

Flood Management Resource Management Strategy

Draft Memorandum

CALIFORNIA WATER PLAN UPDATE 2023

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Acronyms and Abbreviations

CVFPP	Central Valley Flood Protection Plan
Delta	Sacramento-San Joaquin Delta
DWR	California Department of Water Resources
EIFD	enhanced infrastructure finance district
FEMA	Federal Emergency Management Agency
Flood-MAR	flood-managed aquifer recharge
GO bonds	general obligation bonds
ITA	Indian Trust Asset
IWM	integrated watershed management
O&M	operations and maintenance
P3	public-private partnership
RFMP	regional flood management plans
SPFC	State Plan of Flood Control
USACE	U.S. Army Corps of Engineers

1. Introduction

In January 2023 a series of atmospheric rivers set new rainfall records in several locations throughout California, leading to flash floods and levee overtopping with economic costs estimated at \$5 billion to \$7 billion (Moody's Risk Management Solutions 2023). Approximately one in five Californians are exposed to flood risk each year in California, according to an exposure study performed in 2019 (California Department of Water Resources 2019). California's climate models predict an increase in extreme weather events, including extreme rainfall events, creating a significant challenge for flood management and increased flood risk for many Californians. At the same time, California has a dynamic and complex hydrologic system that is increasingly vulnerable to dramatic swings between drought and flood. Increasing flood risk creates new challenges for public health and safety, ecosystem vitality, economic health, opportunities for enriching experiences, and vulnerable communities. The State must respond with innovative and holistic approaches that integrate multiple benefits and cut across water sectors. Further, California must make substantial justified investments, while enacting policies that support the implementation of solutions and collaboration among State, federal, and local partners.

The State is utilizing more integrated approaches to flood management that go beyond simple levee and dam infrastructure (gray infrastructure) to recognize the multi-faceted relationship between flood risk and water supply, groundwater resources, water quality, ecosystems, hydropower, and recreation. Flood management in California increasingly emphasizes multi-benefit projects (green infrastructure) that are designed to reduce flood risk and enhance fish and wildlife habitat. Multi-benefit projects may also create additional benefits such as sustaining agricultural production, improving water quality and water reliability, increasing groundwater recharge, supporting commercial fisheries, and providing public recreation and education opportunities. Meanwhile, the State and federal governments have begun to recognize the racial equity and environmental justice impacts of flood management policy. Current planning efforts are initiating the important conversation about how historical flood management decisions may have contributed to inequities and how flood management policy can ensure that racial equity and environmental justice become intrinsic to the State's flood management efforts. Finally, as recognized in the [Water Resilience Portfolio](#) (California Department of Natural Resources 2020), the challenges of climate change and the need for climate resilience cut across all aspects of water and flood management.

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Flood management agencies in California face numerous challenges to bringing this multi-benefit approach to fruition. Addressing flood risk in this more integrated way requires consistent interagency coordination at a scale that makes sense for flood management, expanded institutional capacity, and well-aligned funding programs. It will require increased funding to meet the need for capital investment, ongoing maintenance, and policy initiatives. It will require improved public understanding of flood risk and public backing of flood management investment and actions.

This *Flood Management Resource Management Strategy* provides an overview of flood management in California, including the benefits of an integrated watershed management (IWM) approach, an assessment of flood risk, a discussion of the investment needed to reduce risk statewide, an outline of funding programs, and a look at barriers to implementation. It also provides a suite of recommendations for action at the local, State, and federal levels that can help address barriers to flood management. As the understanding of flood risks in a changing climate improves, the State must think more creatively and act more urgently than ever before to overcome these barriers and create a more resilient flood management system.

Flood Risk Management in California

California faces various types of flood risks across its diverse geography. These range from slow-rise riverine flooding in the Central Valley, to explosive mud slides in hillside communities, to coastal flooding along the state's seashore. Extreme precipitation events can overwhelm stormwater systems in urban areas and cause flash flooding in desert regions. Low-lying coastal areas are at risk of flooding during king tides, storm surges, and other periods of elevated sea level. With this diversity of flood risks, each of California's 58 counties has experienced at least one significant flood event in the last 25 years (California Department of Water Resources n.d.). Figure 1 shows an overview of California's multiple flood risks and their locations.

Figure 1 Types of Flooding in California



Climate change exacerbates the risk of nearly all types of flooding and contributes to a range of other policy challenges. California’s climate projections show an increase in extreme weather events, increasing the risk of all types of flooding (Bedsworth et al. 2018). As winter storms intensify because of the effects of climate change, pressure on the flood-risk-reduction system increases. More extreme precipitation events lead to greater risk of flash floods, and other localized flooding. The increased wildfire occurrence in California coupled with more intense precipitation events results in higher risk of flood after fire events, which present a unique type of threat that can include debris flows and mudslides. Earlier snowmelt associated with warmer temperatures swells reservoirs and waterways earlier in the year, complicating reservoir operations as operators attempt to balance the need to store water supply with maintaining reservoir space to store and regulate high flows for flood management purposes. Finally, increased storm intensity along with projected sea level rise means that coastal flood risk is projected to increase steadily over the coming decades.

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The State has a host of flood risk reduction actions available to meet the rising risk. Traditionally, levees, reservoirs, sea walls, and other infrastructure, including natural infrastructure, help limit flood risk from these events by channeling water away from homes and other vulnerable resources as quickly as possible. Additional actions including land use planning and risk assessment studies that help minimize development in flood zones and reduce the residual risk associated with flooding. Additionally, changes to the water management system, such as modifying reservoir operations, provide flexibility in storing and releasing water. Another critical suite of risk reduction measures includes promoting risk awareness campaigns for people and property located in flood zones, emergency management planning and preparedness activities, and changes to building codes that allow for escape and retreat routes. Regular maintenance of existing infrastructure and periodic improvements are also required to ensure that the infrastructure operates as intended.

Delivery of these flood management actions is carried out by a complex network of nearly 2,250 local, regional, State, federal, and Tribal agencies. Local agencies, such as cities, counties, and special districts implement many flood management actions. To do so they must coordinate planning processes, raise funding through local taxes, assessments, or fees, and permit projects through State and federal regulatory agencies. State agencies set statewide priorities for flood risk reduction, conduct statewide and system-scale planning, provide funding through targeted grant programs, and implement multi-benefit projects. The State also has maintenance responsibilities as part of the State Plan of Flood Control (SPFC), a State-federal flood management system in the Central Valley that includes 1,600 miles of levees, five major weirs, four dams, six pumping plants, and floodways, bypasses, and related infrastructure. Federal agencies such as the U.S. Army Corps of Engineers (USACE), the Federal Emergency Management Agency (FEMA), and U.S. Bureau of Reclamation set levee standards, ensure flood capacity in federally managed reservoirs, and manage the National Flood Insurance Program. They also help fund disaster preparedness, disaster response, and disaster recovery. Tribal entities, as sovereign nations, also implement flood management projects, with unique regulatory requirements. Consultation with Tribal interests and consideration of impacts to local Tribes is required as part of California Environmental Quality Act and other regulatory processes.

The challenges of flood risk management in California are complex, spanning the state's varied geographies, types of flood risk, and the multitude of agencies involved in its implementation. To address these challenges, which are all intensified by

climate change, California must respond with solutions that span multiple water sectors.

Integrated Watershed Management Approach to Flood Risk Reduction

California is shifting toward an outcome-based planning framework for flood management. This planning framework is driven by the idea that water resources investment in the state should be guided by societal values.

These societal values are:

- **Public health and safety:** Minimizing lives lost, injuries, and health risk from flooding.
- **Healthy economy:** Balancing economic risk and reward on floodplains and increasing benefits from flood-related economic activities.
- **Vital ecosystems:** Preserving or enhancing biodiversity throughout California.
- **Opportunities for enriching experiences:** Preserving agricultural communities and other culturally and historically significant communities, providing access to recreation in natural areas, supporting education, and learning about floodplain systems.
- **Equity and social justice:** Ensuring that socially vulnerable communities have the necessary resources to cope with and recover from flood events.

An outcome-based planning framework for flood management will help California align with these important values by tracking specific outcomes. These specific outcomes would include indicators such as expected annual life loss from flood events, expected annual damage from flood events; improvements to ecosystem processes, habitat, and species, recreation, cultural enrichment, and education opportunities; and the number of vulnerable communities within the 100-year floodplain.

IWM is a comprehensive and collaborative approach for managing water to achieve multiple objectives. The IWM approach to project development combines more than one aspect of water management and encourages water managers to consider the impacts on all water management sectors when developing and implementing a plan. To be effective, planning must span jurisdictional boundaries to take place at the appropriate geographic scale, depending on local hydrology and ecological dependencies. Planning at the watershed scale allows early coordination across city

and county boundaries, and early consultation with Tribal interests. IWM relies on blending knowledge from a variety of disciplines, including engineering, economics, environmental sciences, public policy, and public information. The IWM approach also promotes system flexibility and resiliency to accommodate changing conditions such as regional preferences, ecosystem needs, climate change, flood or drought events, and financing capabilities.

IWM focuses on multiple-benefit projects that not only reduce flood risk, but also address water supply, recreation, ecosystem conservation, and equity. Specific examples of multi-benefit approaches include:

- **Levee setbacks:** Relocating levees farther from rivers (constructing setback levees) creates space for rivers to meander, reconnects floodplains, and provides opportunities to improve ecosystem function and increase habitat connectivity.
- **Bypasses and floodplains:** Expanding bypasses protects large areas of land from development, adds agricultural land and natural vegetation to the floodway, and results in periodic, prolonged inundation of land that was previously isolated from the river system by levees. An expanded, frequently activated floodplain in the bypasses supports the restoration of floodplain ecosystems, and recreational opportunities.
- **Groundwater recharge and flood-managed aquifer recharge:** Flood-managed aquifer recharge (Flood-MAR) uses floodwater resulting from, or in anticipation of, rainfall or snowmelt for managed aquifer recharge on agricultural lands and working landscapes, such as refuges, floodplains, and flood bypasses (California Department of Water Resources 2018). Flood-MAR approaches are still being studied to better understand the opportunities and challenges for broader use.

State of Integrated Watershed Management in California

California has been shifting steadily toward an IWM approach to flood risk reduction since the early 2000s. This section highlights some examples of IWM principles integrated into State programs.

The Central Valley Flood Protection Plan (CVFPP) is an example of IWM in a system-scale flood management plan. California's Central Valley, made up of two of California's largest watersheds, the Sacramento and San Joaquin rivers, is one of the most productive agricultural regions in the world, home to multiple urban centers, as well as critical wildlife habitat, and has the highest flood risk in the country. Originally

adopted in 2012 by the Central Valley Flood Protection Board, the CVFPP is updated every five years, most recently in 2022. The CVFPP is the strategic blueprint for improving flood risk management in the Central Valley and guides State flood risk management actions in areas protected by the SPFC (California Department of Water Resources 2022). As a programmatic vision, the CVFPP presents broad portfolios of multiple-benefit actions at various scales that collectively reduce flood risk for Central Valley communities, enhance ecosystems, and provide other benefits, such as increasing groundwater recharge, community resilience, climate change resilience, water supply reliability, agricultural stewardship, and recreation. The CVFPP guides flood management investments in the Central Valley and includes policies that support comprehensive flood risk management actions at all levels of government.

The CVFPP is intended to help California and its partners develop and implement non-structural actions as well as multi-benefit flood infrastructure improvement projects that integrate project components and strategies that benefit native species and their habitats in the Central Valley. From 2016 to 2021, several multi-benefit and restoration projects were completed in the Central Valley, including fish passage and floodplain reconnection project components. One example is the Dos Rios Ranch Floodplain Expansion Project on the Lower San Joaquin River. This project restored riparian habitat and reconnected approximately 1,000 acres of historical floodplain, allowing for flooding and transient floodwater storage along a 6-mile stretch of the river.

San Mateo County is an example of the need for regional flood management entities when it comes to coastal flooding and sea level rise. San Mateo County is home to 20 cities, all with different governance and independent jurisdictions, creating a challenge to managing common coastal resources. In 2018, the San Mateo City/County Association of Governments recognized the need for a single county-wide agency to address the challenges of flooding, sea level rise and coastal erosion. In 2019, the San Mateo Flood and Sea Level Rise Resiliency District was established to coordinate planning and implementing projects across jurisdictions, enabling uniform levels of protection, and sharing of technical information and resources. The new resiliency district creates a broad and unified vision and voice to streamline funding and regulatory permit applications.

The San Mateo Flood and Sea Level Rise Resiliency District is actively pursuing multi-benefit projects that provide habitat and water quality improvements in addition to flood risk reduction. Their Bayfront Canal & Atherton Channel Flood Protection and Ecosystem Restoration Project will help protect adjacent communities from recurrent

flooding during minor rainfall and high tide events by diverting excess flows to managed ponds owned by the U.S. Fish and Wildlife Service. Another planned project addresses recurrent flooding from Belmont Creek, by protecting the creek's riparian corridor from erosion issues using green infrastructure that also improves water quality. The resiliency district helps prioritize multi-benefit projects and coordinate projects that cross city boundaries.

Future Impact of Climate Change

Climate change is here and is already increasing air temperatures. According to the Western Region Climate Center data collection, California has experienced an increase in mean temperature in the past 10 water years (2013 to 2022) of 1.7 °F when compared to a 1981–2010 base period average temperature. The increase in temperature has not changed the mean annual precipitation but has likely increased the intensity and frequency of 1-day heavy precipitation events since the mid-20th century (Hicke et al. 2022). Precipitation extremes in California are dominated by atmospheric river events, which transport large quantities of water vapor and cause extreme precipitation in the higher-elevation watersheds. Atmospheric rivers are responsible for as much as half of California's annual precipitation and account for more than 80 percent of flood damages, including levee breaches in the Sacramento–San Joaquin Delta (Delta) (Corringham et al. 2019, Florsheim and Dettinger 2015). Furthermore, the rise in temperature is increasing the portion of precipitation that falls as rain instead of snow, which in turn affects snowpack volumes and spring-melt timing, as observed in a 2021 California Office of the State Climatologist hydroclimate report (California Office of the State Climatologist 2022). Warmer temperatures and changes in soil moisture contribute to more frequent and intense wildfires. Areas damaged by these wildfires have a greater potential for flooding associated with accelerated runoff and debris flows. Finally, sea levels along the central and southern California coast have risen more than 5.9 inches during the 20th century, and recent moderate tides and storms have produced extremely high sea levels (Bedsworth et al. 2018).

Based on climate change projections, temperature rise is expected to continue its course with its subsequent effects. There is growing evidence that the frequency and intensity of precipitation extremes will continue to increase in a warming climate, even where projected changes in mean precipitation are minimal or uncertain (Dettinger et al. 2016). Studies have demonstrated a link between the increasing intensity of atmospheric rivers along with warmer air and sea surface temperatures, which support greater atmospheric moisture and wetter, longer, and wider atmospheric rivers that can lead to higher precipitation rates (Dettinger et al. 2018,

Gershunov et al. 2019, Chen et al. 2023). The occurrence of extreme wet and extreme dry conditions and drastic transitions between the two – referred to as “climate whiplash” – may increase (Swain et al. 2018).

Although specific effects of climate change are still difficult to predict reliably, such changes could affect the magnitude and frequency of flood events and, in turn, increase infrastructure and property damage varying by location. For example, the outsized effect of atmospheric river events on precipitation and streamflow may be exacerbated by a warming climate, as a higher portion of mountain precipitation falls as rain instead of snow (California Department of Water Resources 2022). In cases where atmospheric rivers deliver substantial rain in watersheds with ripe snowpacks (that is, close to the melting point), substantial increases in peak streamflow and inflow to the Delta could result (Davenport et al. 2020). Increases in local precipitation intensity in developed urban areas may also increase flood risk, especially for local streams and stormwater systems that discharge to tidally influenced areas where higher water levels caused by sea level rise may impede drainage or back-up into storm drain systems. Rising sea levels mean that tidal impacts will be piled on a higher foundation, increasing the impacts of high tides and king tides, and even increasing the flood risk from small tides.

2. Resilience Benefits of Integrated Watershed Management Approach to Flood Risk Reduction

As California experiences more extreme droughts and floods, rising temperatures, overdrafted groundwater basins, and ecosystems under threat, an IWM approach to flood risk reduction helps create more resilient communities.

Resilience is the ability of a system to return to its natural state after encountering physical stress. It is not enough to be ready for a disaster. A resilient system must also have the capability to return to the original pre-stress state within an efficient timeline. Becoming resilient to more extreme floods, more intense droughts, and rising temperatures requires statewide coordination. California has taken the first steps in that direction with its 2020 *Water Resilience Portfolio*. It provides a blueprint for statewide resilience of California's water systems.

A key component of the *Water Resilience Portfolio* is addressing flood risk in an integrated manner. For flood systems, resiliency is the ability to adapt to and manage large flood events in light of future hydrologic uncertainty, climate change, and other stressors. Addressing flood risk through a regionalized approach has cross-cutting benefits for other long-standing challenges that are exacerbated by climate change, especially in degraded ecosystems, overdrafted groundwater basins, and for constrained water resources.

Ecosystems and Species

Floodplains are important ecosystems and periodic flooding is a necessary function of those ecosystems. Reconnecting floodplains and allowing transient floodwater storage brings positive benefits to riparian habitats. By integrating ecosystem restoration, multi-benefit flood infrastructure improvement projects benefit native species and their habitats.

Multi-benefit flood improvement projects re-integrate the natural benefits of flooding and can help meet a variety of ecosystem-related objectives. They can improve natural processes necessary to maintain floodplain habitats, including a diversity of flows, suitable sources of sediment, floodplain inundation, and broad river corridors that allow channel meandering. They can increase habitat and improve connectivity

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of floodplain habitats, including aquatic, riverine, wetland, riparian, and other habitats, as well as agricultural lands that provide important wildlife values. They can contribute to the recovery and sustainability of native species populations and overall biotic community diversity. Finally, they can reduce stressors to at-risk species by reducing invasive plant species and reducing isolation of floodplains by levees and fish passage barriers. IWM can help identify the most beneficial multi-benefit project opportunities in the watershed. The Yolo Bypass is one example of a multi-benefit flood management project. It can convey as much as 80 percent of the flow of the Sacramento River in wet years, while providing wetland habitat to migratory birds and fish, and preserving agricultural land that can be planted in the dry season.

Guided by State flood management planning, several multi-benefit projects have been implemented in recent years that demonstrate how flood management actions can contribute to ecosystem resilience in the Central Valley. For example, the Oroville Wildlife Area Flood Stage Reduction Project in the Feather River Flood Control Area reduced flood risk, increased the area of inundated floodplain, and restored riparian habitat by augmenting the existing system of inflow and outflow weirs to safely divert additional floodwaters through the Oroville Wildlife Area. Improved drainage from the project also led to reduced fish stranding.

Economic Resources

Resiliency is key to sustaining the economic resources that are necessary to the livelihoods and wellbeing of Californians. Reducing flood risk helps protect the general economic health of a region after a high-water event by reducing the likelihood of damage to property and speedy recovery.

Over the last 60 years, California has experienced many major flood events, resulting in many lives lost, multiple injuries, and billions of dollars in disaster claims to the Governor's Office of Emergency Services and the FEMA. Today, nearly 1 in 5 Californians live within a 500-year flood zone, exposing not just the population to the risk of flood, but also community infrastructure and economic resources that people depend on. These include residential and commercial structures, agricultural land, critical facilities such as schools, fire and police stations, hospitals, and electric and other utility infrastructure. The Southport Levee Setback Project in West Sacramento, for example, provides significant protection for local economic resources. The project will help the West Sacramento achieve a 200-year level of protection, shielding numerous homes, businesses, and critical services from the impacts of flood while also creating 120 acres of restored floodplain habitat. The project includes the planting of more than 77,000 trees to create a native riparian forest.

2. Resilience Benefits of Integrated Watershed Management Approach to Flood Risk Reduction

Economic resilience requires California to look to the future and see flood risk under the changing conditions of climate change. The State will need to adapt flood management approaches to mitigate the risks and consequences of severe flooding events.

Groundwater Basins and Water Resources

With less water storage in the form of snowpack, California must leverage the current water system along with new, sustainable approaches to accommodate longer and deeper droughts and more severe and frequent seasonal flooding. As outlined in the *Water Resilience Portfolio*, diverse and flexible water supplies strengthen water security across California. Coordinated management of floodwaters with water supply can support drought preparedness, sustainable groundwater management, and watershed resilience through actions such as reservoir reoperation, conjunctive management, and using floodwaters for Flood-MAR.

Developing a resilient flood system will require decision-making that does not just manage surface water, but rather the dynamic interchange of surface water and groundwater. Flood-MAR can provide multiple benefits, including wetland and riparian habitat improvement, subsidence mitigation, improved local groundwater subbasin retention, improved aquifer-to-stream accretions, and improved groundwater levels for domestic and public water supply. Flood-MAR helps California meet its Sustainable Groundwater Management Act goals, which require groundwater sustainability agencies to achieve sustainability by 2040. The Sustainable Groundwater Management Act also helps address subsidence in low-lying areas of the state resulting from overuse of groundwater; subsidence has negative impacts on flood conveyance facilities. Flood-MAR can be implemented at multiple scales, from individual landowners using existing infrastructure to divert floodwater, to the use of extensive detention and recharge areas, to the modernization of flood management infrastructure and operations.

Flood-MAR could become an important part of California's portfolio of water resource management strategies. In March 2023, Governor Gavin Newsom signed an executive order suspending restrictions on the diversion of flood stage water for recharging groundwater, which will make it easier for agencies to implement Flood-MAR projects for the first half of the year. Legal and permitting issues remain a potential barrier to the widespread implementation of Flood-MAR, one that the State Water Resources Control Board must play a role in addressing. DWR is currently studying the use of Flood-MAR concepts with a pilot project on the Merced River, in partnership with the Merced Irrigation District. The project will help in evaluating

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feasibility and cost effectiveness while providing strategies for overcoming planning and implementation challenges.

The State and U.S. Army Corps of Engineers (USACE) are also evaluating the potential for implementing forecast-informed reservoir operations in California watersheds where improved weather forecasting capabilities would allow reservoir operators to improve flood control, surface water and groundwater storage, and improve climate change resilience.

Racial Equity and Environmental Justice

Inequities in flood preparedness and response likely have far greater impact on unincorporated communities, including small, rural communities and those created through historical redlining compared to incorporated communities.

Redlining refers to the historical, systemic, and racist practice of classifying certain neighborhoods as “hazardous,” or not worthy of investment because of the racial makeup of their residents. Beginning in the 1930s, the Federal Housing Administration developed color-coded maps to rank the loan worthiness of neighborhoods for federally backed loans. Loan worthiness was based on a range of criteria, including the racial makeup of a neighborhood. These color-coded maps effectively barred Black residents from homeownership and the benefits of owning property, such as building generational wealth.

The impacts of redlining were seen during recent flooding events when small, rural communities such as Pajaro, Planada, and Wilton incurred the worst flooding impacts from a series of atmospheric river events from January through March 2023.

California is home to approximately 1,600 communities. Seventy percent are unincorporated, more than half have populations of less than 10,000, and almost half are economically disadvantaged. Approximately 40 percent are unincorporated and economically disadvantaged. Historical redlining has played a role in creating some of these inequities. To address them, flood management policy and investment decisions require special consideration for economically disadvantaged and small communities.

Unincorporated communities do not have the governing structure of an incorporated community. Incorporated communities have mechanisms in place to increase city revenues and can choose whether to apply for a grant or sign a binding memorandum of understanding, as well as provide project oversight. Unincorporated

2. Resilience Benefits of Integrated Watershed Management Approach to Flood Risk Reduction

communities must depend on other organizations, such as community-based organizations; joint powers authorities, such as water districts; and county governments to advocate for them and act on the community's behalf. For example, many unincorporated communities are protected by levees that are maintained by a local maintaining agency (LMA). An LMA can advocate for projects, apply for grants, sign memoranda of understanding, and provide project oversight on behalf of an unincorporated community. Unfortunately, most community-based organizations and many joint powers authorities do not have the technical expertise needed to develop a flood project grant application or advocate for a project on their own.

Historical redlining has created long-term adverse impacts that leave these communities at greater flood risk, resulting in low property values, a lack of community development, and a lack of infrastructure investment.

When flooding does happen, whatever wealth a disadvantaged community has built up is lost, and poor communities get poorer because federal aid for disaster recovery tends to go to communities with higher property values. Adverse health impacts are also greater in disadvantaged communities after a disaster, though the dynamics of long-term post-disaster issues are not well understood.

In general, incorporated communities created through historical redlining and many incorporated small and financially disadvantaged communities have lower property values, resulting in a smaller property tax base to help meet the needs of the community. Planning and implementing flood protection projects can be costly, and those projects may range in price from hundreds of thousands to hundreds of millions of dollars. These project costs can be shared among multiple agencies at the local, State, and federal levels. The process of applying for a State or federal grant to help fund a portion of the project typically costs tens of thousands of dollars with no guarantee funding will be awarded. Without a guarantee of funding, many communities are unwilling to spend their limited resources applying for grants, leaving these communities with less funding to invest in flood risk reduction.

3. Investment Needs and the Cost of Inaction

Addressing statewide flood risk to lives, property, and critical resources will require significant investment in addition to innovative funding approaches, political will, and increased public awareness. These investments must be weighed alongside the benefits of flood management projects. Meeting statewide investment needs requires a process that will identify, track, and periodically update California's highest-priority long-term outcomes, and prioritize flood management planning and actions accordingly to make the best possible use of limited resources.

Cost of Inaction

While the cost of carrying out comprehensive flood management measures over the next 50 years may be high, it must be considered alongside the amount of life, property, and economic activity that is currently under flood risk in California. In recent years major flooding events have caused billions of dollars in statewide damages. Heavy rains in 2017 caused more than \$2 billion in damages (Rice et al. 2017) and it is estimated that the January 2023 storms caused \$5 billion to \$7 billion in economic losses (Moody's Risk Management Services 2023).

In 2019, as part of preparing the white paper, *California's Flood Future: Recommendations for Managing the State's Flood Risk*, DWR completed a comprehensive analysis of the state's population and resources exposed to flood risk. This white paper shows that 4 million people live in a 100-year floodplain, and 8 million live in a 500-year floodplain. Most of these residents are in the South Coast Hydrologic Region, the Sacramento River Hydrologic Region, and the San Francisco Bay Hydrologic Region. Structures and their contents totaling \$487.4 billion as estimated by their depreciated replacement value are in the 100-year floodplain, and \$945.8 billion are in the 500-year floodplain.

Nearly 30 percent of the value of California's agricultural production, valued at \$12.3 billion, is exposed to flooding at the 100-year level, and approximately 35 percent, or \$14.6 billion, is exposed to flooding at the 500-year level. Exposed agricultural production is located mainly in California's Central Valley, which is comprised of the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions.

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California's critical facilities, including emergency response services that are particularly important during flood events, are also exposed to flood risk. These critical facilities are essential for the health and welfare of the whole population. They include hospitals; police and fire stations; emergency centers and schools; transportation systems; lifeline utility systems such as potable water, wastewater, oil, natural gas, electric power, and communication facilities; and high potential loss facilities such as nuclear power plants, dams, and military installations. In total, there are 9,490 critical facilities in the California's 100-year floodplains, and 13,656 in 500-year floodplains (California Department of Water Resources 2019).

The cost of inaction is high and growing fast. It will cost more to respond to and recover from flood events after they occur than to prepare and act now before the next event.

Statewide Investment Needs

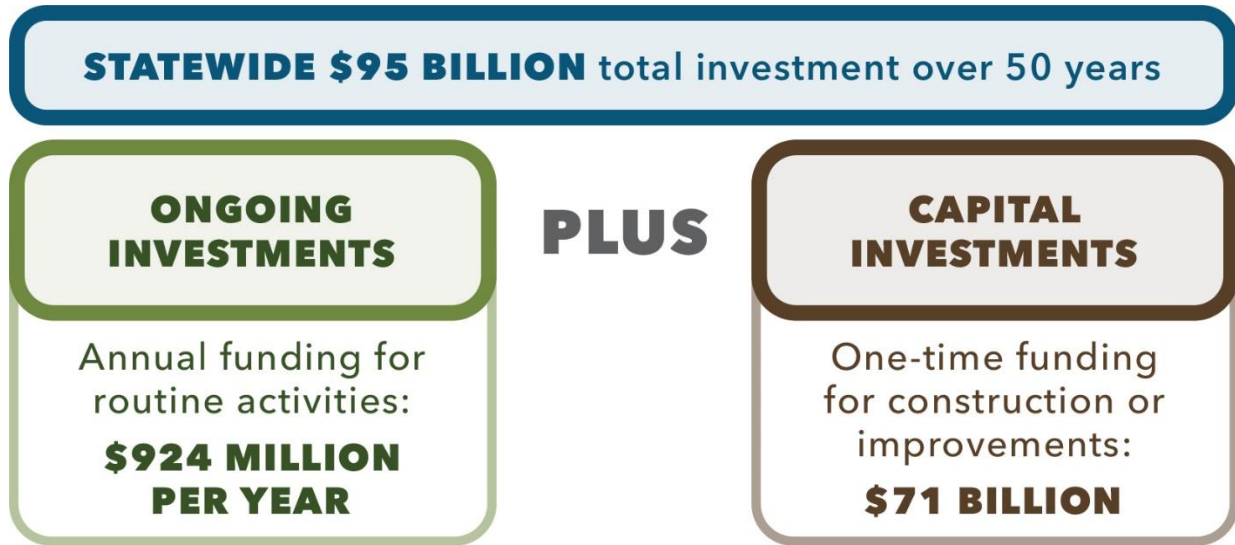
Reducing flood risk in California and increasing resilience will require sustained investment over time. Flood management investment is divided into two types: ongoing and capital. Funding for these two types of investments is summarized below. They are calculated and discussed separately because the investments are derived from different sources.

- **Capital investments:** Capital investments are made via physical flood system improvements and are described in terms of present value cost. They often require years to implement. Capital investments refer to improvements such as bypass expansion, weir and levee improvements, reservoir storage capacity increases, floodplain storage increases, levee setbacks, habitat reconnection actions, and large rehabilitation and replacement projects.
- **Ongoing investments:** Ongoing investments are described in terms of annual levels of investment. They refer to actions that reduce residual risk but must be carried out on an ongoing basis. Ongoing investments include activities such as annual operations and maintenance (O&M), annual emergency management, routine reservoir operation coordination, and annual state flood planning, analysis, and performance tracking.

Based on input from more than 240 agencies responsible for flood management in California, from CVFPP Regional Flood Management Plans (RFMPs), and the 2022 CVFPP Update, the need for flood investment is approximately \$71 billion in capital investment and \$924 million in ongoing investment annually over the next 50 years. In present value terms, this stream of future ongoing needs, in addition to capital

investment needs, represents a total investment need of \$95 billion, as summarized in Figure 2. Statewide investment need is not a funding plan, but an estimate of how much money will be needed to address flood risk over the next 50 years. Funding will need to come from current and potential future funding sources outlined below.

Figure 2 Statewide Flood Investment Need



Current Funding

Meeting the statewide investment need to achieve California’s flood risk reduction goals and societal values will require a marked increase from current funding levels. This may require an increase in funding from existing local, State, and federal sources, as well as new fund-raising mechanisms and authorities.

Existing Funding Mechanisms

Flood management in California is currently funded through local, State, and federal agencies. At the State level, funding is provided mainly through the State general fund, and through the issuance of general obligation bonds, which must be paid back over time. Local cities, counties, and flood management agencies pay for flood improvements through local taxes, property assessments, and fees. Federal agencies such as USACE and FEMA support flood management efforts through the federal budget.

State Funding Mechanisms

State funding makes up one of the largest components of total spending on flood management in California. The two main sources include general obligation (GO) bonds issued periodically, and the State’s general fund, which is collected from taxes,

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fees, and other revenue sources. Since 2007, California has spent approximately \$262 million annually on flood management through DWR's Division of Flood Management and Division of Multi-benefit Initiatives. Other departments, such as the California Department of Fish and Wildlife also fund multi-benefit flood management projects.

GO bonds periodically inject large amounts of funding into flood management. Most recently in 2018, Proposition 68 dedicated \$536 million out of a \$4.1-billion bond to flood management and repair and in 2014, Proposition 1 dedicated \$395 million out of a \$7.5-billion bond to flood management. In 2006, Proposition 1E, the Disaster Preparedness and Flood Protection Bond Act of 2006, dedicated \$4.09 billion entirely to flood management. These large injections of funding help finance capital investments in the state. But they require voter approval and dedicated political effort, making them less reliable as a long-term funding source.

Proposition 1E, for example, was made possible after the record setting flood events after Hurricane Katrina. Another bond on that scale would likely require a significant catalyzing event. DWR's Division of Flood Management GO bond expenditures have averaged \$210 million per year since 2007.

State general fund funding is more reliable in the long term but is generally distributed in smaller amounts than GO bond funding. DWR's Division of Flood Management general fund expenditures have averaged \$52 million per year since 2007. Annual State general fund expenditures are largely dedicated to ongoing O&M costs and maintaining existing flood infrastructure.

Local Funding Mechanisms

Local funding is the other main source of flood management spending in the state. Most flood management projects are implemented by local agencies, including cities, counties, and special districts dedicated to stormwater, reclamation, and flood management. Local districts receive money from State and federal sources and raise their own funds through local tax assessments and fees. Most local resources go toward ongoing expenses of operating existing infrastructure, with some resources dedicated to capital improvements.

Local districts are constrained in their ability to raise additional local funding for investment in flood management. Proposition 218, passed in 1996, requires two-thirds voter approval for any increase in assessments, property-related fees, or other general-purpose taxes, which are the main revenue sources for local agencies. Proposition 13 placed the same requirement on other local taxes. This high bar

3. Investment Needs and the Cost of Inaction

makes it difficult for local agencies to increase the revenue they have available for flood-related spending.

Federal Funding Mechanisms

Federal funding comes mainly from USACE and FEMA. The U.S. Department of the Interior's Bureau of Reclamation also contributes to some flood management actions.

USACE makes up the largest share of federal funding and funds particular projects through surveys, engineering and design, preconstruction programming, construction, and O&M. USACE is often involved as a partner in a project, with a cost-sharing requirement placed on a partner local or State agency. California and USACE have historically partnered with local agencies in the Central Valley for projects aimed at improving the SPFC and other projects of national significance. In fiscal years 2020 through 2022, California received an average allocation of \$500 million per year in the USACE Civil Works Budget (Department of the Army, Assistant Secretary of the Army for Civil Works 2019, 2020, 2021).

FEMA funds flood management actions through their Hazard Mitigation Grant Program, Flood Mitigation Assistance program, and the new Building Resilient Infrastructure and Communities Program. All these programs are aimed at mitigating losses from future floods and other natural disasters. FEMA also aids in responding to large-scale flood events.

Proposed New Funding Mechanisms

The following proposed new funding mechanisms are not currently in used in flood management, but they have potential to add additional fund-raising capacity. Their feasibility is currently being explored.

State River Basin Assessment or Tax

A river basin assessment or tax could be used to fund IWM. The river basin assessments would be assessed statewide with funding returned to the river basin where the assessment or tax originated. Such funding would be distributed across all water agencies in a river basin. Funding could support implementation of management actions previously identified in an integrated watershed resource plan or regional sustainability plan.

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Flood Insurance

A State flood insurance program would be a new funding mechanism that could provide a consistent, long-term funding source for flood management activities. Under a State flood insurance program, California would augment or replace the existing federal National Flood Insurance Program. Beyond providing risk coverage for property owners, a State flood insurance program would be set up to invest in infrastructure and other floodplain management activities that would reduce flood risk. Another version of State-provided insurance could be a local basin-wide insurance program. A local basin-wide insurance program could also be a companion program to a State flood insurance program.

No other state has implemented a replacement program that would enable the state to opt out of the National Flood Insurance Program. Creating a State flood insurance program would require legislative action. The law would have to specify how the program would be implemented, identify funding sources, and detail how much funding would be made available.

Enhanced Infrastructure Financing Districts

Enhanced infrastructure finance districts (EIFDs) could be used to fund local economic development projects in a city or county through tax increment financing. EIFDs went into use in 2014, and they could be used to fund new infrastructure, attract outside capital, or otherwise align public resources. EIFDs work by freezing tax revenues at a base year and using any future increases in tax revenue to pay for improvements or to pay back bond debt.

Public-Private Partnerships

Public-private partnerships (P3s) are long-term contractual agreements between a private party and a government entity. In a P3, the private party provides funding for a public asset or service that is backed by revenue generated from the asset or service. The private party bears significant risk and/or management responsibility in exchange for interest payments on the original funding. For example, a pilot project in the Yuba River watershed is using forest resilience bonds to leverage private investment to finance ecological restoration and wildfire resilience treatments. State agencies and local water agencies that benefit from improved water quality and reduced wildfire incidence in the watershed repay investors over time. It may be feasible to apply a similar approach to flood management activities at watershed scale.

Non-monetary Costs

Undertaking a statewide effort to address flood risk may include additional non-monetary costs or other unintended consequences. While these impacts are by no means certain, they are worth considering in a comprehensive manner when looking at flood management in California so that they can be understood and anticipated where possible.

Relocating people out of a floodplain, one approach to reducing flood risk, may expose them to risk of a different hazard. For example, moving people away from high-risk areas to less flood-prone areas may create added pressure on development at the border of urban and open spaces exposed to wildfire risk, or these moves may put new pressure on development in drier areas, exacerbating drought and water supply issues.

Additionally, relocation efforts and limits placed on development in floodplains may have adverse impacts on disadvantaged communities, creating environmental justice or equity concerns. Households that cannot afford to relocate might remain behind in a flood-prone community and see expansion and economic growth curtailed by land use restrictions. This scenario would be rare and would depend on local zoning restrictions but may require State programs and streams of funding to address.

Aside from the direct cost of investment in flood management infrastructure and activities, increasing the State's funding level to the funding needed over the next 50 years may require shifting resources from other policy areas, or increasing funding at a slower relative rate. Finding a new allocation of resources that prioritize flood investment may require new innovative funding and cost-saving initiatives across multiple budget areas.

4. Barriers to Implementation

Implementing comprehensive flood management in California is a complex undertaking requiring coordination and cooperation across a multitude of local, State, and federal agencies and regulations. The scale and complexity of addressing flood risk presents unique barriers to implementation of flood management actions.

Regulatory, Legal, Technical, and Managerial Barriers

Regulatory

More than 2,250 local, State, federal, and tribal agencies are involved in flood and water resources management activities in the state, creating a complex regulatory environment (California Department of Water Resources 2017). As a result, coordination among agencies can be so complicated that it is a barrier to cost-efficient, outcome-driven flood risk management. Main regulatory barriers include permitting requirements, overlapping jurisdictions, gaps in jurisdictions, and competing interests among land uses, natural resources, and flood risk management.

If not well defined, overlapping responsibilities for implementing management actions can lead to confusion, inaction, or outright conflict. For example, in locations where no government agency is responsible for maintaining unimproved reaches of creeks and rivers, there is a gap in knowledge about who is responsible for flood management. In these cases, an agency may not act to avoid an increase in liability. Another example of a flood management maintenance responsibility gap is on federal lands where local flood management agencies do not have jurisdiction. Conflicts among agencies over which category of management action to implement can lead to project delays. For example, vegetation removal along riparian corridors, wetland habitats near airports, fish passage and in-stream recharge can be difficult to implement because of conflicting regulatory requirements. If the conflict continues for long periods, project delays might lead to deferred projects, and may require additional capital investment.

Agencies experience conflict between flood risk management and land use decisions. Land use in California is managed at a local level through a patchwork of regulations that encourage and limit development. Historically, land use decisions have been driven by short-term revenue gains without considering the long-term cost of putting people and property at risk in floodplains. Although city and county flood management agencies have the potential to wield more influence in land use

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management, there is a schism between land use and flood risk management, resulting in unbalanced risks and rewards in floodplains. Limiting development in floodplains helps address the primary source of flood risk (people and property at risk) instead of merely addressing its symptoms. Limiting development also reduces the need for large-scale physical solutions. Because development brings increases in economic activity, it can be difficult to limit development in floodplains. It is important that local land use and flood managers coordinate to manage flood risk and make risk-informed decisions to balance risk and reward in floodplains.

Permitting and other federal requirements can also be restrictive to local agencies and sometimes conflict with one another. For example, costs associated with applying for and obtaining a permit from a regulatory agency, such as a Clean Water Act Section 404 permit from USACE, can include application fees, expensive technical studies, and mitigation fees. Permitting costs often are not scalable based on project size or scope, making compliance costs for small projects prohibitively expensive. Flood management and multi-benefit projects typically require multiple permits, which involves coordination with multiple regulatory agencies. Coordination can be a challenge and sometimes adds a significant amount of time and expense to a project. Delays in permitting processes can result in project delays, which may increase project costs or result in loss of time-sensitive grant funding. One example is the conflict between State environmental mitigation requirements and USACE levee vegetation policy. The State requires restoration of vegetation in riverine environments; USACE requires removal of vegetation from levees to improve stability.

Long-term liability and operational costs associated with maintenance activities may also prevent a barrier for some local agencies. For example, developers use local infiltration devices that comply with municipal separate storm sewer systems (MS4) permit requirements; these may result in groundwater contamination if the infiltration facility is not adequately maintained, and maintenance is costly. Also, in areas where legacy issues exist with no single identified responsible party, such as abandoned mines and sediments resulting from fires and timber harvests, local agencies can be held financially liable.

Another common challenge among water agencies that own and operate dams and reservoirs is the apparent conflict in managing flows for different purposes, such as flood management, water supply, recreation, and environmental uses. Dams and reservoirs are operated under strict rule curves and regulatory restrictions to meet multiple purposes. Water conveyance facilities such as irrigation canals and

aqueducts often become stormwater catchments and conveyances. Facility owners and operators may have to address changing conditions and updated demands for operational changes from special-interest advocacy groups to provide environmental or recreational benefits. These competing interests may stretch already limited funding and staff resources. This can result in conflicts between facility design purposes and new operations. These changes can cause operating agencies to be out of compliance with existing agreements.

Policies that clarify water management roles and responsibilities for local, regional, State, and federal agencies can improve coordination and access to funding across the large number of agencies and entities involved in water management.

Tribal Relations

The 104 federally recognized Tribes in California face their own unique challenges. Many of these challenges are a result of their unique government-to-government relationship to State and federal agencies. Nearly 89,000 acres of Tribal lands in California are exposed to a 500-year flood event (California Department of Water Resources 2019).

Across California, Tribal entities face similar funding and regulatory challenges as State and federal agencies, and they have additional limitations. For example, Tribes face challenges when securing funding when that funding is tied to their federally recognized status. These challenges can be exacerbated when dealing with off-reservation Indian Trust Asset (ITAs), and where ITAs are shared among more than one tribe. ITAs are properties held in trust by the U.S. government for a federally recognized Tribe. Additional coordination among all levels of government is necessary to address flood risk under these circumstances.

Coordination with federal and State agencies can also be challenging because of conflicts over jurisdictional authority and use of memoranda of understanding or memoranda of agreement can be viewed by Tribes as waivers of their sovereignty (Dolan 2013). Although the U.S. recognizes the sovereignty of Tribal entities, federal environmental regulations apply to reservation land and to management actions that will affect protected wildlife or the navigable waters of the U.S. For example, Tribes must obtain Endangered Species Act and Clean Water Act permits through the same processes as non-Tribal agencies. In addition, Tribal consultation and consideration of impacts on Tribal cultural resources are required during the California Environmental Quality Act process. To help Tribes, USACE provides outreach programs that provide assistance navigating the permitting process, including

providing informational brochures and Tribal liaisons who work as intermediaries between Tribes and the federal government (U.S. Army Corps of Engineers 2014a, 2014b). These resources provide Tribes with information about potential complications that might occur when permitting water resources management actions (U.S. Army Corps of Engineers 2012). USACE also outlines consultation recommendations for their staff members, and methods for interacting and engaging Tribes (U.S. Army Corps of Engineers 2013).

Scale – Local vs. Regional

Many smaller local agencies recognize the benefits regional entities with overarching authorities can provide, including independent and secure funding, a consistent and integrated approach to water management, and the ability to implement larger-scale programs and projects. But there are significant barriers to the formation of new entities, including Proposition 218 and local agency formation commissions.

There has been a move toward regional flood management planning through State-funded and locally led efforts such as the Regional Water Management Program and the CVFPP RFMPs. These efforts have brought together multiple agencies to coordinate planning and resource sharing at a regional scale. The volume of planning efforts currently required or encouraged by the State makes water resources management challenging. These planning efforts reflect the evolution of California's interests over time, resulting in plans that are separate, independent documents. This leads to inefficiencies and greater transactional costs that could be reduced or simplified through a more strategic and consolidated approach that also reflects the connectivity of water resources at the watershed scale. Consolidating State-mandated planning efforts at the watershed scale could reduce "planning fatigue" and provide an integrated, holistic approach to water management. Watershed-scale plans could consolidate planning efforts and support annual preparation of recommended investment priorities for each watershed in California.

In addition to flood management planning efforts, regional-scale partnerships among multiple agencies can facilitate emergency planning, emergency management activities, permitting, financing, O&M, repair, and restoration. Policies and regulations could include investment in human and technological resources to encourage a regional, systemwide, or river-basin-scale approach to water and flood management. Consolidating projects and pooling resources on a regional or watershed level would improve cost effectiveness and financial feasibility.

Financial

Historically, agencies have funded flood management actions through a combination of local fees, State bond funds, and State general funds. But sufficient and reliable long-term funding and restrictions placed on existing funding still present a challenge to delivering comprehensive flood management in California. Changes to federal cost-sharing requirements, lengthy planning processes, and regulatory requirements that are subject to revision exacerbate these funding challenges. For example, at the local level, the requirement for two-thirds voter approval for any new assessments under Proposition 218 has limited options for local fundraising. This limitation has caused many local agencies to depend on developer fees to fund their ongoing services, making the agencies' performance of their missions vulnerable during economic downturns. Proactive planning to fund long-term, sustainable investment in flood management is necessary to ensure agencies can maintain aging infrastructure.

Funding for ongoing flood infrastructure maintenance presents a particular challenge. O&M and repair activities are critical for effective flood management that is sustainable over the long term as climate conditions change. Robust O&M includes a constantly improving levee inspection program that identifies deficiencies and maintenance issues. In the past, O&M of the state's flood infrastructure has been chronically underfunded. Programs such as DWR's Flood Maintenance Assistance Program have helped to address this issue for SPFC levees, but more investment is needed throughout the state.

Implementation of some management actions is limited by restrictions on the use of agency funds. For example, many agencies have restrictions on spending revenue collected from one zone in another zone in their jurisdiction. Other agencies are prohibited from sharing the cost of an action that would benefit a local community because it is perceived as spending revenue outside of an agency's service area. Also, some bonds and funding programs limit the type of management action that can be implemented. These constraints force a focus on action rather than intended outcomes, resulting in silo-type planning and management in individual departments or agencies. This discourages development and implementation of multi-purpose water resources management that could result in multiple benefits and more effective use of resources. These restrictions may also limit the geographic location where funding can be used (for example, only within a specific assessment district). This is particularly problematic for flood management agencies because the best flood management solution or the origin of a flood management problem may lie outside the assessment district boundary.

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Proposition 218, enacted in 1996, presents a particular challenge to local flood management agencies. It imposes voter approval requirements and other restrictions on the levy of new taxes, assessments, or fees, and increases in certain existing taxes, assessments, and fees. These restrictions are formidable hurdles for new or existing local governments to overcome and limit the amount funding that local entities can raise.

Environmental

Environmental and regulatory process changes have placed additional responsibility for ecosystem health on flood management agencies, adding new layers of complexity that can become a barrier to delivering flood management actions. Floodplains and ecosystems exist in the same riverine corridors and require integrated management; their function, benefits, and failures are closely intertwined. As such, flood management agencies may be responsible for preventing ecosystem degradation, and for enhancing an ecosystem. This is a challenge for existing flood management systems that were designed before there were concerns about ecosystem protection. Also, in many areas of California, urbanization has encroached into the floodplain, constraining flood and environmental systems. The intertie between floods and the environment and the complex nature of environmental compliance in California has affected flood risk reduction efforts. Many flood management agencies in the state are taking on greater liability associated with flood risk because of the cost and time associated with environmental compliance. Some agencies are forced to choose between the legal ramifications associated with not complying with permit requirements or the cost of damages resulting from loss in system capacity.

Time and money spent complying with environmental laws, compounded by the need to coordinate with multiple regulatory agencies that often have competing responsibilities and objectives, can drain local agency resources.

Misperception of Risk and Priority

Flood management is typically viewed as lower priority than other critical statewide policy areas and other natural disaster mitigation actions. As a result, flood management may not always receive the attention, funding, and political determination necessary to meet California's flood management goals. Competition at all levels of government over limited funding to address a broad array of societal needs can mean that flood management competes with education, transportation, and other statewide priorities for funding. While flood management usually receives

a boost in public support after large-scale flood incidents, such as Hurricane Katrina in 2006, it tends to decrease in priority without these reminders.

Because of its nexus with environmental resources and water supplies (especially groundwater recharge), flood management should be an integral part of planning efforts. Flood management was not initially included in integrated regional water management planning and grant guidelines. This has changed somewhat with the development of RFMPs in the Central Valley.

Social and Cultural Considerations

Racial Equity and Environmental Justice

Because of historical structural racism, communities of color are challenged by a lack of resources and increased flood risk. For example, flooding caused by a series of atmospheric rivers in early 2023 had disproportionate and devastating impacts on the small, unincorporated communities of color in Planada in Merced County, and Pajaro in Monterey County. Both communities had less than a 100-year level of flood protection. Many residents, already financially vulnerable before the floods, will require extended community aid to recover and rebuild.

Communities of color also tend to suffer disproportionately from a range of environmental justice issues, such as air quality, water quality, and land pollution, which accentuates the interlinked challenges of land use and environmental resource management. While communities of color tend to have higher flood risk, they also have lower land values, which translates to fewer resources available to invest in addressing flood risk, and greater difficulty demonstrating that the benefits of a project outweigh its costs in a benefit-cost analysis. Historically, communities of color have had less power in decision-making processes that determine where investments should go.

According to DWR's Disadvantaged Community (DAC) Mapping Tool, there are 558 disadvantaged communities in California (California Department of Water Resources 2023). Disadvantaged communities are those where the median household income is less than 80 percent of the California average. This is particularly common among small, rural communities. Larger urban areas also contain disadvantaged communities. But large populations in urban areas provide a larger funding base for flood management actions than isolated communities in rural areas. New types of agencies have developed in urban areas to address flood risk and coordinate among

entities. Smaller, rural communities do not have the economies of scale to implement these types of measures.

Because of the differences in ability to pay for investments that lower flood risk at the community level, and relocate out of flood zones, flood risk in California disproportionately affects disadvantaged communities. In recent years, several State and federal programs have been designed to address this incongruity. For example, the federal Justice40 initiative intends to deliver 40 percent of all federal investments in climate resilience and clean energy to disadvantaged communities. This includes funding from FEMA hazard mitigation grants and USACE funding. California is placing a new emphasis on addressing environmental justice through its investments in planning efforts to advance social equity, such as through transformative climate communities, regional climate collaboratives, and the Integrated Climate Adaptation and Resilience Program. California has funding criteria in its existing programs aimed at ensuring responsibility for reducing flood risk does not fall disproportionately on disadvantaged communities.

Communicating Uncertainty

Climate change and its associated effects of changing precipitation patterns and sea level rise are affecting existing and planned flood management actions, resulting in increased costs and uncertainty regarding risk.

Individuals have a complex perception of risk that is based on experience. For example, individuals are more willing to pay for flood insurance if they have experienced a flood event (Zhai et al. 2006). Decision-making and attitudes about risk are affected by an individual's perceptions about whether they can control risk, whether they have accepted risk voluntarily, and whether they understand a risk's potential to be catastrophic (Slovic 1987). Studies show that individuals forget a portion of the costs resulting from damage each year after a crisis, indicating that the severity of the event is difficult to quantify and keep in the public consciousness as time progresses (Deegan 2007). Thus, as memory of the event fades, the individual's perception of risk fades and the willingness to pay decreases.

A risk communication plan can directly address barriers that prevent the public from supporting flood risk reduction measures. Risk communication plans and programs will more effectively influence action if they are communicated through multiple sources and multiple forms and are conveyed by an expert or representative of a trusted institution (Mileti 1999).

5. Flood Protection in the Water Resilience Portfolio

The following is a list of proposals from the *Water Resilience Portfolio* that deal with flood protection:

- **11.** Support the expansion of wetlands, including mountain meadows, to create habitat, filter runoff, buffer floods, and recharge groundwater.
 - **11.3** Support expansion of multi-benefit floodplain projects across the Central Valley and coastal regions, including projects that reduce flood risk and restore or mimic historical river and floodplain processes, such as the Yolo Bypass and Cache Slough Partnership program.
- **25.** Help regions prepare for new flood patterns.
 - **25.1** Support implementation of the CVFPP and its state systemwide investment approach to protect urban areas, small communities, and rural areas; improve O&M of the flood system; better coordinate reservoir operations; improve flood emergency response system; and integrate natural systems into flood risk reduction projects.
 - **25.2** Review State, federal, and local permitting processes for flood risk reduction projects and O&M and recommend ways to improve permitting processes.
 - **25.3** Research and explore ways to provide flood insurance beyond the national program.
 - **25.4** Update and refine the regional flood management strategy in the CVFPP to account for the projected impacts of climate change in order to protect vulnerable communities and infrastructure and restore floodplains along the San Joaquin River and its tributaries.
 - **25.5** Facilitate interagency annual dam, flood, debris flow, and wildfire emergency tabletop exercises with emergency responders and local communities, focusing on testing emergency notification protocols, sirens and warning systems, and evacuation route planning.
 - **25.6** Augment financial assistance and expand state technical assistance for communities to update their local hazard mitigation plans and general plans to meet State adaptation requirements at least once every five years by prioritizing disadvantaged and flood-vulnerable communities. Updates should account for climate change and forecasted population growth.

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- **25.7** Provide hydraulic and economic modeling assistance to update the flood hazards within the California State Hazard Mitigation Plan, review the floodplain management elements of local hazard mitigation plans, and support flood loss avoidance studies following federally declared disasters. These actions will maximize eligibility for federal financial assistance before and after disasters.
- **25.8** Partner with urban communities to improve existing and identify new flood risk reduction projects to meet or exceed State and federal requirements.
- **25.9** Partner with federal, Tribal, and local agencies to support small community flood risk reduction projects in vulnerable communities in the Central Valley and elsewhere.
- **25.10** Make available to the public bathymetric analyses of channels in the Delta to help local flood control agencies, landowners, and habitat managers better understand levee condition, habitat types, and channel siltation.

6. Recommendations

Implementing an IWM approach to flood management in California will require orchestrated action at the local, State, and federal levels. Outlined below are recommended actions to overcome six identified categories of barriers.

Regulatory

- Review existing governance structures to identify overlapping authorities. Collaborate with local, State, federal, and Tribal partners to revise agency missions, authority, and reporting to allow for public agencies to coordinate and invest in integrated water resources management services at a river basin or watershed scale more effectively.
- Modify and align the delivery of public services related to flood and water management around a consistent set of intended outcomes tied to the societal values of public health and safety, a healthy economy, ecosystem vitality, opportunities for enriching experiences, and equity and social justice values, and track results over time.
- State and federal agencies can take the lead by aligning their policies, regulations, programs, and plans to streamline processes toward efficient achievement of IWM goals and objectives. Reducing the number of regulatory agencies involved is one way to streamline the process and reduce transactional costs.
- Coordinate management of floodwaters with water supply to support drought preparedness, sustainable groundwater management, and watershed resilience through actions such as reservoir operations, conjunctive management, and using floodwaters for Flood-MAR.
- Establish a collaborative forum for early agency engagement and coordination where project proponents, whether State or local, can share progress and obtain agency input.
- Align land use planning with water management planning. Pursue legislation that more directly links land use with water and flood management. Encourage land use planning practices that reduce the consequences of flooding. Avoid flood risk escalation on strategically located floodplains. Help local agencies implement non-infrastructure land management solutions, such as converting land into a detention basin or a spreading ground by providing funding in the form of low-interest loans.

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- Remove obstacles within government control that hinder effective local flood and water management. This includes streamlining the permitting process to reduce regulatory hurdles for flood and water management project implementation and maintenance activities.

Scale – Local vs. Regional

- Promote a holistic approach to flood and water management by developing and implementing a comprehensive vision for planning, funding, and permitting projects at the regional or watershed scale. Investigate river basin or watershed scale assessments, governance structures that encourage collaboration, and consolidated planning and reporting requirements. It is important that the lessons learned from integrated regional water management and other regional partnerships are incorporated to more effectively collaborate, plan, and implement at a regional scale.
- Establish intra-agency, basin-specific task forces of high-level decision-makers and staff from local, State, and federal agencies, Tribes, and other partners to:
 - Explore, create, and implement regional-scale and long-term multi-benefit programs for planning, implementation, and long-term management.
 - Connect single-purpose projects to broader, regional actions, leverage funding sources, and align program priorities.
- Explore the feasibility of a regionally based multiple-objective operation, maintenance, repair, replacement, and rehabilitation program.
- Plan and implement programs at all levels of government in manageable three- to five-year cycles that promote performance tracking, continuous learning, and adaptation.
- Complete watershed-based climate change vulnerability and adaptation assessments.

Financial

- Obtain increased, stable, and consistent State and federal funding for flood management and multi-benefit projects, capital projects, and ongoing investments. Commit to consistent, ongoing public investment designed to deliver specific long-term outcomes that contribute to societal goals statewide.
- Pursue new GO bond funding that promotes flexibility in funding flood management projects with single or multiple societal benefits.
- Leverage federal cost-share opportunities including USACE, congressional appropriations through annual Water Resources Development Act funding,

and FEMA (for example, the Building Resilient Infrastructure and Communities Program). Advocate at the federal level for funding to support programmatic implementation of the CVFPP over multiple decades.

- Align the State budget process with the goals established in the *Water Resilience Portfolio* and align various funding programs to best advance multi-benefit projects and other statewide priorities. Invest in flood damage reduction projects that are economically justified and develop policies that provide clear public benefits such as mitigating effects of climate change, improving public safety, and supporting sustainable ecosystems.
- Combine watershed-scale risk assessments with long-term economic evaluations to rank investment priorities.
- Revise Proposition 218 requirements for flood management agencies. Allow flood management agencies an exception similar to the exception provided to water, sewer, and refuse agencies that will assist in meeting funding needs, help prevent deferred maintenance, and enable agencies to put management actions in place.
- Continue to provide financial and technical assistance for programs such as the Flood Maintenance Assistance Program to decrease deferred maintenance in flood management systems statewide.

Environmental

- Initiate memoranda of agreement or memoranda of understanding between DWR and regulatory agencies consistent with the [Cutting Green Tape](#) initiative to standardize and streamline some permitting elements for multi-benefit projects and provide greater transparency of the regulatory process.
- Incorporate the urgency of public safety (i.e., risk to life and critical infrastructure) into environmental laws by allowing projects with public safety benefits to be prioritized during permitting processes. Prepare cooperative agreements for permit reviews among regulatory agencies to increase efficiency.
- Align agency resources to encourage the use of natural and working lands in nature-based solutions. Explore and develop landscape-scale agricultural sustainability strategies alongside environmental conservation strategies to promote sustainable floodplain land uses that are compatible with periodic flooding and adaptive to climate change.

Misperception of Risk and Priority

- Increase public and policy-maker education about flood risk and flood preparedness to improve public support for funding measures and project implementation. Develop a risk awareness campaign for different regions in California that include information about the basic principles of flood risk, how land use affects flood risk, and the likelihood and consequences of flood risk to lives, property, the economy, and the environment.
- Provide technical assistance with assessing and understanding the impacts of climate change in different areas of the state and for different flood types. Work with the Governor's Office of Planning and Research to integrate advancements in climate vulnerability assessments with flood planning efforts.
- Continue to periodically update best available science, tools, and data to improve understanding of the condition, performance, and response of the flood system.

Social and Cultural Considerations

- Work with vulnerable communities and community groups to better understand inequities in flood management. Develop baseline information to understand the disproportionate effect of flood risk to vulnerable communities, communities of color, and disadvantaged communities. Develop strategies to eliminate current inequities and prevent any future inequities.
- Collaborate with the Delta Adapts effort and related vulnerability assessment tool development to understand and identify socially vulnerable populations in California. Work with USACE to develop strategies that consider social vulnerability and community resilience in flood project planning and decision-making.
- Augment financial assistance and expand technical assistance for disadvantaged, flood-vulnerable communities to update their local hazard mitigation plans and general plans to meet State adaptation requirements at least once every five years. Updates to these plans should account for climate change and forecasted population growth.

Related Resource Management Strategies

- Urban Stormwater Management.
- Reservoir Reoperation.

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8. Useful Web Links

Cutting Green Tape Initiative

<https://resources.ca.gov/Initiatives/Cutting-Green-Tape>

Water Resilience Portfolio

<https://resources.ca.gov/Initiatives/Building-Water-Resilience/portfolio>

