the need to adjust decisions over time as new information and conditions emerge. Adjusting to these factors requires a flexible and robust approach to managing deep uncertainty. Adaptation Pathways is an approach to adaptation strategy development that allows decision makers to build adaptation capacity, prioritize strategies, stagger investment, maintain flexibility, and communicate critical climate adaptation concepts that a community should understand as it pursues adaptation goals.[1, 2, 3, 4] If a community has resources, including access to experts, time, funding, or other resources, for a potentially more robust strategy development process, the Adaptation Pathways approach is an opportunity to enhance or expand strategy development and the community's adaptation planning framework.

Flexible Adaptation Pathways

In 2018, the Climate-Safe Infrastructure Working Group to the California State Legislature and the Strategic Growth Council issued *Paying It Forward: The Path Toward Climate-Safe Infrastructure in California.* This report provides recommendations to chart a path toward helping California invest in climate-safe infrastructure. The report discusses how resilience is best achieved through a pathway that has multiple strategies that are evaluated and implemented in different stages over time – "the Climate-Safe Path does not mean a once-and-for-all step change, but a change in many steps.[5]

In addition, the *California Coastal Commission's Sea Level Rise Policy Guidance* emphasizes that solutions should be flexible and adaptive over time. Adaptation pathways are suggested as one approach to consider when designing an adaptation strategy.

Although the Adaptation Pathways approach is an alternative approach to the traditional predict-and-plan method described in the APG, much of the guidance provided in the APG can also support an Adaptation Pathways approach. This appendix provides additional information on Adaptation Pathways, including comparisons or considerations for integrating it with the guidance provided in the APG.

Adaptation Pathways could be incorporated in any of the planning mechanism categories noted in the APG. Pathways could provide a framework and guidelines in comprehensive plans or focused plans and can also provide a framework for laying out implementation programs and the monitoring and evaluation processes needed to provide ongoing feedback on whether to stick with a particular adaptation strategy.

Contrasting Adaptation Pathways with Traditional Approaches to Adaptation

This APG generally follows a predict-and-plan approach, meaning that planners try to understand what the future will look like to the extent possible and develop a plan around the optimal adaptation strategies to implement in the near-term, as well as specific strategies to implement in the future. When using Adaptation Pathways, communities are instead taking a monitor-then-act approach. Users select a portfolio of strategies (even if one strategy is to maintain the status quo), then monitor performance. Once a predetermined threshold is reached, communities can evaluate and select additional strategy options are evaluated. Communities can add new adaptation strategies for consideration as they become available over time.

A key difference between these approaches is that the traditional approach plans for a single expected future, whereas the Adaptation Pathways approach identifies a suite of strategies that is suitable for addressing a range of potential future conditions.

Adaptation Pathways and Timing

Phase 1 discusses the importance of identifying time frames to support the scenarios assessed in Phase 2, the strategies developed in Phase 3, and the monitoring and implementation in Phase 4. Time frames might look different if a community is taking an Adaptation Pathways approach. In this case, it is not necessary to commit to implementing specific adaptation strategies by a certain date. As further described in this appendix, actions have a "sell-by" date when predefined thresholds are exceeded. It is vital that a community identify and monitor suitable metrics to track, so that the organization can take appropriate action when the community is close to exceeding a threshold.

Stakeholder Engagement Around Adaptation Pathways

When applying Adaptation Pathways, it is helpful to emphasize the gradual nature of the approach. All decisions do not need to be made now, and it is not essential to try to predict future scenarios with precision. This graduated implementation feature can be advantageous in stakeholder engagements. Stakeholders can feel overwhelmed if they feel pressured to accurately predict future scenarios and make major investment decisions now. Emphasizing gradual implementation can make adaptation less intimidating and consequently achieve better buy-in from stakeholders. Stakeholders are able to focus on immediate next steps, advising decision makers on how to effectively monitor conditions, what sort of thresholds should trigger action, and other smaller steps of implementation. The stakeholder outreach and engagement approach integrated throughout Phases 1 to 4 of this APG can also apply to the Adaptation Pathways approach.

Visualizing Interim Steps Along the Pathway

Community members may find it challenging to engage in conversation about certain adaptation solutions if they don't understand the impacts and the steps to a solution. Engagement during interim points along a pathway can help stakeholders stay connected through the development of solutions, and can provide opportunities to clarify decision-making needs, finance options, and trade-offs. Visualization tools, including virtual reality, can help stakeholders to understand impacts and solutions, and to participate in crafting and implementing steps along a pathway.

Identifying Strategies for Adaptation Pathways

Phase 3 of this APG presents an approach to preparing an adaptation framework and strategies using the predict-and-plan approach, and identification of feasible adaptation strategies is also needed when using Adaptation Pathways. However, rather than selecting a static set of adaptation strategies to implement today, organizations identify a suite of potential adaptation strategies that can be implemented over time and can address a range of possible future conditions.

The community then identifies thresholds or future conditions that would trigger implementation of a new strategy and monitor these thresholds over time, enabling it to respond as conditions change. The different sequences of adaptation strategies over time form adaptation "pathways." This approach enables communities to prepare for addressing a broad range of plausible futures while maintaining flexibility.

For example, a community might determine that once sea levels rise by 0.2 foot they will begin expanding wetland vegetation to protect a coastal walkway, and once sea levels rise by 0.5 foot and the walkway will soon become regularly flooded, they will rebuild or reroute the coastal walkway. Thresholds can be measurements of climate statistics such as precipitation levels or extreme heat days, or they can measurements of socioeconomic data or other pieces of information, such as the percent of community residents who are senior citizens. As with all metrics, the thresholds used in an Adaptation Pathways approach should be easy to monitor and report on.

Communities need to understand relative pros/cons of different strategies and situations under which one strategy would be preferable over another. They also need to identify strategies that allow for a pathway that is both flexible and robust. Flexibility is the ability of a particular pathway to accommodate future change. Robust pathways are effective across a wide range of potential future scenarios.

At the early stage of the Adaptation Pathways approach, communities need not commit to one specific strategy or strategies for the long term; rather, they should identify a portfolio of potential strategies. As conditions and information change, the organization can evaluate whether their current course of action remains optimal or whether corrective action must be taken to maximize community resilience.

When using the Adaptation Pathways approach, prioritizing adaptation strategies is not as important as establishing a robust monitoring and evaluation system. In many cases, immediate action might not be necessary (or the appropriate immediate action is known to be a short-term solution only). However, it is essential that a community develop and implement a plan for monitoring thresholds that trigger a re-evaluation of the appropriate actions. During re-evaluation, prioritization factors are used to select the appropriate strategy or set of strategies to pursue going forward.

The Adaptation Pathways approach can identify, evaluate, prioritize, and sequence over time multiple adaptation strategies. Strategies not chosen for implementation in the short-term can be used later in the sequence, allowing adaptation to be a process of continual adjustment see Figure B.1). The range of options left for the future gives decision-makers flexibility, allowing decisions to be responsive to changing conditions and iterative. The following concepts allow for understanding of climate adaptation both in city government and the broader community.

Sell-by dates. Climate change is advancing and increasing the frequency and severity of climate-related hazards and other effects. A single action does not address a climate effect indefinitely. The sell-by date is the point at which a strategy is no longer effective. In addition, communities change over time, and community change (physical form, economy, community characteristics, etc.) can further diminish strategies' effectiveness. Acknowledging that strategies have a finite period

of effectiveness allows a community to better understand climate change adaptation and the steps needed to address effects over longer periods. These steps include identification and implementation of multiple strategies arranged in a sequence.

Triggers. When the current strategy begins losing effectiveness, a trigger or threshold determined ahead of time, is the set of conditions that signals the time for a new strategy. A trigger is based on factors specific to the effect it addresses. It can be any number of signals(e.g. such as a specified level of service disruption such as transit service availability[6]) or a biophysical signal of effect progression (e.g. beach width or flood frequency[7]). With a defined trigger a community can shift strategies before the loss of effectiveness provokes a reactive response, which is nearly always more expensive. Pre-emptive action also allows greater flexibility in choosing the best path forward.

Figure B-1. Adaptation Planning Process

A. Enhance operational alternatives
B. Install cooling equipment in impacted elevator machinery rooms
C. Increase elevator redundancy by adding a heat-resilient elevator
D. Redesign and replace current elevators with heat-resilient elevators

Legend

— Adaptation action
○ Transfer point
I Adaptation action no longer viable
•••• Adaptation action potentially viable
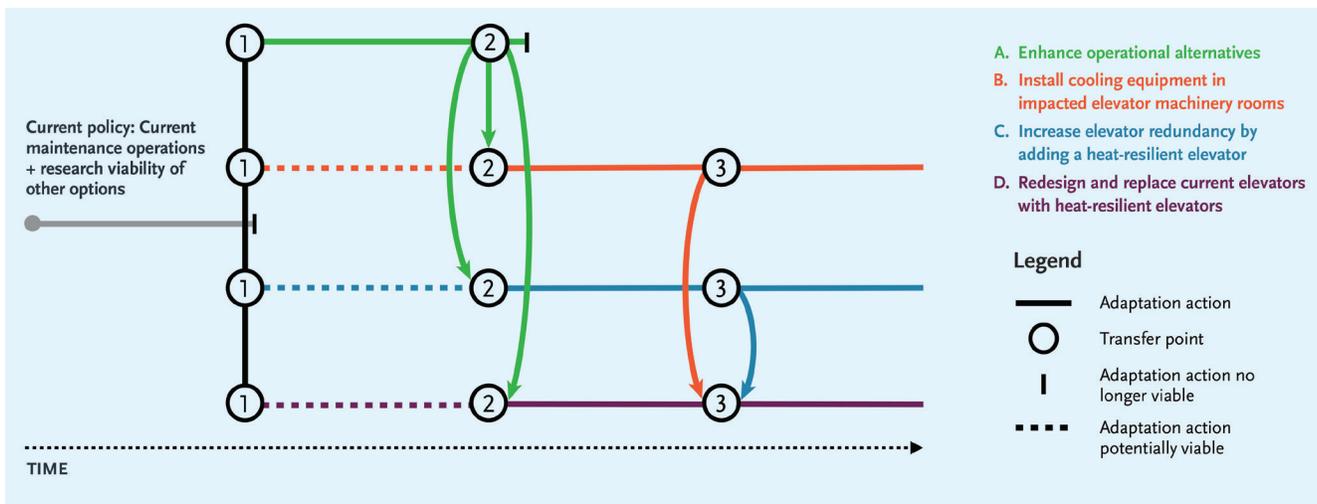
Source: Los Angeles County Metropolitan Transportation Authority (Metro). Metro Climate Action and Adaptation Plan 2019, 2019 Los Angeles: author, page 38.

Note: When conditions reach a trigger (numbers), the adaptation strategy changes to one of the other options.

Monitoring. Though all adaptation strategies should be monitored to track effectiveness, monitoring identified triggers requires formal support and regular attention. As mentioned above, it is far less expensive to adjust or change the strategy addressing an effect based on a trigger reaching a specified threshold, than to reactively address an effect that has progressed beyond the ability of an adaptation strategy to address it.

Steps to Taking an Adaptation Pathways Approach

The core tenant of the Adaptation Pathways approach is that all strategies have a finite period of effectiveness that ought to be defined. The process of formulating specific adaptation strategies under this tenet has four main steps.

1. Determine the effect being addressed and specifically define a desired outcome or objective.

    This step has two parts. First, explicitly describe the effect being addressed. Second, detail the effect, the desired outcome. This information is the basis for defining an objective that combines effect specificity and desired outcome. The objective makes it simpler to be identify specific strategies that address the projected effect and meet community needs (Step 2). Also, specifically defining both the effect and desired outcome alleviates some of the challenge posed by uncertainty.

2. Identify the potential adaptation strategies to address the effect and meet the objective.

    Based on the defined objective (Step 1), identify strategies that both address the effect and satisfy the outcomes specified in the objectives. It is a good idea to identify at least three or four strategies that address multiple potential climate effect scenarios. The strategies should address short-term and long-term projected effects with various levels of funding allocation, implementation time, and duration of effectiveness (evaluated in Step 3). Also define the trigger signaling the need for the approach. This information is critical to completing Step 3.

3. Analyze potential strategy sequences for:
    *   Pros/cons
    *   Lead time to implement strategies
    *   Longevity of effectiveness

    Each strategy identified in Step 2 should be evaluated and organized into a sequence. This includes the pros/cons of each strategy. Pros/cons include the cost of both implementation and ongoing operations and maintenance. Disproportionate outcomes also should be evaluated by assessing who or what wins or loses through implementation of the strategy. This can apply to populations within the community based on factors such as age, location of home or work, social or political power, and health; or it can apply to the viability of certain community assets such as ecosystems, infrastructure, or other critical services.

After detailing the cost and potential outcomes of strategy implementation, evaluate the pragmatic feasibility assessments of lead time to implement and secondary consequences of implementation. Secondary consequences may include outcomes such as service disruption, land use change, alteration of wave pattern, or structural realignment. The final aspect of strategy feasibility is assessing the likely longevity of effectiveness. For each strategy, define an expected time period of effectiveness and the measurement that signals a loss of effectiveness (trigger) and the need to move to another strategy.

4. Assess compatibility of potential strategies

After sequencing strategies based on ease of implementation and longevity of effectiveness, communities should assess the compatibility between strategies. This is the process of asking, *Would pursuing one strategy lock a community out of pursuing another?* This is critical both within a single objective, but also between them. Pursuit of a particular strategy should not prevent pursuit of another (for the same effect or another adaptation need).

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APPENDIX C: ADAPTATION PLANNING RESOURCES

State of California Resources

Cal-Adapt (cal-adapt.org). Cal-Adapt is an online resource for viewing and downloading data about projected changes in climate conditions and associated natural hazards. It has several tools that allow users to view customized maps and charts showing changes over time. Adaptation planners can easily look at future conditions in their communities and how severe the impacts of climate change may be. Users can also download the datasets behind these maps and charts, allowing them to prepare their own graphics and conduct their own analyses. UC Berkeley's Geospatial Innovation Facility, developed Cal-Adapt, with support from the California Energy Commission.

California's Climate Change Assessment (climateassessment.ca.gov). California's Climate Change Assessment is a series of reports looking at future climate conditions throughout the state and the consequences that may result from them. The reports bring together extensive academic research and other studies and provides detailed information about specific changes. The Fourth Climate Change Assessment includes a statewide report, a set of regional reports looking at the effects of climate change in different parts of the state, topical reports that reflect perspectives and issues of statewide importance, and a number of technical reports on focused topics (for example, the impacts of changing wildfire risks on California's residential insurance market). The Fourth Assessment should not be confused with the Fourth National Climate Assessment, a similar document about climate change and its potential for harm, which looks at the entire United States. The California Natural Resources Agency, Governor's Office of Planning and Research, and the California Energy Commission led preparation of the Fourth Assessment.

California Adaptation Clearinghouse (resilientca.org). The Adaptation Clearinghouse is an online resource with links to California-specific climate adaptation and resilience resources. Users can filter resources by specific topics, such as public health, equity and environmental justice, or land use and community development. Under each topic is a summary of the issue and links to available resources. Users can further filter resources by type of resource, the climate change effects involved, the agencies behind the resource, and whether resources apply statewide or to specific regions. The Adaptation Clearinghouse also provides links to different climate datasets and case studies and example documents on numerous issues. The Governor's Office of Planning and Research manages the Adaptation Clearinghouse.

California Building Resilience Against Climate Effects (CalBRACE https://www.cdph. ca.gov/Programs/OHE/Pages/CalBRACE.aspx). CalBRACE is a project of the California Department of Public Health's Climate Change and Health Equity Program, with an online toolkit to help plan for the public health impacts of climate change. This program also produces climate change and health vulnerability indicators, which provide local data on climate change exposures, sensitivities, and adaptive capacities that can be helpful when assessing human health vulnerabilities. The CalBRACE framework aligns with the four phases in the Adaptation Planning Guide, with the addition of an additional step "to project the burden of disease." The CalBRACE framework also focuses on identifying existing health, environmental, and social conditions as well as projecting how health conditions combine with climate threats to impact the health and well-being of communities. It provides a framework for public health adaptation planning, technical information and methods for assessing climate-related health vulnerabilities, and examples of best practices for building health resiliency. The toolkit also includes case studies that other communities can reference.

CalEnviroScreen. CalEnviroScreen 3.0 is an online screening tool that identifies communities most affected by and vulnerable to the effects of many sources of pollution and population-based disparities. It aggregates state-wide environmental, health, and socioeconomic information to produce scores for every census tract in the state. A census tract with a high score is considered more disadvantaged than a community with a low score as a result of pollution burden and population characteristics. When overlaid with climate impact and exposure data, CalEnviroScreen can provide insight into built and environmental exposure factors that contribute to vulnerability.[1] The most visible part of CalEnviroScreen is a mapping and search function, but the tool also allows users to view and download the data behind the assessment. CalEnviroScreen was developed by the California Office of Environmental Health Hazard Assessment.

California Heat Assessment Tool (CHAT). CHAT is an online tool (https://www.cal-heat. org/) that provides detailed information about future extreme heat conditions across California. Users can view and download information about extreme heat for a specific location, including several weather variables, pollution levels, and demographic and land use factors that influence vulnerability to extreme heat conditions. The tool also has links to several other resources to help build resiliency to extreme heat events. The California Natural Resources Agency funded CHAT which Four Twenty Seven developed in partnership with Argos Analytics, Habitat Seven, and the Public Health Institute (PHI).

California Office of Environmental Health Hazard Assessment (OEHHA). OEHHA assesses the health risks cause by environmental hazards throughout California. The mission of OEHHA is to protect human health and environmental through scientific

evaluation of risks posed by hazardous substances. The indicators of climate change in California, used to develop CalEnviroScreen 3.0, were developed by OEHHA.

California State Hazard Mitigation Plan. The California State Hazard Mitigation Plan (SHMP) is a summary of the threat posed by hazardous conditions in the state, strategies to mitigate hazardous events, and information about resources to support hazard mitigation. Because many of the hazards in the SHMP relate to climate change, it is a useful resource for better understanding the threat posed by these hazardous conditions and the state's current efforts to mitigate them. The California Office of Emergency Services leads preparation of the SHMP.

MyPlan. MyPlan is an online tool that allows users to enter a location in California, such as a city or specific address, and view the potential hazards that may affect that location. The tool includes climate-related hazards, such as floods and wildfires, as well as non-climate hazards such as seismic activity. It brings together mapping data from a variety of sources. Users can browse statewide hazard maps and export maps and mapping data for other purposes. The California Office of Emergency Services developed MyPlan.

Ocean Protection Council Resources. California's Ocean Protection Council's Climate Change Program publishes multiple resources meant to assist coastal communities with adapting to ocean-related climate hazards and building resiliency for oceanic assets. Resources include State of California Sea-Level Rise Guidance studies and reports on ocean acidification and its effects, and opportunities for grant funding on relevant issues. The Ocean Protection Council also works on issues such as marine pollution and sustainable fisheries, which may relate to climate change resiliency for some communities.

California Coastal Commission. The California Coastal Commission developed Sea Level Rise Policy Guidance and Coastal Adaptation Planning Guidance: Residential Development to provide an overview of the best available science on sea level rise in California and recommend planning and regulatory actions for adaptation. These guidance documents are intended to serve as a multi-purpose resource and includes a high level of detail on many subjects pertaining to sea level rise. The Coastal Adaptation Planning Guidance: Residential Development guidance provides a range of land use policies to facilitate planning for resilient coastal communities.

Building Blocks: A Comprehensive Housing Element Guide. The *Building Blocks Guide* is a comprehensive resource explaining requirements, state of practice, and useful examples under State Housing Element Law. The California Department of Housing and Community Development's (HCD) *Building Blocks Guide* was created to assist jurisdictions in developing housing elements that address varying groups and other land issues. It also provides resources for local governments to build community

resilience among vulnerable populations, including those experiencing homelessness and housing insecurity.

California Climate Change. California Climate Change lists useful resources for both local governments and businesses to gather information on greenhouse gas emission reduction and climate change impacts. This resource has a collection of links to additional sites that fall under climate change impacts and GHG emissions. It is a "one-stop shop" for information on these topics.

Planning and Investing for a Resilient California. Planning and Investing for a Resilient California, developed by OPR's Technical Advisory group, is a guidebook for state agencies to integrate climate change considerations into every aspect of government. Its guidance on scenario selection, identification of vulnerable communities, community engagement, and fostering equity are applicable to local adaptation planning.

Sea the Future. Developed by the Coastal Conservancy, NOAA, and the Sentinel Site Cooperative in the San Francisco Bay Area, the Sea the Future resource provides a platform that highlights all tools available for visualizing sea level rise in California. It has a filter and compare tool with filters such as geographic scope, shoreline processes, exposure analysis and projected flooding information display, to identify which sea level rise tool matches the user's needs.

From Mountains to Cities: Exploring California's Urban Connections to Sierra Nevada Ecosystems. *From Mountain to Cities*, developed by the Alliance of Regional Collaboratives for Climate Adaptation, describes the interconnections between upstream rural communities, and downstream urban areas. This whitepaper focuses on the resources that the Sierra Nevada Mountains provide communities throughout the state and presents the need for urgent and ongoing collaboration to address current and future climate related hazards.

California Ready Program. The Climate Ready Program, administered by the California Coastal Conservancy, provides grant funding to multi--benefit projects that use natural systems to assist communities in adapting to the effects of climate change. This program has awarded $10.7 million for 57 projects throughout the state that provide both adaptation and greenhouse gas reductions. Eligible grantees include government agencies, non-profit organizations, and federally recognized tribes with projects that use nature-based solutions, promote collaboration, reduce greenhouse gas emissions, address the needs of underserved coastal populations, promote on-the-ground demonstration projects, and incorporate outreach and education.

Federal Resources

FEMA's *Local Mitigation Planning Handbook* is a guidance document to help communities across the country develop hazard mitigation plans. Although hazard mitigation plans are not necessarily identical to adaptation planning efforts, there is significant overlap between the two. The guidance and resources in this handbook can also be used for adaptation planning. The handbook includes information about assembling stakeholders and conducting outreach, determining community capabilities, assessing the potential for harm, and developing hazard mitigation strategies. It also contains checklists and worksheets for use throughout the hazard mitigation process. The *Local Mitigation Planning Handbook* was last updated in 2013.

US Census Bureau's data.census.gov. Data.census.gov is an online database hosted by the US Census Bureau that allows users to view, download, and map results from the decennial census, the annual American Community Survey, and other specialized surveys and analyses carried out by the Census Bureau. This updated database also includes a mapping feature that allows planners to visually display the results of the data. Adaptation planners can use data.census.gov to understand the demographic and other socioeconomic characteristics of a community, such as how many residents belong to a particular frontline community.

US Climate Resilience Toolkit. The US Climate Resilience Toolkit is a set of national resources to assist practitioners in conducting climate adaptation work. It provides a number of tools for looking up climate change–related data, guidance documents on the climate adaptation process, and case studies on improving resiliency. The Climate Resilience Toolkit also includes videos and other training modules on adaptation-related topics. The toolkit is a program of the United States Global Change Research Program.

Regional Resilience Toolkit. The *Regional Resilience Toolkit*, prepared by FEMA and EPA in partnership with the Metropolitan Transportation Commission/Association of Bay Area Governments, is a toolkit to help with regional disaster planning across multiple jurisdictions and with non-governmental partners. This toolkit provides a 5-step process with helpful worksheets and outreach materials, to help communities plan for resilience, or move from planning to action.

NOAA's Digital Coast is a comprehensive platform for data, tools, and training for communities to address coastal issues. One-way adaptation-related resources can be accessed on the site by topic area, including adaptation strategies, coastal economy, coastal land cover, coastal storms, natural infrastructure, risk communication, vulnerability assessments, and water quality. This website provides data, information, and technical support that can be applied in California at state, regional, and local levels.

Federal Highway Administration Nature-Based Solutions. The Federal Highway Administration provides resources, pilot studies, webinars, and examples of nature-based solutions that help protect coastal highways from sea level rise, flooding, and coastal erosion. The implementation guide provides best practices for how and where nature-based and hybrid solutions can be used to improve the resilience of coastal roads and bridges. This resource also provides research and technical assistance from transportation practitioners across the country.

Guidance for Considering the Use of Living Shorelines. *Guidance for Considering the Use of Living Shorelines* was developed in 2015 by NOAA to provide insight on implementing a living shoreline along estuarine coasts, bays, and tributaries. The guidance document provides information for addressing shoreline erosion through natural solutions that add stability. It also discusses NOAA's role in reviewing living shoreline projects in critical habitat, essential fish habitat, or protected areas.

Nongovernmental Resources

Climate Adaptation Knowledge Exchange. The Climate Adaptation Knowledge Exchange (CAKE) was launched in 2010 as a shared knowledge base for managing the natural and built systems in the face of climate change. CAKE includes case studies and documents from across the world. This resource also includes several tribal nation examples in the United States.

Guide to Equitable Community-Driven Climate Preparedness Planning. The Guide to Equitable Community-Driven Climate Preparedness Planning, prepared by the Urban Sustainability Directors Network in 2017, provides guidance on how to complete an equitable climate adaptation planning process. This guide provides background on inequities in planning, as well as a framework conducting an inclusive climate preparedness process. Table 8 of this guide demonstrates considerations and strategies that can be integrated into climate adaptation measures to account for social and climate justice inequities in communities.

Making Equity Real in Climate Adaptation and Community Resilience Policies and Programs: A Guidebook The Greenlining Institute aims to advance economic opportunity and empowerment for people of color through advocacy, community building, and leadership development. This guidebook prioritizes the climate adaptation and community resilience needs of frontline communities and offers planning staff a step-by-step process for defining equity in measurable factors in policies and grant programs. These steps include embedding equity in the mission, vision, and values; building equity in the process; ensuring equitable outcomes; and measuring and analyzing for equity.

Healthy Places Index. The Healthy Places Index, developed by the Public Health Alliance of Southern California, is an interactive mapping tool that combines 25 community characteristics into a weighted score that ranks census tracts across California for conditions that support health. It displays some climate change exposures, sensitivities, and adaptive capacities in "decision support layers" to assist in assessing climate and health vulnerability and planning for policy changes to support community resilience.

Mapping Resilience: A Blueprint for Thriving in the Face of Climate Disasters Mapping Resilience, prepared by the Asian Pacific Environmental Network, aims to raise the public visibility of the needs of frontline communities within statewide climate adaptation and resilience efforts. For adaptation planning, the report provides research and resources on communities disproportionately impacted by climate change–related disasters in California and lessons learned from examples across the US; key existing indicators, data, tools, and analytical frameworks for understanding the intersection of climate impacts, health and well-being outcomes, socioeconomic vulnerability, and adaptive capacity factors; and lessons learned from development and use of indicators in related fields (e.g., public health, environmental justice, and land use).

Community-Driven Climate Resilience Planning Framework. Community-Driven Climate Resilience Planning Framework was developed by the Movement Strategy Center and community-based organizations across the country to strengthen climate adaptation efforts through culturally relevant, democratic processes with meaningful community engagement. The primary audience of this resource is community-based organizations developing, advocating for, and implementing climate solutions; however, local government staff can use this resource to help increase cross-sector collaboration and increase the community's voice and leadership role in the adaptation process.

Coastal Adaptation Policy Briefs. The Stanford Center for Ocean Solutions developed a set of Coastal Adaptation Policy Briefs that provide engineering, financial, and legal and regulatory solutions for coastal resources. Each policy brief introduces coastal adaptation strategy, describes trade-offs and any legal considerations, and illustrates examples of projects along the California coast. The financial resources include buyout programs, conservation easements, geologic hazard abatement districts, and transfer of development rights solutions.

Tribal Climate Change Adaptation Planning Template. This toolkit, developed by the Institute for Tribal Environmental Professionals, contains templates and other resources to support tribal climate change efforts. It includes guidance on procedures and methods, worksheets for identifying the potential harm posed by climate change and developing policies in response to these vulnerabilities, and guidance for thinking about effective implementation. The toolkit also contains a list of tribal climate change assessments and adaptation plans from several different states.

APPENDIX D: EXAMPLES OF LOCAL ADAPTATION STRATEGIES BY SECTOR

TABLE D-1. EXAMPLES OF LOCAL CLIMATE ADAPTATION STRATEGIES BY SECTOR							
CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
Agriculture Sector							
Extreme Heat, drought, flooding	**Strategy AG-1: Encourage the breeding of livestock animals and adoption of crops that are better adapted to warmer temperatures and greater precipitation variability.** This is a broad, high-level strategy responding to concerns that warmer temperatures and more precipitation extremes will decrease the productivity or quality of agricultural products for plants and animals that are susceptible to these changes. In many cases, projected future conditions may better suit particular varieties of plants or livestock animals. If not, ongoing research efforts may be successful in producing such examples. Local governments do not (and should not seek to) control what varieties of plant or livestock animal are grown or raised, nor do they conduct research on new crop or livestock varieties. However, communities can work with farming and ranching groups to encourage adoption of these varieties, and in some cases may be able to support research efforts at local institutions.	Every community will face different specific needs for this strategy, depending on the types of crops and livestock in the local agricultural industry and the changes in climate conditions that are projected for the area. Some crops and livestock have readily available varieties that are suitable for future conditions and meet market requirements, while more research may be needed for other crops and livestock to produce a viable future-adapted variety. If a viable strain is available but adoption is slow, consider pilot incentive programs to encourage this.	Education, Outreach, Coordination Programmatic Evaluation	Water	Cities and counties	General Fund State Water Efficiency & Enhancement Program grant Climate Adaptation and Resiliency Program grant FEMA hazard mitigation grant Other grant funding	Adaptation Resources for Agriculture Southwest Regional Climate Hub Santa Clara Valley Agricultural Plan
All climate hazards	**Strategy AG-2: Revise land use plans to accommodate changes in types of agricultural activities, and to allow for shifts in agriculturally viable areas.** As the climate changes, crops and livestock currently raised in an area may no longer be viable, and newly viable crops and livestock may require different land uses (for example, orchards converting to row crops). Agricultural operations may also consider accessory uses, including agritourism and direct retail activities, to help keep their businesses successful. Communities should revise and revise as needed their land use plans, including General Plan land use elements, zoning codes, and development standards, to ensure that they are not creating unintended barriers to continued viability of agricultural areas as climate conditions change. In communities with a range of topographic and climate conditions, these changes may include allowing certain types of agricultural activities in areas that were previously unsuitable.	As with any land use decision, communities should consider changes to the standards that govern where and how agricultural operations occur as part of addressing overall community well-being and quality of life. Keep in mind that changes to agricultural locations and types of operations may create conflicts with other land uses, including natural ecosystems which may also be stressed by climate change. Strategies such as agricultural buffers and wind rows can help minimize potential incompatibilities. Local governments may need to remove some barriers on agricultural operations while simultaneously enacting additional regulations. If a community has a right to farm ordinance or a land conservation program, be aware of any changes that may need to be made to accommodate shifts in agricultural activities. Multiple jurisdictions working together can take a regional approach to help maintain agricultural viability across political boundaries.	Plans, Regulations, and Policy Development	Land Use and Community Development Water	Cities and counties Council for Association of Governments	General Fund SB 1 Grant Climate Adaptation and Resiliency Program grant State Water Efficiency & Enhancement Program grant Other grant funding	Adaptation Resources for Agriculture Santa Clara Valley Agricultural Plan

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CLIMATE HAZARDS	**ADAPTATION STRATEGY**	**FACTORS TO CONSIDER**	**CATEGORY**	**SECTOR OVERLAP**	**RESPONSIBLE AGENCIES**	**FUNDING**	**EXAMPLES & SOURCES**
All climate hazards	**Strategy AG-3: Change soil management and planting and growing techniques to improve soil and plant health.** Farmers rely on specific techniques to ensure that their soil and crops remain healthy and productive. These may include specific planting schedules, use of soil additives, growing plants to a particular height or shape, combining multiple plants in the same growing area, and many others. Farmers may make several adjustments to these strategies in response to climate change. For example, altered crop rotation and soil cover management can help maintain soil moisture levels, protecting against drought, and changes to the types of additives used in soils may provide additional nutrients to plants that can protect them against climate stress. Decisions about the types of changes made to these activities should be left to individual farmers, and local governments should not impose requirements for specific growing activities. However, in coordination with agricultural operations and research institutions, local governments can provide important education and outreach opportunities, and may be able to incentivize pilot programs.	Changes to soil management and planting and growing techniques should largely fall within the existing framework of agricultural regulations established by state and local governments. However, be aware of potential conflicts. For example, farmers may wish to erect shade structures in fields that could exceed height requirements for row crops, or it may be necessary to alter aerial crop-spraying schedules. In consultation with farming groups, identify what changes to these techniques farmers intend to make, and review local regulations to make sure there are no unnecessary barriers to these changes. In cases where changes to these techniques may expose workers or community members to new or increased levels of potentially harmful materials, ensure that local governments and agricultural operations take all needed steps to minimize the risk, remembering that protection of community (including ecological) health, safety, and welfare is paramount.	Education, Outreach, Coordination Programmatic Evaluation Plans, Regulations, and Policy Development	Biodiversity and Habitat Water	Cities and counties	General Fund Climate Adaptation and Resiliency Program grant Healthy Soils Program grant FEMA hazard mitigation grant State Water Efficiency & Enhancement Program grant Other grant funding	California Healthy Soils
Extreme heat	**Strategy AG-4: Plant trees or construct shade structures for livestock.** Extreme heat can be very harmful for livestock animals, leading to significant illness or death. These conditions may also decrease the quantity or quality of products from livestock, such as milk from dairy cattle or eggs from laying hens. Providing shade for livestock can provide protection against harm from extreme heat, as temperatures in the shade may feel 10 to 15 degrees Fahrenheit cooler than in the sun. Ranchers can plant trees or tall shrubs to provide shade, which may provide fruit or other crops as a side benefit. Ranchers may also erect shade structures, which they can use as a trellis for crop plants or as a mount for solar panels, providing energy to the ranch. Positioning water troughs under shade structures can also reduce evaporation, decreasing overall water use.	Local governments should encourage farmers to plant shade trees that are drought tolerant. Ideally, farmers would also plant native trees that provide habitat to beneficial insects and other animals. While landscaping and tree ordinances often do not apply to agricultural lands, if these regulations are applicable, ensure that there are allowable trees that meet the needs of ranchers. Communities may need to amend the zoning code or development standards to allow shade structures, including elevated ground-mounted solar arrays, on pastures or other ranch lands. If agricultural areas abut other land uses, local governments may require farmers to screen the view of the shade structure. If the community encourages farmers to install solar panels as a shade structure, ensure that these efforts are coordinated with any existing community-wide renewable energy and energy efficiency strategies. Communities may want to use incentive programs to encourage adoption of shade trees or shade structures.	Education, Outreach, Coordination Evaluation Plans, Regulations, and Policy Development	Biodiversity and Habitat Water	Cities and counties	General Fund Climate Adaptation and Resiliency Program grant Healthy Soils Program grant FEMA hazard mitigation grant State Water Efficiency & Enhancement Program grant Other grant funding	Adaptation Resources for Agriculture Southwest Regional Climate Hub Santa Clara Valley Agricultural Plan

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Extreme heat, air quality, pests and diseases	**Strategy AG-5: Ensure that all agricultural workers have adequate protection from extreme conditions, and that healthy and safe working conditions are maintained.** Agricultural work is vital, but often physically demanding, and can lead to chronic health impacts. The socially vulnerable nature of many agricultural workers may be a barrier to receiving the safe and just working conditions that they deserve. Through educational efforts, as well as enforcement of labor laws in coordination with state and federal agencies, communities can make sure that agricultural workers have the resources and supplies they need to be safe and to remain healthy while at work. This can include access to appropriate protective gear (such as N95 masks during days of poor air quality), sufficient water and rest breaks during high heat conditions, access to safe and comfortable shelter, and ensuring that workers suffering from heat-related illnesses receive prompt and appropriate medical care.	Community-based organizations are vital partners to implementation of this strategy, as agricultural areas often have organizations that work directly with agricultural workers on issues of health and equity. Communities should work with these organizations to purchase and distribute supplies, and to listen to complaints that agricultural workers may have about their working conditions. Be aware that some agricultural workers, especially undocumented workers, may be reluctant to interact with government staff. Simultaneously, communities should work with agricultural groups to ensure that owners and managers fully understand their own responsibilities to maintain a safe and healthy working environment, especially as climate conditions change. Communities should not hesitate to coordinate with state and federal labor agencies about potential health or safety violations.	Education, Outreach, Coordination Programmatic	Climate Justice Public Health	Cities and counties Community-based organizations State and federal agencies	General Fund Transformative Climate Communities grant Other grant funding	Adaptation Resources for Agriculture Southwest Regional Climate Hub Santa Clara Valley Agricultural Plan
All climate hazards	**Strategy AG-6: Provide sufficient habitat for native pollinators and beneficial species in and adjacent to agricultural areas.** Agricultural lands, especially buffers and other areas left in a more natural state, are directly beneficial to agricultural operations. These natural areas act as habitat to pollinator species as well as animals that prey on agricultural pests and disease vectors. Providing this habitat helps ensure healthy crops and livestock, especially in the face of increased climate stressors, and for crops such as almonds and melons that are heavily reliant on managed pollinators (which themselves may face greater stress from climate change). Natural lands can also provide other ecosystem benefits, including increased carbon sequestration, groundwater recharge, and flood protection and water filtering.	Local governments can encourage or incentivize habitat for these species, require natural buffers as part of land use standards. In cases where agricultural buffers are required habitat for native species can meet this need. Agricultural operators do not necessarily need to dedicate part of their own land as buffers, as it could be set aside as part of a development adjacent to an agricultural land (this has the added benefit of not taking land out of agricultural development). Neighboring property owners and managers should take care not to expose native habitat buffer areas to herbicides, insecticides, or other compounds that may be harmful to native species. Local governments can integrate proper care and maintenance of these habitats into a community-wide integrated pest management strategy.	Education, Outreach, Coordination Plans, Regulations, and Policy Development	Biodiversity and Habitat	Cities and counties	General Fund Health Soils Program grant State Water Efficiency & Enhancement program grant Other grant funding	Adaptation Resources for Agriculture Southwest Regional Climate Hub Santa Clara Valley Agricultural Plan

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Biodiversity and Habitat Sector							
All climate hazards	**Strategy BH-1: Improve interagency cooperation on ecological conservation efforts.** Ecological communities very often cross jurisdictional boundaries, and many protected natural areas are under state or federal jurisdiction. Protecting and improving habitat resiliency for the parts of an ecosystem only within one community will likely not achieve the hoped-for degree of adaptation benefits. Instead, communities should coordinate with each other, with appropriate state and federal agencies, and with other relevant stakeholders on biodiversity and habitat protection to develop and implement a comprehensive resilience strategy. These efforts should take advantage of the resources and opportunities available to each stakeholder, including regulatory authority, access to funding sources, and staff time and institutional knowledge.	Depending on the agencies involved, building cooperation and developing a comprehensive adaptation approach for ecological conservation can vary widely in the level of complexity. Any existing agreements or memoranda of understanding (MOUs) between agencies can be a good place to start. When deciding which agencies should be involved, consider those that own or regulate both current and future suitable land for local biological communities, as well as agencies that have regulatory authority over wildlife (such as the California Department of Fish and Wildlife, or the US Fish and Wildlife Service) even if they do not have land use control in the area.	Education, Outreach, Coordination	Forests Ocean and Coast Land Use and Community Development Water Parks and Recreation	Cities and Counties Council or Association of Governments State and federal agencies Community-based organizations	General Fund Habitat Conservation Fund grant Department of Fish and Wildlife grants Department of Water Resources grant Wildlife Conservation Board grant ESA Nontraditional Section 6 grant National Fish and Wildlife Foundation grants Other grant programs	Integrated Regional Conservation and Development (ICARD) program, and RePlan System

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All climate hazards	**Strategy BH-2: Restore and conserve land identified as newly suitable for habitats and species of concern, as well as corridors between current habitat and future newly suitable lands.** One of the primary climate vulnerabilities for biodiversity and habitats in California is the anticipated shifts in the areas that are suitable for these ecological communities. To protect these habitats, jurisdictions should conserve as natural lands the areas that become newly suitable for shifting ecosystems. They should also conserve the corridors between the current and future suitable areas, so that the ecosystem has the space to migrate naturally. These actions enhance the overall connectivity of California's natural systems, removing barriers to species movement and helping to limit habitat fragmentation. As a part of this strategy, identify land in the newly suitable area that may be degraded, but is appropriate for ecological restoration. Sync the timeline for restoration so that communities can complete these activities in time for the area to act as a suitable "receiving site" for migrating biological communities.	Ensure that the land being protected is suitable in the long term for the habitats and species of concern. Be aware that, in mountainous terrain, climate conditions can vary widely over a relatively short horizontal distance, and so ecosystems may be able to migrate to newly suitable land that is only a short distance away. However, in flatter areas and other locations that have similar climate conditions over a large region, habitats may need to migrate a greater distance to stay viable. Multijurisdictional and interagency cooperation is critical to the success of this strategy. Consider how to adapt or expand existing habitat protection efforts, such as conservation easements, to meet the needs of this strategy. Ensure that riparian corridors and other water bodies are protected, as well as terrestrial habitats. Once habitats begin to migrate, monitor the state of the migration, and be prepared to protect additional lands as needed to ensure continued protection of the area's biodiversity.	Plans, Regulations, and Policy Development Evaluation	Forests Ocean and Coast Land Use and Community Development Water Parks and Recreation Agriculture	Cities and Counties Council or Association of Governments State and federal agencies	General Fund Habitat Conservation Fund grant Department of Fish and Wildlife grants Department of Water Resources grant Wildlife Conservation Board gran ESA Nontraditional Section 6 grant National Fish and Wildlife Foundation grants Other grant programs	Integrated Regional Conservation and Development (ICARD) program, and RePlan System

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All climate hazards	**Strategy BH-3: Restore degraded ecosystems to enhance the natural adaptive capacity of biological communities.** Healthy ecosystems are better able to resist the pressures of climate change and other stressors than damaged ones. Even if an ecosystem type is generally resilient to climate change, it may face higher-than-expected harm if it has been damaged. Restoring these degraded ecosystems back to their natural state helps to better prepare them for climate change. Such ecosystems often have higher biodiversity, improving overall ecosystem health and reducing the odds that invasive or other non-native species will replace them. Restoring degraded ecosystems also allows them to support other biodiversity and habitat-related adaptation efforts, or to provide additional ecosystem services that benefit surrounding communities.	Ensure that degraded ecosystems are restored to a "climate-smart" condition that allows for a healthy and functioning biological community both now and in the future, rather than a "business as usual" ecosystem that may have been appropriate in past years but is not adapted to expected future conditions. The species and specific breeds or strains of organisms re-introduced to degraded areas should be appropriate for the current ecosystem and demonstrate a moderate or high level of climate change resilience, to the extent possible. Communities should also practice climate-smart restoration should also be practiced in non-organic restoration activities, such as corrections to the area's hydrology. Conduct regular monitoring of the site once the primary restoration is complete, especially as climate stressors appear or become greater, and adjust future restoration and management practices as needed.	Plans, Regulations, and Policy Development Programmatic Evaluation	Forests Ocean and Coast Land Use and Community Development Water Parks and Recreation Agriculture	Cities and Counties Council or Association of Governments State and federal agencies	General Fund Habitat Conservation Fund grant Department of Fish and Wildlife grants Department of Water Resources grant Wildlife Conservation Board grant ESA Nontraditional Section 6 grant National Fish and Wildlife Foundation grants Other grant programs	Integrated Regional Conservation and Development (ICARD) program, and RePlan System Save the Bay Restored Wetlands

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CLIMATE HAZARDS	**ADAPTATION STRATEGY**	**FACTORS TO CONSIDER**	**CATEGORY**	**SECTOR OVERLAP**	**RESPONSIBLE AGENCIES**	**FUNDING**	**EXAMPLES & SOURCES**
All climate hazards	**Strategy BH-4: Educate community members about the climate risks to habitats and biodiversity, and the need to safeguard these natural systems.** Protecting nature is an important value for many Californians, but it is still helpful to reinforce the importance of natural systems, particularly as climate change stressors require a greater allocation of government resources toward conservation activities. In partnership with community-based organizations and landowners, jurisdictions should educate community members of all ages about why it is necessary to safeguard species and natural resources in their area. These educational and outreach efforts can often be integrated into existing programs, which can make them easier to implement.	Consider what types of education programs could be most effective in the community. This can include interpretive signage and in-person educational events at natural sites, online resources and information on social media, outreach to community groups and stakeholders, volunteer opportunities, more intensive efforts such as after-school and summer camp programs, and any other strategies that may be relevant. Multiple forms of outreach could likely be helpful. Ensure that educational programs are widely accessible to the community, including persons with different income levels and access to resources, who speak different languages, and who have differing levels of ability. Ensure that educational efforts reflect the most recent and best available science, which may require revisions to outreach approaches as scientific understanding evolves. Communities should also ensure that educational efforts are universally accessible, including to people with access and functional needs.	Education, Outreach, Coordination Programmatic	Public Health Parks and Recreation	Cities and counties Community-based organizations	General Fund EPA Environmental Education grants Other grant programs	
All climate hazards	**Strategy BH-5: Promote diverse economic opportunities that are responsive to changes in available natural resources.** The economies of communities often rely at least in part on local natural ecosystems as a source of economically important resources, a site for cultural and recreational activities, and as a scenic benefit, among others. Damage to these ecosystems may lead to economic harm for the community, causing a host of indirect effects. Communities should expand their economic activities to use resources that are less vulnerable to climate change, and resources that may shift into the area as ecosystems migrate. This economic diversification can also help to buffer the community against other types of economic hardships.	Economic development plan or program that can serve as an overarching implementation mechanism for this strategy. In some cases, adapting to future ecosystem conditions may be a relatively easy process for businesses, requiring little government involvement other than education and outreach. In other cases, communities may need to extensively alter their land use plans and zoning codes to allow for new types of activities, or activities in new locations. If changes to the natural environment are likely to lead to economic opportunities requiring different job skills than those currently held by community members, jurisdictions and their economic partners should enact appropriate job training programs and other workforce development efforts. Such programs should emphasize empowering and retraining economically disadvantaged persons and those whose jobs face the greatest risk from climate change.	Education, Outreach, Coordination Programmatic Evaluation Plans, Regulations, and Policy Development	Land Use and Community Development Parks and Recreation Forests Ocean and Coast	Cities and counties Community-based organizations	General Fund Workforce development grants Other grant programs	

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All climate hazards	**Strategy BH-6: Use nature-based solutions to improve resilience while promoting biodiversity.** Many infrastructure and other capital projects to improve community resilience involve "hard" structures, which are often made out of materials such as concrete and metal and are very clearly built by people. While sometimes effective, these artificial structures can interrupt natural activities and may be actively harmful to the ecosystem. Nature-based solutions, sometimes called "green infrastructure," rely on natural materials and systems to increase resilience. These strategies can offer the same or greater adaptation benefits to the community at large while also providing habitat to local flora and fauna.	Nature-based solutions can be implemented at multiple scales. For example, a rain garden or bioswale near a parking lot can provide protection against floods, as can a restored wetland or dune system. If constructing multiple small-scale green infrastructure projects, consider connecting them to create a habitat corridor, further enhancing local biodiversity and the health of regional ecosystems. Be aware of the types of ecosystems that are naturally present in the community and would best support endemic species and consider developing nature-based solutions to restore and enhance degraded habitats. As with all other types of adaptation infrastructure, nature-based solutions should be designed to protect against hazards caused by both current and future climate conditions. Consider using habitat types that are still viable in the future climate of the area.	Plans, Regulations, and Policy Development Capital Improvement & Infrastructure Projects	Land Use and Community Development Parks and Recreation Forests Ocean and Coast Water	Cities and counties Council or Association of Governments	General Fund Habitat Conservation Fund grant Department of Fish and Wildlife grants Department of Water Resources grant Wildlife Conservation Board grant National Fish and Wildlife Foundation grants Other grant programs	Guidance for Considering the Use of Living Shorelines, Living Shorelines: From Barriers to Opportunities

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Emergency Management Sector							
All climate hazards	**Strategy EM-1: Revise emergency management plans, programs, and activities to account for changing hazard profiles and their consequences.** Changes to the frequency and severity of climate-related hazards may cause existing emergency management efforts to be less effective. A community's existing resources may not be enough to adequately prepare for and respond to more frequent and intense disasters, or existing emergency plans may not adequately account for new hazard regimes. To ensure the continued effectiveness of emergency management efforts, these efforts should be developed to account for anticipated future climate conditions and associated hazard regimes, as well as addressing current needs.	Climate-smart emergency management activities will likely require an increased commitment of staff time and expertise, materials and equipment, and other resources. Multi-jurisdictional emergency management efforts can allow for communities to effectively share resources but ensure that there is also a sufficient supply if all participating communities are simultaneously affected by a major disaster. Be mindful that future projections of climate conditions are likely to change based on future levels of greenhouse gas emissions and as scientific understanding evolves. Use the most recent best science to inform emergency management efforts whenever plans, programs, and activities are updated.	Plans, Regulations, and Policy Development Evaluation Operational Education, Outreach, Coordination	Transportation Energy	Cities and Counties		Safeguarding California: 2018 Update
All climate hazards	**Strategy EM-2: Integrate findings of climate vulnerability into all phases of emergency planning.** Emergency planning, including mitigation, preparedness, response, and recovery efforts, should be tailored to match the specific needs of the community. These efforts should incorporate the findings of the vulnerability assessment and be responsive to any unique challenges in the community identified through the assessment. This should include addressing the needs of populations who may be less able to effectively prepare for or respond to emergency events, ensuring that critical facilities and services are protected and kept operational during disasters, and conducting recovery operations to improve resiliency relative to pre-disaster levels.	Numerous plans, operating procedures, programs, and other efforts cover the full spectrum of emergency management activities, and these activities may be managed by different agencies. It is important to coordinate efforts across activities and agencies to ensure that the results of the vulnerability assessment are being appropriately integrated. In particular, ensure that vital life-saving emergency management efforts such as evacuations, shelters, emergency medical response, and temporary housing are responsive to any unique needs of the community. Climate-smart emergency planning efforts should be reflected in implementation activities, including training for both professional emergency responders and community volunteers.	Evaluation Plans, Regulations, and Policy Development Operational	Public Health Energy Transportation Land Use and Community Development	Cities and counties State and federal agencies		

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All climate hazards	**Strategy EM-3: Develop a notification system for natural hazards that is responsive to community needs.** Emergency notification systems are a critical type of communication, letting people know of potential, impending, and ongoing disaster events. Community members can find out how they can prepare for a future event, what they can do and where they should go to be safe, and how they can make recovery easier. These vital pieces of information should be communicated clearly and effectively in a way that reaches as many community members as possible (and ideally, all of them).	Emergency notification information should be distributed as widely as possible. Television, radio, email, telephones, text messaging, and social media should all be used as appropriate. For mitigation and preparedness notifications, there is often enough time to conduct in-person awareness and educational efforts. Notifications can also be made at existing meetings and gatherings, such as religious services, school board or PTA meetings, and other well-attended events. Ensure that notifications are made in all commonly spoken languages in the community. Consider the needs of community members who may have functional needs, such as vision or hearing-related disabilities, and ensure that there are means for them to receive important information. It may be helpful to partner with existing community-based organizations to help distribute notifications about emergency issues, particularly in places where some community members may be more insular or where there may be lower levels of trust for government agencies.	Programmatic Capital Improvements & Infrastructure Projects Education, Outreach, Coordination	Public Health	Cities and Counties Tribal State and federal agencies		Safeguarding California: 2018 Update

TABLE D-1. EXAMPLES OF LOCAL CLIMATE ADAPTATION STRATEGIES BY SECTOR							
CLIMATE HAZARDS	**ADAPTATION STRATEGY**	**FACTORS TO CONSIDER**	**CATEGORY**	**SECTOR OVERLAP**	**RESPONSIBLE AGENCIES**	**FUNDING**	**EXAMPLES & SOURCES**
All climate hazards	**Strategy EM-4: Assess the potential for climate refugees as a sending or receiving community and develop short- and long-term strategies for shelter/housing and services.** As demonstrated by recent wildfires in California and hurricanes in the Gulf Coast, there is a potential for significant movement of people in response to climate-related disasters. This may be short-term, evacuation-associated displacement while response operations occur or longer-term displacement due to catastrophic loss of structures and infrastructures and the supporting economy. Such displacement activities have profound impacts on the evacuating community, but also on the community receiving a large influx of people. Communities should develop scenarios for the rapid and significant change in population and the associated social, cultural, environmental, and economic effects.	These planning efforts should consider both the needs of the community to evacuate elsewhere (a sending community), as well as the possibility of the community to accept people evacuating from elsewhere (a receiving community). Bear in mind that such displacements may be short-term, long-term, or in some cases permanent. Communities may not have the need or the resources to conduct detailed studies of their ability to act as sending and receiving sites, but it is worth exploring at a general level at the very least. When examining potential for a sending community, consider issues such as how to maintain necessary levels of community services while residents are elsewhere, how to rebuild quickly and effectively so as to bring residents back, and if wholesale reconstruction of the community offers unique chances to improve any aspects of the community's health, safety, well-being, or overall quality of life. When looking at potential to act as a receiving community, consider issues such as how to house incoming persons in a manner that is safe and affordable, where their property can be stored, and what increases in community services may be needed to meet the greater demand. In both cases, work to ensure that displaced people can receive news and information from both the sending and receiving communities.	Evaluation Plans, Regulations, and Policy Development Programmatic	Land Use and Community Development	Cities and Counties Tribal State and federal agencies Community-based organizations		Butte County Recovers

TABLE D-1. EXAMPLES OF LOCAL CLIMATE ADAPTATION STRATEGIES BY SECTOR							
CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
All climate hazards	**Strategy EM-5: Ensure that emergency management activities are being conducted equitably.** Emergency management activities should be responsive to the needs of all community members, but these needs vary widely. Differences in ability, language, income and economic means, access to lifelines, living situation, and many other factors all influence how community members can mitigate and prepare for disaster events, and respond and recover to them. Inclusive emergency management efforts recognize these differences and provide the tools, information, engagement, and other resources to ensure that the health, safety, and well-being of all community members is equitable addressed.	Communities should convey information about emergency management activities to a wide audience, which means communicating in many different formats, and in multiple languages as appropriate. Different forms of educational efforts could be needed. To address differences in adaptive capacity, some community members may need financial assistance, or help with labor or equipment. Recognize that people who do not own their home may be more limited in their emergency management capacity, even if they are not disadvantaged in other respects. As discussed elsewhere in this guide, differing levels of vulnerability are often a function of systemic issues that may not be apparent to people who are not part of disadvantaged communities. If the staff conducting the emergency management planning are not reflective of the makeup of the community, it may be helpful to have an advisory group of community members who can more knowledgeably speak to equity issues, and to conduct regular outreach with and to seek feedback from members of the community who face equity issues.	Plans, Regulations, and Policy Development Education, Outreach, Coordination	Public Health	Cities and Counties State and federal agencies		USDN Guide to Equitable, Community-Driven Climate Preparedness Planning

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CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
Energy Sector							
Avalanches, coastal flooding, drought, flooding, forestry pests and diseases, landslides, sea level rise, severe weather, wildfire	**Strategy EN-1: Harden energy infrastructure systems against damage from climate-related effects and expand redundancy in the energy network.** California's energy infrastructure is a complex system of refineries, power plants, renewable generation facilities, utility lines, storage facilities, substations, and many other pieces of infrastructure, not to mention the roads, rails, and retail outlets used to distribute some energy resources. All these factors render the system vulnerable to several different types of climate-related effects. Damage to any component of these networks can cause a loss of energy supplies, and can also create additional hazard events, such as a downed power line that sparks a wildfire. Communities and other organizations that manage the energy network can construct or retrofit these infrastructure components so that they are less likely to be damaged by and so that they can quickly recover from a climate-related event. Additionally, communities and other organizations can ensure that there are redundant energy systems (e.g., backup generators, multiple transmission lines feeding a given area), which can help prevent a complete loss of service. Local governments may also consider moving toward a more decentralized electric supply system that relies on microgrids and distributed generation (e.g., local renewable energy generation), reducing the need for long-range transmission systems that may run through densely forested areas and cause wildfires, or may be impacted during utility public safety power shutoffs. See Strategy EN-5 for more examples of this.	In most cases, local communities have very limited control over the energy networks. With the exception of communities that have their own publicly-owned utilities (not including community choice aggregator programs), private companies control much of the electricity and natural gas infrastructure. Private companies also control the refining and distribution systems that supply fuels such as gasoline, diesel, and propane. Because of this, coordination with external agencies is critical to hardening the energy network to enhance system resilience. Electricity and natural gas systems are heavily regulated by state agencies, who should also be involved in such efforts as feasible. Local governments should evaluate if local permitting procedures or development standards create barriers to hardened or redundant energy systems and identify ways to reduce these barriers in a way that maintains public health and safety and is compatible with the community character. In some instances, hardening energy systems may mean retreating from highly exposed areas and rebuilding in a less susceptible location.	Capital Improvement & Infrastructure Projects	Emergency Management Land Use and Community Development Public Health Water	Utility providers Cities and Counties		SDG&E and SCE weather network, Fire Potential Index (FPI) and Santa Ana Wildfire Threat Index (SAWTI) monitoring, and wildfire watch camera network concentrated in HFRAs, vegetation management programs CCCA4 Dale et al. report on wildfire impacts to the California electricity grid CCCA4 Bruzgul et al. report on Natural Gas assets in San Diego Coastal Commission Guidance 2018 Consolidated Edison Co. of New York Post Sandy Enhancement Plan, Preparedness at Greenwich Hospital, CCCA4 Bruzgul et al. Report on SDG&E electricity asset risk and adaptation to coastal flooding

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CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
All climate hazards	**Strategy EN-2: Transition to climate-smart sources of energy.** Climate change is likely to influence the generation capacity of different energy sources. Hydroelectric facilities in particular are likely to be harmed by more frequent and severe drought events, reducing the amount of electricity available to California from these sources. Some industrial facilities and associated infrastructure that are key nodes in the state's energy network, including refineries and seaports, may be harmed by climate change and are vulnerable to disruptions, particularly since alternatives may be limited. Centralized power generation facilities (both renewable and fossil fuel) rely on long-range transmission infrastructure which could be increasingly susceptible to impacts from climate effects. Additionally, policies to reduce greenhouse gas emissions may also affect sources of energy from fossil fuels. Communities can transition their sources of energy to those that are less likely to be affected by climate change, especially energy sources that are renewable and decentralized and do not rely on long-range transmission from centralized generation sources (see EN-5 for more information).	If the community has control over its electricity sources (as a public electrical utility or a community choice aggregator), consider transitioning away from fossil fuels and hydroelectric sources in favor of local or regionally-based renewable sources. Explore opportunities to increase adoption of electric vehicles, which are less dependent on potentially vulnerable industrial facilities. Increasing public electric vehicle charging stations, as well as providing educational opportunities and incentives, can help with this. Communities also have the option to decarbonize by reducing natural gas use, or by encouraging or requiring a transition away from natural gas as part of any significant retrofit activities. When transition to a new source of energy, of any type, ensure that the new sources are also resilient in the long-term to climate change, avoiding the need for multiple adaptation efforts. New energy sources should be cost-competitive with the sources they are replacing. Communities should also ensure that the new sources of energy will not create new environmental justice issues or exacerbate existing ones.	Capital Improvement & Infrastructure Projects Plans, Regulations, and Policy Development	Water Ocean and Coasts	Cities and Counties Councils/ Associations of Government Utility Providers		

TABLE D-1. EXAMPLES OF LOCAL CLIMATE ADAPTATION STRATEGIES BY SECTOR							
CLIMATE HAZARDS	**ADAPTATION STRATEGY**	**FACTORS TO CONSIDER**	**CATEGORY**	**SECTOR OVERLAP**	**RESPONSIBLE AGENCIES**	**FUNDING**	**EXAMPLES & SOURCES**
Extreme Heat	**Strategy EN-3: Minimize stress on the electrical grid.** During very high heat events, electrical equipment can operate less effectively and be more prone to failure. At the same time, power demand often rises during extreme heat due to the increased use of air conditioners and other cooling equipment. The combination of these factors places stress on the electrical grid and increases the risk of a power loss, even though there may be little or no physical damage. Communities can work to decrease their electricity use during extreme heat events, reducing the stress placed on the electrical grid. These actions may involve educational efforts and changes to behavior, upgrades to equipment and infrastructure, or some combination of the two. As a side benefit, these efforts also decrease electrical bills and reduce greenhouse gas emissions associated with energy use. Microgrids manage distributed energy resources through control technologies within or independent of a central grid. Islanding refers to the ability of microgrids to continue operating when the surrounding grid experiences an outage. Combined with storage, islanding via microgrids helps to reduce stress on the electrical grid and to maintain critical operations and services during outages due to climate-related hazards.	There are several strategies at a community's disposal to reduce energy use during extreme heat events. Demand response programs alert energy users at times when grid stress is likely to be high and provide financial incentives to users who sufficiently reduce their use. Weatherization programs help insulate buildings against very high or very low temperatures, decreasing the need for cooling (or space heating). Energy efficiency programs can replace inefficient air conditioners with more efficient models, allowing for the same level of cooling while using less energy. On-site renewable energy and storage systems allow buildings to power their air conditioning systems with electricity generated or stored on the property, rather than pulling from the grid. Numerous funding sources are available to help communities implement these programs, or communities can partner directly with local utilities. Communities should make sure that this effort (as with all other adaptation planning efforts) is conducted equitably, as different populations face different levels of vulnerable to extreme heat events and have varying levels of adaptive capacity to these events.	Programmatic Plans, Regulations, and Policy Development Capital Improvement & Infrastructure Projects	Emergency Management Land Use and Community Development Public Health	Utility providers Cities and Counties		

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CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
Drought, extreme heat, flooding, landslides, severe weather, wildfire	**Strategy EN-4: Maintain hydroelectric generating capacity as feasible.** Hydroelectric power plants are an important source of electricity for California, in addition to other benefits that dams can provide (water storage, recreation, and flood control, among others). However, as drought conditions become more frequent and intense, and as warmer temperatures cause faster snowmelt and greater evaporation, the overall capacity of hydroelectric facilities is threatened. Communities have the opportunity to maintain generating capacity, or to work with agencies that manage these facilities to do so.	Agencies that operate hydroelectric facilities should take improved hydrometeorological forecasting into account, and ensure that planning procedures for wet, normal, and dry years (including multiple dry years) reflect the new precipitation patterns that are expected in the watershed. Consider solutions such as covering reservoirs, particularly smaller ones, to reduce water loss from evaporation. If conditions change to the point where the hydroelectric facility is no longer able to function as a normal run-of-river installation, consider converting it to a pumped storage facility that can be used to store excess electricity on demand. Some hydroelectric operators may consider increasing dam capacity, especially to improve generating potential during very wet years, but be mindful of environmental barriers and other challenges that such projects are likely to face. Additionally, in the long term, recognize that some hydroelectric facilities may no longer be viable and could be deconstructed to allow river restoration.	Capital Improvement & Infrastructure Projects Education, Outreach, Coordination	Water	Utility providers Cities and Counties		International Hydropower Association Hydropower Sector Climate Resilience Guidance

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All climate hazards	**Strategy EN-5: Decentralize energy supplies and energy storage capacity to improve energy independence.** Some of the vulnerability in California's energy network is because most energy supplies are produced at centralized large-scale facilities such as refineries and power plants and distributed across large distances. Disruptions at these centralized facilities or along the main paths for transporting energy resources can create shortages and service disruptions over large regions. Decentralizing energy generation and storage systems helps to reduce the potential for energy supplies to be disrupted by distant events. With present-day technologies, electricity is the energy source that is most suitable for decentralization, as natural gas and petroleum-derived fuels require industrial facilities, and so electrification of the built environment and transportation systems can help spur energy independence. Local governments can also seek to decentralize by creating municipal energy utilities and/or forming electric co-ops between rural jurisdictions for more local control over infrastructure and energy supply. In the future, emerging power-to-gas technologies and local sources of renewable natural gas may also enhance local energy resilience.	Decentralizing the energy system, predominantly the electrical grid, allows community members to generate electricity and store it as needed at their properties or in their neighborhoods, reducing their dependence on the statewide electrical grid. Rooftop solar photovoltaic panels are often the most suitable form of decentralized energy generation, and battery storage systems are increasingly available for individual buildings. However, people living in rental units or those with limited financial means may need financial assistance or special programs to be able to install these technologies. Consider creating microgrids, which allows for a single building or group of buildings to share distributed energy generation and storage resources. Under state law, new small residential buildings are already required to install solar panels. Communities have the authority to require some or all additional types of buildings to install distributed energy, either when they are constructed or at times of significant renovations, but such actions require adopting a reach code that is subject to state review. Helping to transition building and transportation energy sources to electricity can make decentralizing the energy network easier.	Capital Improvement & Infrastructure Projects Operational	Emergency Management Land Use and Community Development Public Health	Cities and Counties		Enhancing Energy Efficiency in the Santee Unified School District CCCA4 Moezzi et al. report on energy efficiency research CCCA4 Burillo et al. report on LA County electricity grid risk to extreme heat CCCA4 Taha et al. report on urban heat islands

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Forests Sector							
Pests and Diseases, Wildfire	**Strategy FOR-1: Develop a local forest management taskforce to manage fuel loads, thinning, brush removal, and prescribed burns.** A forest management taskforce is a group of forestry and fire management professionals, local government stakeholders, private businesses, local community members, and non-profits that collaborate to effectively manage wildfire fuel loads. The taskforce can work together to conduct thinning, brush removal, and prescribed burns, while also working with community members to reduce fuel loads on private properties and in developed areas. This could expand capacity to restore forest health on private and public lands, which includes active management to reduce fire risk, including removal and disposal of diseased trees and other fuels. Local governments can also use this taskforce to work with public and private partners to identify appropriate locations for mills, biomass facilities, or other facilities that support the reuse of trees for other uses, including composting and renewable energy.	An important factor to consider when managing fuel loads in forests is the indirect impacts on the residents and businesses in the community. Prescribed burns can cause smoke and poor air quality conditions, and logging trucks can cause congestion on small mountain roadways. It is also important to coordinate with contractors and biomass facilities, to integrate biomass facilities into the fuel management process. Local governments can work with these facilities to process woody materials from tree mortalities to expedite removal. To minimize the impacts of transporting cleared woody material, including the GHG emissions from trucks, consider locating facilities that can use or process this material near forested areas, as environmental conditions and other constraints allow.	Operational Programmatic Education, Outreach, Coordination	Energy Biodiversity and Habitat	Cities and Counties Fire Departments CAL FIRE	CAL FIRE Fuel Reduction Project Grants CAL FIRE Forest Health Grants FEMA Hazard Mitigation Grant	Placer County Sustainability Plan (2020) Safeguarding California: 2018 Update California Forest Management Taskforce

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Wildfire	**Strategy FOR-2: Provide information to homeowners about statutory vegetation management requirements and promote fuel breaks to slow fire spread in forested and WUI areas.** California law requires landowners in areas with flammable groundcover (e.g., forest, brush, grasslands) to maintain defensible space around buildings that can help slow or prevent the spread of wildfire. Local communities and fire protection agencies should strengthen standards as needed to provide adequate protection in response to changing fire regimes. Standards should include retrofitting structures with fire-resistant or fire-proof building materials, for both new construction and retrofits to existing buildings. While these standards can reduce wildfire risk, not all landowners may be aware of them and may not take appropriate action. Local jurisdictions should encourage landowners in forested areas and the WUI to establish fuel breaks that can slow the spread of fire, in addition to maintaining fire safe landscaping around structures Local communities can work with fire protection agencies to provide information to landowners about creating defensible space and fuel breaks.	Homeowners may be unaware that the State has vegetation management requirements for homes throughout. The Wildfire Mitigation Program (AB 38) is intended to promote structure hardening and retrofitting, as well as other mitigation techniques. Local governments should provide flyers to all homeowners within their jurisdictions that are reflective of the languages spoken in their communities. It is also important for jurisdictions and their strategic partners to provide educational opportunities for homeowners to learn about vegetation management on their properties. For cultural and historic resources, jurisdictions should consider local and regional preservation plans and guidelines to ensure cultural value of buildings and sites remains intact. In the case of rental properties, especially those owned by remote landlords, communities may need to conduct additional outreach to engage with landlords and ensure they comply with vegetation management requirements and best practices. Some property owners may require assistance from others to conduct vegetation management activities, including those who may be considered vulnerable populations. Incentive programs that subsidize vegetation clearing may be helpful in these cases.	Education, Outreach, Coordination Plans, Regulations, and Policy Development	Land Use and Community Development Emergency Management	Cities and Counties CAL FIRE Fire Departments	Forest Improvement Program FEMA Hazard Mitigation Grant The Wildfire Mitigation Financial Assistance Program (Fire Hardened Homes Revolving Loan Fund)	Resilient IE (2020) CAL FIRE: Fire and Fuels Treatment OPR: Fire Hazard Planning General Plan Technical Advice Series National Park Service: Cultural Resources Climate Change Strategy
Wildfire, Pests and Diseases	**Strategy FOR-3: Establish partnerships to apply prescribed burns in priority areas and manage forests at an ecologically meaningful scale.** Local governments can establish local partnerships with CAL FIRE, the U.S. Forest Service, tribal governments, and local fire departments to identify priority areas and conduct prescribed burns as applicable. Priority areas could include overgrown forests and forest understories and floor that are littered with debris. Priority areas could occur on federal, State, tribal, local, or privately-owned lands, and therefore it is essential to create partnerships to implement prescribed burns on a large scale. It is essential to include tribal partners where applicable, as in many cases they have previously conducted prescribed burns on lands throughout the state.	One factor to consider is the air quality impacts of prescribed burns. Local and regional air quality could decline due to smoke conditions created by these burns. Communities should also closely monitor weather conditions, as hot, dry, and windy conditions could cause the prescribed burn to launch into an uncontrollable wildfire.	Education, Outreach, Coordination Programmatic	Biodiversity and Habitat	Cities and Counties CAL FIRE Fire Departments	CAL FIRE Fuel Reduction Project Grants USDA Forest Service CAL FIRE Forest Health Grants	Safeguarding California: 2018 Update Sauls Creek, Colorado USDA Forest Service South Bench Prescribed Burn

TABLE D-1. EXAMPLES OF LOCAL CLIMATE ADAPTATION STRATEGIES BY SECTOR								
CLIMATE HAZARDS	**ADAPTATION STRATEGY**	**FACTORS TO CONSIDER**	**CATEGORY**	**SECTOR OVERLAP**	**RESPONSIBLE AGENCIES**	**FUNDING**	**EXAMPLES & SOURCES**
Wildfire, Pests and Diseases	**Strategy FOR-4: Provide private landowners with incentives for forest protection through easements and working forests that can return revenue from timber harvesting to cover taxes and other expenses of maintaining forest lands, thereby preventing land fragmentation and conversion to non-forest land uses.** To prevent the fragmentation or conversion of forested land, local governments can provide private property owners with incentives to prevent an economic loss. These incentives can include timber harvesting, which can also help reduce fuel loads on private properties and prevent uncontrollable wildfires. Local governments and private property owners can partner with local land conservancies or the Wildlife Conservation Board to place land in forest protection easements.	Local governments should consider the economic viability of timber harvesting on lands before proceeding with an easement. Properties should have a certain quantity and quality of trees to support timber harvesting that can cover taxes and other expenses on the land. Properties protected by timber easements should also be located near mills that can process the wood products to the extent possible, to avoid significant construction of new infrastructure.	Programmatic Education, Outreach, Coordination	Land Use and Community Development Biodiversity and Habitat	Cities and Counties Land Trusts or Conservancies	State and Private Forestry Grants	Wildlife Conservation Board's Land Acquisition Program California Forest Legacy Program
Extreme Heat, Flooding	**Strategy FOR-5: Establish policies and management plans to develop urban forests and incentivize the use of best practices for long-term maintenance and preservation of urban trees.** Urban forests can not only increase natural habitat within urban areas, but also lower surface temperatures and provide pervious surfaces that reduce flooding. Local government should develop new or update older policies and plans to increase and manage urban forests within their communities. These policies can be integrated into updated general plan elements, zoning codes, or stand-alone documents with enforceable measures. These measures should include priority areas for new urban tree programs, preservation policies for existing urban forests, and long-term maintenance strategies to ensure the health of the urban forest ecosystem.	When establishing policies for urban forestry programs, local governments should not only ensure that budget is available to plant trees and install watering systems, but also provide budget for staffing and equipment for the maintenance of the urban forests. Local governments can provide educational programs to teach community members to care for the trees in their neighborhoods, which can provide public support during the implementation phase of an urban forestry plan. Urban forestry plans and policies should also consider areas that may have a low quantity or quality of trees or tree canopy as priorities for implementation.	Plans, Regulations, and Policy Development Education, Outreach, Coordination	Land Use and Community Development Biodiversity and Habitat	Cities and Counties	Urban and Community Forestry Grant Program California Natural Resources Agency Urban Greening Grant Program	Safeguarding California: 2018 Update City of Los Angeles: First Step City and County of San Francisco: Urban Forest Plan

Appendix C: Adaptation Planning Resources

TABLE D-1. EXAMPLES OF LOCAL CLIMATE ADAPTATION STRATEGIES BY SECTOR							
CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
Land Use and Community Development Sector							
All climate hazards	**Strategy LUCD-1: Integrate climate change adaptation considerations into general plan Safety Elements, Local Hazard Mitigation Plans, emergency operations plans, and other public safety documents.** This strategy is a long-term goal of all adaptation planning efforts. Almost all communities maintain plans to help prepare community members and municipal staff for disasters and other hazards, and to guide staff response once a disaster occurs. These plans can include General Plan Safety Elements, Local Hazard Mitigation Plans, and Emergency Operations Plans, among others. Climate change-related hazards and other climate change effects can pose threats to human health and property and should be included in public safety and planning documents. Communities throughout California should strive to ensure that their public safety documents address emergencies that may be created or otherwise affected by climate change, including discussion on how the effects may vary in the future due to a changing climate.	Per state requirements, jurisdictions must update these plans regularly to include the most recent and should include the most relevant climate change projections. Community and staff understanding, and support of climate adaptation strategies, is critical for integration into safety documents and implementation of the strategies. Therefore, updating public safety documents should coincide with comprehensive outreach and education programs for the community. Local governments should also consider updating zoning and development codes for consistency with public safety documents.	Plans, Regulations, and Policy Development	Emergency Management Public Health	Cities and Counties	FEMA Hazard Mitigation Grant CA SB 1 Grant	City of Foster City Local Hazard Mitigation Plan & Safety Element (2016) Mammoth Lakes Safety Element (2019) Riverside County Multi-Jurisdictional LHMP (2018) California Government Code Section 65302(g) Resilient IE (2020) State of California General Plan Guidelines (2017)

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Wildfire, Landslide, Extreme Heat, Air Quality, Drought, Flooding, Severe Weather, Sea Level Rise	**Strategy LUCD-2: Increase the resiliency of existing residential and commercial development through structural strengthening, fire safe landscaping, and energy efficiency upgrades.** Many existing developments are located near or on lands that are within hazard prone areas and can be damaged or destroyed by wildfires, landslides, flooding, and coastal flooding. Older building may also not be energy efficient, and homeowners and business owners may have to increase the use of air conditioning systems during extreme heat or poor air quality days. Damage to buildings and increasing energy use can cause financial burdens and limit the recovery options for building owners. To alleviate recovery costs and prepare existing development for potential hazards and other negative effects of climate change, local governments can identify funding opportunities, including grant assistance or PACE programs, to increase the resiliency of existing residential and commercial development. Homeowners and business owners can use these funds to make structural strengthening and energy upgrades, as well as adhere to fire safe landscaping standards developed by Cal FIRE. However, these upgrades and changes can often be too expensive for economically disadvantaged populations. Local governments can pursue grant funding such as the Transformative Climate Communities Program through Strategic Growth Council and identify regional PACE programs that can support business and residents in strengthening and upgrading their homes and buildings.	This strategy includes creating funding to make buildings more resilient. However, local governments should also put resilient building requirements in their General Plan policy documents, the zoning code, and local building codes. FEMA's Hazard Mitigation Grant program funds mitigation measures in communities. The Wildfire Mitigation Program (AB 38) is intended to promote structure hardening and retrofitting, as well as other mitigation techniques. Jurisdictions should also consider upgrading historic buildings and significant cultural sites. Co-benefits of these retrofits and upgrades include reducing greenhouse gas emissions and reducing the potential spread of wildfires.	Programmatic	Energy	Cities and Counties	Grant funding PACE programs Community Development Block Grant The Wildfire Mitigation Financial Assistance Program (Fire Hardened Homes Revolving Loan Fund) FEMA Hazard Mitigation Grant	Resource Legacy Fund: Paying for Climate Adaptation in California SoCalGas: Climate Grant PACE in California State of California General Plan Guidelines (2017) Fire Hazard Planning General Plan Technical Advice Series (2015) Office of Historic Preservation: Disasters & Historic Resources

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All climate hazards	**Strategy LUCD-3: Collaborate with local and regional partners to support business resiliency through preparedness education, trainings, and resources.** Climate change-induced hazards and other climate change-related effects can severely damage both urban and rural local. For example, communities in mountainous areas often face a threat from wildfires that destroy mountain communities, droughts and agricultural pests can harm agricultural communities, or coastal flooding can harm commercial centers near the water. These types of effects, along with many others, can all directly or indirectly impact local economies. Working with local business and regional employment centers to support business resiliency can produce a more resilient local economy. Actions under this strategy could include increasing access to business related emergency preparedness and mitigation resources, supporting the business community in increasing their resiliency and ability to reopen after disaster through FEMA and other financial assistance, and expanding the availability of business resiliency trainings, data backup plans, and other resources specific to business owners.	The loss of residents and visitors during or after a disaster has direct economic effects on these communities. As communities lose homes and essential infrastructure due to disasters, residents may choose or be forced to leave the community, hampering economic recovery. Keeping businesses and employers open can help keep these residents in the community in the long-term. Ensure that business resiliency is integrated into any community or regional economic development plans and initiatives, and that local business groups are key stakeholders in any implementation efforts.	Education, Outreach, Coordination Programmatic	Emergency Management	Cities and Counties		Mammoth Lakes Safety Element (2019) Capital Region Business Resiliency Initiative Moreno Valley Business Emergency Resiliency Training Program
Drought, Extreme Heat, Flooding	**Strategy LUCD-4: Encourage and incentivize the use of pervious and climate-smart landscaped surfaces in new and existing development.** The use of pervious and landscaped surfaces in existing and new development can help neighborhoods reduce the urban heat island effect, catch stormwater where it falls to reduce flooding and help groundwater recharge, and lower overall water use on a property. Many new developments are required to have a specific percentage of pervious or landscaped surfaces. Encouraging existing developments in urban areas to use these materials can increase the resilience of the community.	Although landscaping can improve groundwater recharge and reduce the urban heat island effect, it is also essential to incorporate wildfire mitigation landscape standards into this adaptation strategy. Adding these standards can reduce the risk of wildfire spreading between properties in some cases, depending on the specific landscaping approach.	Programmatic	Public Health Biodiversity and Habitat	Cities and Counties	Utility Companies Grants State Water Resources Control Board: Stormwater Grant Program	Safeguarding California: 2018 Update Mammoth Lakes Safety Element (2019) San Luis Obispo County Cash for Grass Program SoCal Water $mart Residential Rebates State Water Resources Control Board: Stormwater Strategy

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CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
All climate hazards	**Strategy LUCD-5: Collaborate with local, regional, State, and federal partners to develop a community-wide outreach program to educate a diverse community on how to prepare and recovery from climate change effects.** Implementation of climate adaptation strategies requires the community to understand the climate effects in their area. Local governments can work with Cal FIRE, community-based organizations, FEMA, tribal nations, and other partners to create an educational program that can help community members act. This program is also an opportunity for community members to brainstorm strategies unique to their community and neighborhoods.	Education and outreach programs should consider their audience and the timing and location of the events. Local governments should work with community-based organizations to identify location and timing to reach specific populations such as seniors, school age children, and linguistically isolated persons. Educational programs should be in multiple languages, at different locations, and during varying times in the day to reflect the unique demographics and needs within each community.	Education, Outreach, Coordination	Emergency Management Public Health	Cities and Counties Cal OES FEMA Community-Based Organizations		Safeguarding California: 2018 Update Marin County – Resilient Neighborhoods California Air Resources Board
Wildfire, Landslide, Flooding, Sea Level Rise, Extreme Heat	**Strategy LUCD-6: Identify and establish climate hazard overlay zones.** Local governments can use Geographic Information Systems (GIS) to identify where climate change-related effects are most likely to occur now and, in the future, and then overlay the at-risk areas with existing parcel, infrastructure, and building information. Communities can determine expected extent of sea level rise and where flooding, wildfires, and landslides are most likely to occur. Jurisdictions can then put specific development and infrastructure regulations in place to ensure that neighborhoods can prevent and are prepared for climate hazards and other effects. Each community can tailor hazard overlay zones to meet their needs.	When hazard overlay zones are established, local governments should also consider superimposing maps of vulnerable populations to identify hot spots of vulnerability in wildfire, flooding, sea level rise, landslide, and extreme heat areas. These areas may need funding assistance to upgrade facilities and properties to comply with risk reduction measures in the hazard overlay zone. Communities can also use these overlay zones to identify essential infrastructure such as hospitals, schools, and power plants that are at risk of damage from climate hazards and other effects. Jurisdictions should also consider historic districts or overlay zones, and how they will integrate with the hazard overlay zones.	Evaluation Plans, Regulations, and Policy Development	Emergency Management Public Health Transportation Energy	Cities and Counties Council or Association of Governments	SB 1 Grant General Fund	Cal FIRE: Fire and Resource Assessment Program County of San Luis Obispo: Geologic Study Area FEMA: National Flood Hazard Layer Coastal Adaptation Policy Brief APEN: Mapping Resilience Report

	TABLE D-1. EXAMPLES OF LOCAL CLIMATE ADAPTATION STRATEGIES BY SECTOR						
CLIMATE HAZARDS	**ADAPTATION STRATEGY**	**FACTORS TO CONSIDER**	**CATEGORY**	**SECTOR OVERLAP**	**RESPONSIBLE AGENCIES**	**FUNDING**	**EXAMPLES & SOURCES**
Wildfire	**Strategy LUCD-7: Develop a fire risk assessment for all new development within fire hazard severity zones or the wildland-urban interface (WUI).** Fire risk assessments can help identify the potential for fires to occur within and surrounding a new or existing development. These assessments can assign numerical values to metrics such as fire history, FRAP fire threat, response time, proximity to the WUI, fuel reduction efforts, community collaboration, and unique local criteria. Based on the fire risk assessment, local governments can understand if new development is prepared for or even considers wildfire threats within the area. Jurisdictions can place additional requirements on projects that do not meet specific thresholds based on a community's fire risk assessment.	The fire risk assessment can be integrated into existing plans or development review processes. Communities can apply this assessment at different scales to accommodate small developments or large subdivision projects. Jurisdictions can also use fire risk assessments for event permits and other special use permits that may be located within wildfire hazard areas.	Plans, Regulations, and Policy Development Evaluation	Emergency Management Forests	Cities and Counties Council or Association of Governments	FEMA Hazard Mitigation Grant SB 1 Grant General Fund	Permit Sonoma – Fire Risk Assessment
All Climate Hazards	**Strategy LUCD-8: Facilitate affordable housing options for all residents.** People experiencing homelessness and People who are housing-insecure (i.e., one financial shock away from eviction) are the two most vulnerable to impacts from climate change. These two populations are growing as a share of the overall population due to severe shortages of affordable housing on local and regional scales. Local jurisdictions can utilize new approval processes (i.e., SB 35 streamlining and CEQA exemptions), new infrastructure funding, and planning grants, in order to facilitate increased housing production to meet local and regional needs. Doing this will reduce the number of housing-insecure residents and people experiencing homelessness who are especially vulnerable to all climate hazards.	Ensure an adequate supply of affordable homes locally and regionally would reduce the incidence of housing insecurity and/or people experiencing homelessness for low-income households and households in poverty. This would reduce the numbers of individuals who are most exposed to safety impacts and health impacts in climate disasters.	Plans, Regulations, and Policy Development	Emergency Management Public Health	Cities and Counties Associations of Governments State and federal agencies	Affordable Housing Programs Planning grants: SB 2 Planning Grants Program & Local Early Action Planning (LEAP) Program	CalHOME No Place Like Home (NPLH) Supportive Housing Multifamily Housing Program (SHMHP) Affordable Housing and Sustainable Communities Program (AHSC) Infill Infrastructure Grant Program (IIG)

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Ocean and Coast Sector							
Sea level rise	**Strategy OCR-1: Develop an adaptive management plan to address the long-term impacts of sea level rise. Include an assessment of local vulnerability, including infrastructure such as roads and water reclamation facilities, buildings in the inundation areas, and ecosystems.** An adaptive management plan can provide for flood and erosion protection with consideration for future sea level rise, taking into account 100-year flood events when planning new development and infrastructure projects and/or reconstruction of existing projects. This plan should result in identification of areas of priority, suggested strategies, long-term indicators, and integration into other local policy documents (e.g., local hazard mitigation plans and local coastal programs).	These measures are likely to be most successful if efforts are made to coordinate sea level rise protection measures with adjacent jurisdictions to create contiguous shoreline protection. The California Coastal Commission should also be involved in this process.	Plans, Regulations, and Policy Development	Land Use and Community Development	Cities and counties California Coastal Commission	General fund LCP Local Assistance Grant	California Coastal Commission Residential Adaptation Policy Guidance City of Del Mar Sea-level Rise Adaptation Plan San Francisco Sea Level Rise Action Plan: https://sfpublicworks.org/about/san-francisco-sea-level-rise-action-plan
Sea level rise	**Strategy OCR-2: Facilitate managed retreat from, or upgrade of, the most at-risk areas. Gradually retreat from the most at-risk areas, use these areas differently, or upgrade buildings and other facilities in at-risk areas. Develop plans allowing for coastal inundation in defined areas.** Jurisdictions should assess local risk areas based on projected coastal inundation and the importance of facilities, infrastructure, or ecosystems that are at risk. Based on this assessment, top-priority areas should be identified, and actions should be taken for retreat or upgrade. Each development or infrastructure project must be assessed based on how long the action will be adequate given sea level projections.	When evaluating development or infrastructure projects, determine whether to (1) relocate them inland, (2) elevate them above projected sea level rise, or (3) leave them in place and make new or proposed facilities more flood-proof. Determine factors such as cost, environmental impacts, funding sources, timing, and compatibility with other plans. These choices should be made in close collaboration with the California Coastal Commission.	Plans, Regulations, and Policy Development	Land Use and Community Development Transportation	Cities and counties California Coastal Commission	General fund LCP Local Assistance Grant	California Coastal Commission Residential Adaptation Policy Guidance City of Del Mar Sea-level Rise Adaptation Plan San Francisco Sea Level Rise Action Plan: https://sfpublicworks.org/about/san-francisco-sea-level-rise-action-plan

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Sea level rise	**Strategy OCR-3: Require accounting of sea level rise in all applications for new development in shoreline areas. Ensure that all applications for new development account for projected sea level rise and provide adequate protection (e.g., elevation setbacks, nature-based solutions).** Shoreline areas can include beaches, bluff-tops, and areas along bays or estuaries. Accounting of sea level rise in these areas requires that jurisdictions prepare projected sea level maps to estimate long-term changes in the coastline, bluff erosion rates, and projected coastal flooding. Based on these maps, appropriate setback and/or other appropriate protection can be determined. For consistency, consideration of sea level rise should be included in project review guidelines, integrated into local coastal programs, and reviewed as part of California Environmental Quality Act (CEQA) evaluation.	Collaboration among adjoining jurisdictions will foster more comprehensive shoreline protection. The implementation of this strategy will also require staff and community education about sea level rise, inherent risks, and available options for addressing the risk.	Plans, Regulations, and Policy Development Programmatic	Land Use and Community Development	Cities and counties California Coastal Commission San Francisco Bay Conservation and Development Commission (BCDC)	General fund LCP Local Assistance Grant	BCDC: https://bcdc.ca.gov/BPA/SLRfactSheet.html
Sea level rise	**Strategy OCR-4: Preserve undeveloped and vulnerable shoreline. In shoreline areas, preserve undeveloped land to support ecosystem adaptation in areas where sea level rise may cause inland migration of species and habitat.** Undeveloped shorelines areas, particularly along bays or estuaries, should be evaluated for ecological value, vulnerability, and role in local flood protection. Protection and restoration of these areas can provide flood protection and support habitat and species migration. Tools that can be used to facilitate this protection can include several that are familiar to local and regional jurisdictions, including land use designations (e.g., zoning), building setbacks, consideration during project review, easement acquisition, and habitat conservation plans in situations where special-status species are present.	Land use and tax policies should be evaluated to avoid development on restorable habitat that is critical to ensuring that ecosystems are resilient to climate change impacts. Action such as land preservation can be coordinated with local land conservation and wildlife organizations. The California Coastal Commission should also be consulted. These actions do not need to strictly prohibit development. Instead, shoreline areas should be carefully evaluated. In some cases, development can be managed to allow for future ecosystem resilience.	Plans, Regulations, and Policy Development	Land Use and Community Development Biodiversity and Habitat	Cities and counties California Coastal Commission California Coastal Conservancy	General Fund Habitat Conservation Fund grant Department of Fish and Wildlife grants Department of Water Resources grant Wildlife Conservation Board grant ESA Nontraditional Section 6 grant National Fish and Wildlife Foundation grants Other grant programs	Case Studies of Natural Shoreline Infrastructure in Coastal California San Francisco Bay Living Shorelines Project Living Shoreline Academy Save the Bay Restored Wetlands

CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
Sea level rise; flooding	**Strategy OCR-5: Use transfer of development rights for the rebuilding of structures damaged or destroyed due to flooding in high-risk areas. Designate areas for increased density in a community, allowing landowners in the high-risk areas to sell their development rights.** Transfer of development rights (TDR) is often used to preserve agricultural lands or undeveloped areas. In this case, the same approach would be used to transfer the development rights of a high-risk property to a lower-risk property. The advantage is that the landowner in the high-risk area is compensated for the loss of development potential and a flood-prone area is set aside, decreasing flood risk for the whole community.	Often the most controversial aspect of TDR programs is selection of the receiving areas that will see an increase in development density. Community acceptance of this density increase requires that the program be accompanied by public education and outreach. Local land trusts can be valuable collaborators in developing the program, particularly restricting new development in high-risk areas. Jurisdictions should also consider the transfer of development rights for properties with historic and cultural significance.	Programmatic	Land Use and Community Development	Cities and counties California Coastal Commission	General fund	
Ocean acidification	**Strategy OCR-6: Establish early warning systems to monitor carbon chemistry at shellfish hatcheries and worked with hatchery managers to develop methods that protect developing oyster larvae from exposure to low pH waters.** Ocean acidification impacts are largely not able to be mitigated by local-level action, but cities and counties can work with state and federal agencies to monitor near-shore water chemistry and develop responses to mitigate damage to fisheries. In addition, land use practices to reduce non-point source pollution can reduce overall stress on shellfisheries.	Though not widespread in California, the state does have commercial shellfisheries that are important to the local economy and coastal culture. In addition to short-term actions to preserve these fisheries, communities may need to consider the long-term loss of these fisheries and how to transition impacted families and businesses to other activities.	Programmatic	Agriculture [aquaculture]	Cities and counties California Department of Public Health California Department of Fish and Game	California Department of Public Health	Center for Ocean Solutions: https://www.oceanfdn.org/sites/default/files/Why%20Ocean%20Acidification%20Matters%20to%20California.pdf NOAA Ocean Acidification Program: https://oceanacidification.noaa.gov/Home.aspx State of Washington Department of Ecology: https://ecology.wa.gov/Water-Shorelines/Puget-Sound/Issues-problems/Acidification

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Parks, Recreation, and California Culture Sector							
Sea level rise, flooding	**Strategy PRC-1: Develop coastal management plan to protect park infrastructure and natural resources.** Local and regional governments can work in partnership with the California Coastal Commission to develop coastal management plans for infrastructure and natural resources used for park and recreational purposes. This plan could include protecting existing open space adjacent to the coast, restoring dune habitat to increase the resilience of beaches, using soft or natural solutions for protecting structures facing flooding or inundation, require mitigation for impacts to public access, and the retrofitting or relocation of recreation and visitor-serving facilities.	Coastal management plans should consider the residents, visitors, and historic and cultural resources in coastal areas. During periods of extreme heat in inland areas, there may be an increase in the number of visitors to coastal areas. These plans should also consider managed retreat for relocation of trails, parking lots, park facilities, and cultural resources farther inland.	Plans, Regulations, and Policy Development	Ocean and Coast Land Use and Community Development	Cities and Counties Local and Regional Parks and Recreation Departments	LCP Local Assistance Grant	Safeguarding California: 2018 Update California Coastal Commission's 2018 Sea Level Rise Policy Guidance Living Shoreline Academy
Pests and diseases, flooding, landslide, wildfire, severe storms	**Strategy PRC-2: Collaborate with local and regional partners to provide robust trail and park maintenance to prevent and respond to damage from climate change effects.** Fallen trees, flood waters, wildfires, landslides, and severe storms, among other effects, can all damage trails and parks. To prevent long-term closures of park and trail facilities, local governments and collaborate with regional park districts and California State Parks to maintain park and trail facilities. Park management agencies can harden and stabilize park buildings and trails to prevent future damage.	Local agencies should consider funding and land ownership when providing robust trail and park maintenance. Preventative activities to make parks and trails more resilient can often receive grant funding, whereas recovery efforts more likely will derive from emergency funds. However, preventative measures can help avoid damage to facilities that would cost more money to fix.	Education, Outreach, Coordination Programmatic	Forests	Local and Regional Parks and Recreation Departments CA State Parks	California Department of Parks and Recreation California Natural Resources Agency	Safeguarding California: 2018 Update Park Planner's Toolbox
All hazards	**Strategy PRC-3: Maximize opportunities for the public to participate in and inform the parks and recreation adaptation planning process.** When park districts, California State Parks, or other park management agencies update park plans to add adaptation elements, public participation should be maximized. This could include several different outreach strategies, including public workshops, surveying persons using park facilities, and talking to stakeholders from nearby communities about the parks and recreation planning process.	Outreach should include both residents of the area and visitors to the area, as these populations are both key stakeholders for parks and recreation. Any type of public participation should be in multiple languages and culturally appropriate to the demographics that these programs would be serving.	Education, Outreach, Coordination	Land Use and Community Development	Cities and Counties Local and Regional Parks and Recreation Departments CA State Parks	California Department of Parks and Recreation California Natural Resources Agency	Safeguarding California: 2018 Update

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Extreme heat, flooding	**Strategy PRC-4: Identify park-poor communities and ensure that new urban parks and trail systems are within walking distance to underserved populations and are connected to high-density infill, homes, and offices.** Many neighborhoods with urban areas may not have access to parks and trail systems that can promote healthy living and active transportation. Local governments can work with community members and community-based organizations to identify these areas and designate land to build parks and recreational areas. These can include connections to larger trail networks, or pocket-parks in the center of urban areas. It is important to involve communities' members from the onset of urban park planning to receive feedback and find consensus on what is best for the community.	When building parks in park-poor communities, it is essential to ensure that communities have ownership of their neighborhood parks. This can be achieved through integrating local cultural assets such as stories, public art, cultural activities, artists, and traditions into park design.	Programmatic	Land Use and Community Development Public Health	Cities and Counties Local and Regional Parks and Recreation Departments	Urban Greening Grant Program Urban and Community Forestry Program Grants AB 31 – Park Poor Communities Program	Safeguarding California: 2018 Update City of Los Angeles: 50 Parks Initiative
Drought, extreme heat	**Strategy PRC-5: Coordinate with owners of winter recreation areas and water recreation areas to support additional recreational activities that are less dependent on snowpack and water levels.** Changing snowpack conditions and precipitation patterns may force snow and water recreation sites to support alternative recreational opportunities. Local governments should coordinate with the owners of these sites to ensure that they can remain economically viable and help sustain the local economy and workforce. Alternative forms of recreation could include biking and hiking trails on skiing mountains during the summer season, or ropes courses and other alternative recreational activities at water recreation sites.	Ski resorts often make their own snow in winters that do not provide enough natural snow to sustain skiing. Local government should encourage ski resort owners to estimate future energy demand for snow-making activities and to install renewable energy generation and energy storage systems to accommodate this demand.	Education, Outreach, Coordination Operational	Water Land Use and Community Development	Cities and Counties	Prop 68 – State of California Parks and Water Bond 2018	Placer County Sustainability Plan (2020)

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Extreme heat	**Strategy PRC-6: Install refillable water stations at parks, trailheads, community centers, and sport courts/fields with available water supplies to encourage proper hydration and protection against heat-related illnesses.** Extreme heat events may not deter people from hiking, biking, and participating in other outdoor recreational activities. However, local governments should make sure that parks and recreational areas adequate water supply and water refill stations. This can reduce heat stress, heat stroke, and dehydration during periods of extreme heat.	When installing water refill stations, local governments should provide education signage in multiple languages to enable visitors to understand how to prevent heat related illnesses. Local governments can also consider providing free insect repellent at outdoor recreation facilities. This can help prevent vector-borne illnesses from mosquitoes and ticks from spreading.	Capital Improvement& Infrastructure Projects Education, Outreach, Coordination	Public Health	Cities and Counties	California Department of Parks and Recreation California Natural Resources Agency	Placer County Sustainability Plan (2020)
All climate hazards	**Strategy PRC-7: Educate community members about the climate risks to historic, cultural, and tribal cultural resources, and the need to safeguard these cultural resources.** Protecting cultural and tribal cultural resources is important for many Californians, but it is still helpful to reinforce their importance, particularly as climate change stressors damage these resources or compel relocation. In partnership with tribal nations and community-based organizations, jurisdictions should educate community members of all ages about why it is necessary to safeguard historical and tribal cultural resources in their area. These educational and outreach efforts can often be integrated into existing programs, which can make them easier to implement.	Consider what types of education programs could be most effective in the community. This can include interpretive signage and in-person educational events at historic or culturally significant sites, online resources and information on social media, outreach to community groups and stakeholders, and volunteer opportunities. Multiple forms of outreach would likely be helpful. Ensure that educational programs are widely accessible to the community, including persons with different income levels and access to resources, who speak different languages, and who have differing levels of ability. Ensure that educational efforts reflect historic, cultural, and tribal cultural resources as well as the most recent and best available science, which may require revisions to outreach approaches as scientific understanding evolves. Communities should also ensure that educational efforts are universally accessible, including to people with access and functional needs.	Education, Outreach, Coordination Programmatic	Biodiversity and Habitat	Cities and Counties Community-Based Organizations Tribal Nations	Cultural, Community and Natural Resources Grant Program	

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Public Health Sector							
Air quality, extreme heat, wildfire, flooding, sea level rise	**Strategy PH-1: Establish resilience hub locations in neighborhoods throughout the community.** Resiliency hubs consist of well-used, existing community-serving facilities that are upgraded to provide local communities with shelter and electricity during extreme heat events, poor air quality, and disasters. These hubs should have other essential resources such as food, ice and refrigeration, charging stations, basic medical supplies, and other emergency supplies. They should have their own renewable energy and energy storage systems that should be able to operate up to 72 hours if a power outage occurs. Resiliency hubs should also act as education centers, where community members can go to learn about climate-related hazards and other effects, how to prepare and respond to them, and enhance community connections to increase adaptive capacity. Local and regional General Plan Safety Elements, Local Hazard Mitigation Plans, and Emergency Operations Plans should integrate site planning and establishment of resiliency hubs, and their importance to emergency preparation and response.	When establishing resilience hubs, local governments should focus on existing community facilities that can be upgraded, instead of new facilities that are unfamiliar to the community. These facilities should be located outside of hazard-prone areas. Jurisdictions should consider ease of access to the site, as those with limited mobility or without access to transportation may be unable to travel to a resilience hub during a disaster. Resilience hubs should be located in or near residential areas to ensure that they are easily accessible. People experiencing homelessness are often overlooked as a population that requires the assistance provided by resilience centers, so local governments should consider this population when planning for resilience hubs. Local governments can work with community-based organizations and neighborhood leaders to identify resilience hub locations and establish neighborhood outreach programs to disseminate information to older adults and linguistically isolated populations.1	Capital Improvement & Infrastructure Projects Programmatic Education, Outreach, Coordination	Emergency Management Land Use and Community Development Climate Justice	Cities and Counties Council and Association of Governments	Transformative Climate Communities Grant	Resilient IE (2020) USDN: Guide to Equitable, Community-Driven Climate Preparedness Planning Tuolumne County Community Resilience Centers USDN Resilience Hubs
All hazards	**Strategy PH-2: Integrate climate change and health equity into traditional public health programs and core functions.** Traditional public health programs primarily focus on treating individuals who are sick based on their symptoms. Integrating climate change and health equity into this traditional public health system can allow doctors to understand underlying conditions that create illnesses and whether climate change effects could exacerbate those illnesses. Public health officials could use hazard data, such as areas vulnerable to extreme heat or poor air quality, to reach vulnerable populations that may not otherwise have access to healthcare services.	When integrating climate change and health equity into public health programs, local governments should consider where the most vulnerable populations are located and if there are existing community centers or resilience hubs to focus resources. Part of health equity incorporation will be to provide care and educational programs in languages that match the demographics of the local community. This should encourage community members to participate in public health programs.	Operational Education, Outreach, Coordination	Land Use and Community Development Emergency Management Climate Justice	Cities and Counties Council and Association of Governments		APEN: Mapping Resilience Climate Change, Health, and Equity: Guide for Local Health Departments Making Equity Real in Climate Adaption and Community Resilience Policies and Programs: A Guidebook

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Extreme Heat, Air Quality, Flooding	**Strategy PH-3: Collaborate with community-based organizations to develop or expand urban greening and urban agriculture programs.** Community-based organizations have direct ties to the communities they are from or work in, and therefore are optimal partners to identify areas for urban greening and urban agriculture, and then develop and implement these programs. Urban greening can include adding trees, parks, green infrastructure, and other green elements to a neighborhood. This program can help reduce temperatures on the ground by providing shade, clean the air to improve air quality, and provide natural drainage areas that prevent flooding. Urban agriculture includes community gardens or small farms within urban areas of a community. This program can replace paved areas and reduce the urban heat island effect, while also providing additional food and educational opportunities for the community.	The first factor to consider is where urban greening and urban agriculture is most needed, which is typically in areas with few trees, parks, or healthy food options. Local governments should also consider gentrification and displacement that could occur because of these programs. To prevent this, local governments can protect affordable rentals and the ability of residents to remain in their homes, while also hiring local youth or young adults to install green infrastructure or other plants as part of workforce development jobs program. This effort could also include on-site capture of rainwater on private properties.	Programmatic Education, Outreach, Coordination	Land Use and Community Development	Cities and Counties CBOs	Transformative Climate Communities Grant General Fund	City of San Francisco Green Trees Program City of Santa Monica Rain Barrel and Cistern Rebate Program City of Seattle's Housing Affordability and Livability USDN: Guide to Equitable, Community-Driven Climate Preparedness Planning
All hazards	**Strategy PH-4: Develop a climate preparedness outreach program focused on vulnerable populations that provide information on staying healthy and safe during hazardous events.** Community members, especially those within a vulnerable population group, may be unaware of the climate-related effects that may be harmful to their community, or how to stay safe during hazardous events. Vulnerable populations may be the least prepared for the impacts of climate effects. Local governments can develop climate preparedness outreach programs to work with community members to increase resiliency to hazardous events. Programming can include educational events, workshops for school aged children, and providing emergency kits to community members. Jurisdictions should prioritize resources for vulnerable populations, provide them in multiple languages, and design them to communicate effectively with all groups to reduce health inequities in communities.[2]	Local governments should consider the populations they are trying to reach in these outreach programs, and the effects most likely to impact those communities. Some communities may be at high risk of flooding, while others could be in the high wildfire hazard severity zones. It can be difficult for jurisdictions to reach some populations, especially those that are isolated, with these outreach efforts. Local governments can work with established neighborhood outreach programs or collaborate with community-based organizations to improve trust and communication to reach as many people as possible.	Education, Outreach, Coordination Programmatic	Emergency Management	Cities and Counties		USDN: Guide to Equitable, Community-Driven Climate Preparedness Planning Oakland Community Climate Action Guide City of Seattle Equity & Environment Initiative

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Air Quality, Extreme Heat, Wildfire, Human Health Hazards	**Strategy PH-5: Expand employer and worker training in industries with outdoor work, including assurance or adequate water, shade, rest breaks, protection from poor air quality, training of heat impacts, and vector borne diseases.** Health effects from climate change can be more severe for individuals who work outdoors, such as construction workers, landscapers and grounds crews, and agricultural workers. Extreme heat and poor air quality are the primary health effects for these workers, although increased exposure to potential disease vectors such as ticks and mosquitoes can also pose a hazard. The local and regional governments can provide guidance to employers and workers, as well as work with the private sector and community-based organizations, to ensure that outdoor employees are aware of the harm posed by these climate-related effects and how to reduce them.	Many workers in these industries may be difficult to reach and outdoor workers may be fearful of engaging with the government. However, local governments can work with community-based organizations and worker rights advocates to determine the best method to outdoor workers. Information can include protections from climate-related effects, but also information about worker protect laws. Outreach should also be culturally relevant and be in multiple languages that are representative of the outdoor worker population.	Programmatic Education, Outreach, Coordination	Emergency Management Agriculture	Cities and Counties		USDN: Guide to Equitable, Community-Driven Climate Preparedness Planning Fair Work Center
All hazards	**Strategy PH-6: Coordinate with local homeless services to ensure that emergency shelters are available during extreme heat events, poor air quality, severe weather events, and other highly hazardous conditions. Ensure that the local homeless population is made aware of these resources.** Local communities should coordinate with agencies and organizations that provide homeless services to provide shelter during hazardous conditions. These emergency shelters should provide information about hazardous events and basic supplies such as insect repellent and hygiene provisions that can increase the adaptive capacity of individuals experiencing homelessness. Outreach and support efforts to homeless individuals is essential to disseminate information on how to stay safe during hazardous conditions and where the nearest emergency shelters are located.	This is a two-pronged adaptation measure that involves both coordination with homeless services and outreach to local homeless individuals or populations. Some communities have existing homeless shelters that can be used during emergencies, and others would have to develop new emergency shelters that can accommodate the homeless population. Recently enacted legislation from 2019 (AB 101, SB 450, SB 744) streamlines the approval process to construct emergency shelters, navigation centers, and supportive housing for vulnerable populations, and it assists local communities with required CEQA review. This can help address a serious shortage of emergency shelters and related facilities in local communities. These locations may not be familiar to homeless individuals, and therefore it is essential to go to the homeless community, homeless shelters, and local soup kitchens to disseminate this information.	Education, Outreach, Coordination	Emergency Management Land Use and Community Development	Cities and Counties Local homeless services organizations (Continuum of Care, homeless partnerships, etc.)	Homeless Assistance Grants Emergency Solutions Grants (ESG) Program	Placer County Sustainability Plan (2020) Resilient IE (2020)

TABLE D-1. EXAMPLES OF LOCAL CLIMATE ADAPTATION STRATEGIES BY SECTOR							
CLIMATE HAZARDS	**ADAPTATION STRATEGY**	**FACTORS TO CONSIDER**	**CATEGORY**	**SECTOR OVERLAP**	**RESPONSIBLE AGENCIES**	**FUNDING**	**EXAMPLES & SOURCES**
All hazards	**Strategy PH-7: Work with local medical providers and hospitals to ensure that medical facilities are prepared to meet any increased demand because of hazardous events.** Hazardous events, such as wildfires, floods, poor air quality, and extreme heat, can increase illnesses such as heat stroke, asthma, and cardiovascular diseases. This can increase the demand for medical services at hospitals and local medical providers. This demand can create an unexpected overflow of patients and can strain hospitals and clinics in a community. Local governments can work with the regional public health systems, hospitals, clinics, and private practices to prepare for an influx of patients during hazardous events. This could be stocking up on specific medical supplies for local emergencies or working with emergency management agencies to have medical professionals and supplies at emergency shelter locations.	Local governments can work with medical providers to identify specific health impacts that may occur due to different climate change effects. Medical providers are trained to understand the illnesses of patients, but they may not understand health hazards that are created or worsened by climate change. This adaptation strategy can help community members be treated effectively and efficiently to recover from climate-related effects.	Operational Education, Outreach, Coordination	Emergency Management	Cities and Counties Public Health Departments		Placer County Sustainability Plan (2020) Health Care Climate Council Preparing Public Health Officials for Climate Change: A Decision Support Tool
Human Health Hazards	**Strategy PH-8: Identify and remedy poor drainage areas to reduce disease risk from stagnant water.** Expand outreach programs to educate communities about potential increases in vector-borne diseases from stagnant water. Stagnant water provides a breeding ground for mosquitoes, which in turn can increase the risk of mosquito-borne pathogens such as West Nile virus. Stagnant water can develop in areas of poor drainage following flood events, creating a health risk in the vicinity. Communities can identify poorly drained areas and complete infrastructure improvements so that they drain properly. If infrastructure improvements are not feasible, communities can categorize these locations as needing mosquito-control efforts following a flood event. Communities can collaborate with local mosquito abatement districts to expand public education programs regarding preventative actions against vector-borne diseases that have the potential to occur in the future.	Local governments can work with local flood control districts and mosquito abatement districts to both identify poor drainage areas, implement abatement measures, and conduct community outreach. Outreach should focus on the most vulnerable populations and be presented in a culturally relevant manor in languages that are representative of the local demographic.	Capital Improvement& Infrastructure Projects Education, Outreach, Coordination Programmatic	Land Use and Community Development Water Biodiversity and Habitat	Cities and Counties Mosquito Abatement Districts Flood Control Districts		Resilient IE (2020) Pacific Southwest Center of Excellence in Vector-Borne Diseases California Department of Public Health Mosquito and Vector Control Association of California

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CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
Transportation Sector								
Coastal storms, Extreme heat, Flooding, Landslides, Severe storms, Sea level rise, Wildfire	**Strategy TRANS-1: Update maintenance protocols to incorporate climate vulnerabilities.** The increase in intensity and frequency of climate-related hazards and other effects, such as flooding and extreme heat, can affect day-to day operations and maintenance of transportation infrastructure, including roadways, railways, airports, and active transportation routes. Updating maintenance system to adapt to climate change effects can involve shifting outdoor physical labor hours to earlier in the morning during extreme heat days. Transportation agencies might also increase stormwater drainage infrastructure maintenance to ensure that when storms arise, there is sufficient drainage capacity to convey any surface-level flooding.	Local governments should not only consider roadways, but also look at railways, airports, seaports, transit, and active transportation systems when updating maintenance protocols. Railway systems can move large amounts of freight, including essential goods, in addition to an important element of moving people during commuting hours in some areas of the state. Maintenance of active transportation corridors could include installing green infrastructure to increase drainage capacity, or planting trees to increase shade cover.	Plans, Regulations, and Policy Development	Emergency Management Public Health	Cities and Counties Transportation Agencies Councils/ Associations of Governments		LA Metro CAAP SCAG Adaptation and Resilience Planning FHWA Climate Resilience Resources Resilient IE (2020) County of San Diego Infrastructure Resources
Coastal storms, Extreme heat, Flooding, Landslides, Severe storms, Sea level rise, Wildfire	**Strategy TRANS-2: Coordinate with both community members, transportation agencies, and private entities to identify local and regional transportation, transit, and active transportation corridors that are at-risk from climate change effects.** Transportation corridors, such as evacuation routes, transit routes, regional bike paths, and major commuting routes may be impacted by climate change effects. These corridors can include hundreds of miles of roadways, rail, or multiple airports, which can create difficulties in identifying at-risk areas on those routes. However, throughout coordination with community members, transportation agencies, Caltrans, and private entities, such as Union Pacific Railroad, local governments can locate specific areas that may be at the greatest risk to damage or destruction from climate-related effects.	An important factor to consider when coordinating with multiple stakeholder is the method of communication. Formal meetings and roundtables may work for transportation agencies and private entities, but workshops or hosting community events may work better for engaging community members. Community members typically have local knowledge of their neighborhood, which can help in identifying acute problems at a local street scale. When conducting outreach to community members, it is essential to work with community residents and groups to determine appropriate and culturally relevant communication strategies to reach all sectors of the population.	Education, Outreach, Coordination	Public Health	Cities and Counties Transportation Agencies Councils/ Associations of Governments		USDN: Guide to Equitable, Community-Driven Climate Preparedness Planning City of Baltimore Make a Kit, Build a Plan, Help Each Other

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CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
Coastal storms, Extreme heat, Flooding, Landslides, Severe storms, Sea level rise, Wildfire	**Strategy TRANS-3: Use the best available science and resilient design features in transportation infrastructure to improve resiliency to extreme climate events.** Local governments can take a number of steps to increase transportation resiliency of roadways, railways, airports, and seaports. For example, special sealants and other materials on roadways can help prevent roadways from softening during extreme heat. Other resilient design features include choosing appropriate roadway materials for wildfire prone areas, treating rail lines to be heat-resistant, and incorporating expansion joints into rails that reduce the risk of damage during high temperatures. Roads and railways can be built on foundations that are resistant to washouts from flood events. For airports, infrastructure reinforcement, stormwater improvements and drainage upgrades, and pumping and water storage facilities can be installed to increase resiliency to flooding and wave action by coastal storms. In some cases, increasing resiliency may involve updating design standards or replacing existing infrastructure to account for the changing conditions.	When deciding which resilient design features to use, it is important to consider where the vulnerable infrastructure is located (mountains/hills, low-lying valleys, coastal areas, desert). This can help determine whether design features should include hardening for landslides and wildfires, additional stormwater drainage for coastal and inland flooding, or replacement of resources with heat-resistant materials. Resilient design can also include increasing levee height, raising or relocating roads and railways, and installation of tidal gates in coastal areas. It is also essential to coordination with transportation agencies, Caltrans, airports, and railway operators to ensure that resilient design features are consistent between different entities. Additionally, local governments should consider these features for alternative transportation routes, such as walking and biking paths.	Capital Improvement & Infrastructure Projects	Emergency Management Land Use and Community Development Ocean and Coast	Cities and Counties Transportation Agencies Councils/ Associations of Governments		Caltrans Realignment of Highway 1 Safeguarding California: 2018 Update Caltrans Pervious Pavement Design Guidance Specifications Low Impact Development Manual for Southern California County of San Diego Guidance of Green Infrastructure
Coastal storms, Flooding, Landslides, Severe storms, Wildfire	**Strategy TRANS-4: Coordinate with regional transportation agencies to ensure redundancy of critical transportation routes to allow for continued access and movement in the event of an emergency.** Transportation routes, which often double as evacuation routes, are at risk of shutdowns during a climate-driven emergency. If essential transportation and evacuation routes are closed or blocked due to hazardous conditions or major traffic delays, evacuations may not be possible. Critical services, such as healthcare and emergency response may not be able to properly carry out their functions, and economic activities may slow or stop. Creating redundancies in transportation systems can lessen the potential severe effects of a shutdown on critical routes.	Local governments should study changes along designated evacuation routes associated with more frequent and severe wildfire, coastal and inland flooding, landslides, and severe storm events. Important nodes along evacuation routes include bridges and segments that are located above streambeds or waterways. This study can ensure that high risk areas are hardened, and infrastructure remains operational during emergencies to ensure there are means to conduce community-scale evacuations.	Education, Outreach, Coordination Capital Improvements & Infrastructure Projects	Emergency Management	Cities and Counties Transportation Agencies Councils/ Associations of Governments		Resilient IE (2020) Caltrans Pervious Pavement Design Guidance Specifications

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Coastal storms, Flooding, Landslides, Severe storms, Wildfire	**Strategy TRANS-5: Coordinate with regional transit providers to identify alternative routes and stops if normal infrastructure is damaged or closed as a result of extreme events.** Disruption to transit services can deprive some community members of their only means of travel to school, work, or services. To help ensure that transit services can continue to operate during and after extreme events, local governments should collaborate with regional transit providers, transportation agencies, and private transit providers to identify alternative routes and tops in the event that they can no longer use normal infrastructure. Alternatives should be located near normal routes and stops with clear communication to reduce disruptions to transit riders.	When creating alternative transit routes or stops, local governments should consider to communication methods used to convey the changes in service. Methods could include signage and flyers, television, radio, print media, and digital services. Communication should be presented in a culturally relevant manor in languages that are representative of the local demographic.	Education, Outreach, Coordination Operational Ocean and Coast	Emergency Management Public Health	Cities and Counties Transportation Agencies		Resilient IE (2020)
Air quality, Extreme heat	**Strategy TRANS-6: Collaborate with public works departments and regional transit providers to increase shading and heat-mitigating materials on pedestrian walkways and transit stops.** Adequate shade on sidewalks and transit stops is essential for community members who walk or use public transit to get to their destinations. To increase the comfort of pedestrians and bicyclists on hot days, local governments can work with local jurisdictions to install pavement with high albedo, which absorbs less heat and contributes less to the urban heat island effect. Heat-reflective pavement can be applied either by replacing existing surfaces or by coating surfaces with a highly reflective coating. Local governments can also encourage tree planting programs along walkways to provide shade, particularly in communities that have little shade. This could help reduce heat and improve local air quality, as well as incentivize outdoor activity.	Local governments should prioritize areas that have few trees or lack shade covers when implementing heat-mitigation projects. When increasing shade at transit stops and walking or biking paths, local governments should also consider installing green infrastructure, which can both increase shade and prevent flooding in low-lying areas.	Programmatic Education, Outreach, Coordination	Public Health	Cities and Counties Transportation Agencies		Resilient IE (2020) County of San Diego Green Infrastructure Resources Low Impact Development Manual for Southern California

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CLIMATE HAZARDS	ADAPTATION STRATEGY	FACTORS TO CONSIDER	CATEGORY	SECTOR OVERLAP	RESPONSIBLE AGENCIES	FUNDING	EXAMPLES & SOURCES
Water Sector							
Flooding, drought	**Strategy W-1: Reduce flood and drought risk through integrated watershed management.** This is a high level, integrated approach to balancing water availability (both surface and groundwater), demand, and an ecosystem's minimum water needs to ensure a balanced consideration of economic, social, and ecosystem welfare. Healthy watersheds where development is planned to minimize impact and use and water sources are carefully managed to assure long-term, sustainable supply are more resilient to both variable, intense rainfall and drought. A healthy watershed maintains wetland areas as flood mitigation and maintains undeveloped natural areas, promoting soil health to blunt flood impacts and to assure greater resilience to drought.	Each city should assess its context in a watershed and, if needed, engage in a collaborative relationship with other entities in the local watershed. This should include collaboration with various departments in a community from planning, to natural resources, to water providers, and more. Conservation measures should be pursued to preserve wetlands, particularly upstream of a community, and manage undeveloped areas. Planning should work to ensure that floodplains remain intact with minimal development and have safety margins that expect expanded flood extents. Cities can collaborate with water providers to encourage increased water efficiency (e.g. graywater systems, reduced outdoor use, low flow fixtures) and to diversify water sources.	Operational Programmatic	Agriculture Biodiversity Land Use and Community Development	Cities and counties (planning, hazards, & natural resource departments) Water providers	General Fund DWR Integrated Regional Water Management Grant Programs	DWR. "Integrated Regional Water Management" The Water Institute. "Focus on Integrated Watershed Management"
Flooding, drought	**Strategy W-2: Reduce local flooding through implementation of low impact development.** This strategy is specific to the stormwater management system in a community. The approach through installation of bioretention elements in parking lots and on the street margin. It can be implemented through green infrastructure plans, landscape codes, green street standards, and off-site standards. The approach seeks to mitigate the local flooding resulting from the effects of climate change and impervious surfaces on runoff events. These strategies also increase groundwater recharge and moderate increased streamflow in the receiving waterways.	This requires cities to assess the underlying soils, geology, and water table to assure infiltration is possible. Strategies should be developed appropriate for the local conditions. It is best to combine these approaches with road paving schedules and implementation of road diet approaches as the reduction of lane frees space for bioretention along the road margin in combination with other amenities such as sidewalks, bike lanes, and bus stops.	Plans, Regulations, and Policy Development Capital Improvement/ Infrastructure Project	Biodiversity Land Use and Community Development	Cities and counties (utility dept.)	General fund Capital improvement fund State Water Resources Control Board: Stormwater Grant Program State Water Resources Control Board: Stormwater Strategy	Central Coast Low Impact Development Initiative (CCLIDI). "Municipal Codes" from https://www.centralcoastlidi.org/

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Drought	**Strategy W-3: Increase water efficiency and conservation.** Cities, on their own or through collaboration with water providers, encourage increased water conservation and efficiency (e.g. graywater systems, reduced outdoor use, low flow fixtures). This is a key strategy to facing increasing frequency of drought conditions as it allows existing water supplies to stretch a further. Such efforts can be implemented through a variety of tools from turf replacement programs to building codes.	As assessment primary water uses in a community can help narrow and focus the measure chosen such as communities with high levels of outdoor use can pursue strategies to limit the amount used and type of water used (e.g. gray or recycled). This can be promoted through adjustments to a tiered fee system, outreach, turf replacement programs, or building requirements for low-flow fixtures. The fee-based options require careful assessment of impacts on lower income community members.	Plans, Regulations, and Policy Development Education/ Outreach/ Coordination	Land Use and Community Development	Cities and counties	General fund DWR Water Use Efficiency Grants	DWR. "Water Use & Efficiency" from https://water.ca.gov/Programs/Water-Use-And-Efficiency
Flooding, drought	**Strategy W-4: Upgrade water and wastewater systems to accommodate projected changes in water quality and availability.** Under future conditions, existing water and wastewater systems may not be able to meet community demand. For example, wells and intake systems may be too shallow to effectively pull enough water supplies from groundwater aquifers and surface water bodies, higher levels of water contaminants may exceed the capacity of water treatment systems, and water storage tanks may not be able to hold enough water to meet demand if there is a supply interruption. This can be a particular challenge for smaller systems. Making retrofits to these pieces of infrastructure in advance of future conditions can help communities be better prepared and ensure that there are fewer disruptions to water and wastewater services.	When upgrading existing water and wastewater systems, it is critical to identify the specific needs of the systems under future conditions, and what upgrades are required to ensure these needs are met. As with any engineering project, retrofits should be designed to err on the side of caution in case future conditions are more extreme than projected, without overengineering retrofits to the point of wastefulness. Retrofits are also a prime opportunity to consider other upgrades not directly related to water availability and quality, but which provide other adaptation benefits, such as energy efficiency and renewable energy.	Capital Improvement/ Infrastructure Project	Public Health	Water and wastewater service providers	General fund Capital improvement fund Water and wastewater infrastructure improvement grants State Water Resources Control Board: Clean Water State Revolving Fund Water and Wastewater Infrastructure Improvement Grants	

ENDNOTES
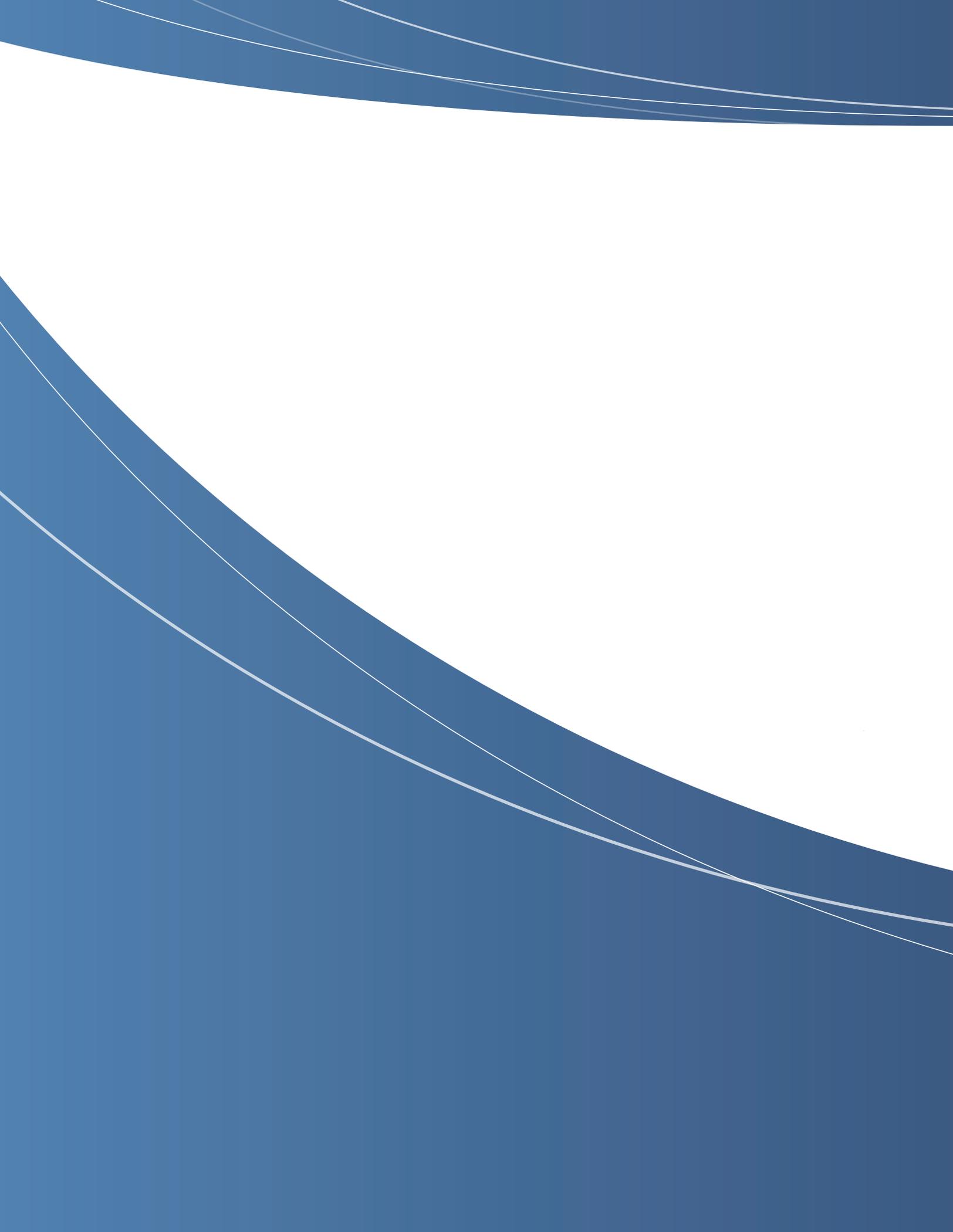
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Appendix C

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Appendix D

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