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State of California
California Natural Resources Agency
Department of Water Resources

California Water Plan

Update 2018

PUBLIC REVIEW DRAFT

December 2018

Edmund G. Brown Jr.
Governor
State of California

John Laird
Secretary for Resources
California Natural Resources Agency

Karla Nemeth
Director
Department of Water Resources

Reviewer's Guide

This is the public review draft of California Water Plan Update 2018. Comments received on this draft by January 21, 2019, will be used to inform the final Update 2018.

Where to Find This Draft

The public review draft is posted online in PDF format at:

<https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/PRD/California-Water-Plan-Update-2018-Public-Review-Draft.pdf>

How to Comment

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What to Review

The following are recommendations for what to focus on during your review:

- **Completeness of information:** In general, does the text say all it should say? Is all information present that an average reader might need? Is it appropriately presented?
- **Organization of information:** Does any portion of the text cause readability issues because information is presented in a confusing sequence, or because it is difficult to tell how sections and subsections relate to one another?
- **Factual accuracy:** Is anything in the text incorrect? Does any information need additional attribution to a specific source?
- **Primary messages:** There are several primary messages in Update 2018; for example, modernizing California's green and grey infrastructure for water management; sustainability as it relates to societal values; better alignment, accountability and adaptive decision-making through improved tracking and reporting; improving regulatory outcomes; and need for sufficient and stable sources of funding. To what extent do the messages align with your or your organization's thinking? What, if anything, can be added or changed to make the messages more compelling?
- **Relevance to you/your organization:** Update 2018 was prepared to support the water community's planning, decision-making, and water management. Thinking about your planning and decision-making processes, what, if anything, would you add, remove, or change to make Update 2018 more useful to you or your organization?

California Water Plan

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This front matter (of the public review draft) is a placeholder. The final California Water Plan Update 2018 will show the complete list of those whose invaluable work and participation made possible this California Water Plan update, including the State Agency Steering Committee, Policy Advisory Committee, and Tribal Advisory Committee.

Developing the water plan requires the knowledge, work, expertise, research, and technical advice of scores of individuals and groups — governmental, private, and nonprofit — representing multiple disciplines and many State agencies; federal, Tribal, regional, and local interests; and environmental, agricultural, and urban stakeholders.

Acknowledgments

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Note: Titles and terms in red within this document correspond to links provided in the section “Useful Web Links.” The Update 2018 Glossary is listed in the section “Supporting Documents.”

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Acronyms and Abbreviations

AB	Assembly Bill
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
CDFW	California Department of Fish and Wildlife
Delta	Sacramento-San Joaquin Delta
DWR	California Department of Water Resources
EIFD	enhanced Infrastructure finance district
GHG	greenhouse gas
GO bond	general obligation bond
HSP	Healthy Soils Program
maf	million acre-feet
SASC	Water Plan State Agency Steering Committee
SGMA	Sustainable Groundwater Management Act
Update 2013	California Water Plan Update 2013
Update 2018	California Water Plan Update 2018

Executive Summary

California Water Plan Update 2018 (Update 2018) provides recommended actions, funding scenarios, and an investment strategy to bolster efforts by water and resource managers, planners, and decision-makers to overcome California's most pressing water resource challenges. It builds on progress made in *California Water Plan Update 2013*; reaffirms State government's unique role and commitment to sustainable, equitable, long-term water resource management; and introduces implementation tools to inform sound decision-making.

Challenges to Sustainability

For generations, California has represented much more than a place. It invokes images of exceptionally satisfying ways of life and well-being coupled with enduring, world-renowned natural resources. Yet the people and ecosystems of California are increasingly vulnerable to extremes that underscore the need to bolster planning and infrastructure to prepare for the effects of climate change. Update 2018 documents challenges that significantly affect the state's ability to manage water resources for sustainability. Among them:

- One in five Californians lives in a floodplain. More than \$580 billion in assets is at risk.
- Thousands of Californians lack access to safe, clean water and adequate sanitation.
- Many ecosystems and the services they provide continue to decline.
- Groundwater overdraft and unreliable water supplies persist in some regions.
- Extensive tree mortality has contributed to the most destructive wildfires in the state's history and in devastating mudslides.
- Climate change is exacerbating many critical challenges, including flood risk, reduced water supply, and wildfire.

Some communities that are proactively planning and investing in water management strategies have shown resilience. At the same time, many communities remain vulnerable — those with limited resources and insufficient technical, managerial, and financial capacity to manage water resources.

Bold Action to Overcome Challenges

This plan recommends significant additional investment in infrastructure and ecosystem improvements to overcome challenges to sustainability. It recommends actions to resolve systemic and institutional issues that contribute to many of the state's water challenges.

The recommended actions, listed in Table ES-1, are organized according to six goals for sustainability:

- Improve Integrated Watershed Management.
- Strengthen Resiliency and Operational Flexibility of Existing and Future Infrastructure.
- Restore Critical Ecosystem Functions
- Empower California's Under-Represented or Vulnerable Communities
- Improve Inter-Agency Alignment and Address Persistent Regulatory Challenges.
- Support Real-Time Decision-Making, Adaptive Management and Long-Term Planning.

The plan also describes scenarios to leverage existing funding for California water management and discusses some additional concepts that can inform funding decisions over the long term.

A Shared Vision for California's Water Future

Update 2018 envisions a future where all Californians benefit from reduced flood risk, more reliable water supplies, reduced groundwater depletion, and greater habitat and species resiliency. It suggests actions to help align decision-making processes, track outcomes and adaptively manage programs and investments to achieve the sustainability goals.

Table ES-1 Update 2018 Recommended Actions Organized by Goal

Goal	Action #	Description
Improve Integrated Watershed Management	1.1	Address the Water Management Needs of California's Most Vulnerable Communities
	1.2	Support the Role of Working Landscapes
	1.3	Promote Flood Managed Aquifer Recharge
Strengthen Resiliency and Operational Flexibility of Existing and Future Infrastructure	2.1	Improve Infrastructure and Promote Long-Term Management
Restore Critical Ecosystem Functions	3.1	Address Legacy Impacts
	3.2	Facilitate Multi-Benefit Water Management Projects
	3.3	Quantify Natural Capital
Empower California's Under-Represented or Vulnerable Communities	4.1	Improve Tribal Involvement in Regional Planning Efforts
	4.2	Engage Proactively with Disadvantaged Community Liaisons
Improve Inter-Agency Alignment and Address Persistent Regulatory Challenges	5.1	Incorporate Ecosystem Needs into Water Management Infrastructure Planning and Implementation
	5.2	Streamline Ecosystem Restoration Project Permitting
	5.3	Address Additional Regulatory Challenges
Support Real-Time Decision Making, Adaptive Management, and Long-Term Planning	6.1	Facilitate Comprehensive Water Resource Data Collection and Management Program
	6.2	Coordinate Climate Science and Monitoring Efforts
	6.3	Improve Performance Tracking
	6.4	Develop Regional Water Management Atlas
	6.5	Bolster Reporting Requirements for State Financial Assistance
	6.6	Expand Water Resource Education
	6.7	Explore Ways to Develop Stable and Sufficient Funding

Chapter 1. California Water Today

This chapter describes geophysical and water-use conditions that affect water resource management and planning in California today. (For more detailed information about California’s water resources, see Chapter 3, “California Water Today,” in Volume 1 of *California Water Plan Update 2013* [Update 2013].)

Setting the Context for California Water Plan Update 2018

The state relies on a complex network of water storage and conveyance systems to control, capture, and store water when it is available in the wet winter and spring for use during the dry summer and fall. Many of these systems reflect World War II-era investments and were not designed to meet today’s environmental requirements or Californians’ current values and evolving needs. Deferred maintenance and the effects of a changing climate are affecting the ability of these systems to reliably meet those needs.

Since Update 2013, California has endured an unprecedented multi-year drought that threatened the water supplies of communities and residents; decreased agricultural production in many areas; worsened groundwater overdraft and subsidence, with associated impacts on essential water, transportation, and other utility infrastructure; and harmed fish, wildlife, and ecosystems. The drought was ended by record-breaking rainfall that underscored the vulnerability of California’s aging flood and water management infrastructure and fragile ecosystems.

State Initiatives and Investments

In the face of those risks, consequences, and vulnerabilities, California has adopted substantive policy changes and made significant investments in water resource infrastructure and watershed management improvements. Many of these plans and initiatives informed California Water Plan Update 2018 (Update 2018). They are listed in the “**Featured Companion State Plans**” section of Update 2018.

- The *California Water Action Plan*, released by Governor Brown’s administration in January 2014 and updated in January 2016, describes a set of essential actions intended to lay the foundation for sustainable water management in the coming decades. Actions recommended in Update 2018 would significantly contribute to achieving three of the plan’s primary goals: providing a more reliable water supply for farms and communities, restoring important wildlife habitat and species, and improving the resiliency of the state’s water systems and environment.
- The *Sustainable Groundwater Management Act of 2014* (SGMA) set in motion a transformation in governance, planning, and management of groundwater basins in California. SGMA requires local agencies in high- and medium-priority basins to halt overdraft and bring groundwater basins into balance. In a major step toward achieving SGMA’s goals, 99 percent of affected basins are now covered by a local groundwater sustainability agency. Proactive management will need to continue for decades to keep delivering the intended outcomes.
- In the wake of the Lake Oroville spillways incident in February 2017, Governor Brown announced a **four-point plan** to bolster dam safety and flood management. Consistent with that

plan, California is carrying out a suite of initiatives to ensure California remains a leader in dam safety.

- **California WaterFix** is a science-driven upgrade to improve the reliability and sustainability of California's aging water system and protect water supplies for 28 million Californians and 3 million acres of farmland. The project will also restore more natural river flows and benefit the fragile Sacramento-San Joaquin Delta (Delta) ecosystem. WaterFix marked key milestones in 2017 and 2018, and the State is working to advance the project through the remaining steps needed to begin construction.
- Senate Bill 606 (Hertzberg) and Assembly Bill (AB) 1668 (Friedman), signed by Governor Brown in May 2018, build on the ongoing efforts to "make water conservation a California way of life." Together, the two bills establish a foundation for long-term improvements in water conservation and drought planning that will help the state adapt to climate change and resulting longer and more intense droughts. These bills establish new state agency authorities and local agency responsibilities, facilitating permanent water use efficiency improvements.
- **California EcoRestore**, initiated by the California Natural Resources Agency in 2015, is advancing the restoration of at least 30,000 acres of Delta habitat by 2020. Progress on this initiative continued to accelerate in 2018, with five significant habitat restoration projects breaking ground. A first-of-its-kind request for proposal mechanism was developed for the California Department of Water Resources (DWR) Fish Restoration Program, facilitating public-private partnerships aimed at restoring thousands of acres of tidal habitat.
- The California Department of Fish and Wildlife's (CDFW's) **Regional Conservation Investment Strategies Program** is using a science-based approach to identify conservation and enhancement opportunities. Created by AB 2087 (Levine, 2016), the program sets forth a voluntary regional planning process to improve conservation outcomes.
- *California Biodiversity Initiative: A Roadmap for Protecting the State's Natural Heritage* is aimed at securing the future of California's biodiversity while supporting the mutually beneficial relationship between the environment and the economy. Released by the California Natural Resource Agency, California Department of Food and Agriculture, and Governor's Office of Planning and Research in September 2018, the initiative calls for identifying what needs to be protected and developing strategies to protect, manage, and restore those ecosystems. Monitoring progress will help to inform decision-making and to adapt management actions as efforts increase in scope and accelerate. Collaboration across resource management sectors and communities is essential to the success of this initiative.
- The State Water Resources Control Board is **in the process of updating** the 2006 *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* with revised water quality control measures and flow requirements needed to protect beneficial uses in the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) watershed. The plan is being updated through two plan amendments: The first focuses on San Joaquin River flows and southern Delta salinity, while the second plan amendment focuses on the Sacramento River and its tributaries, Delta eastside tributaries, Delta outflows, and interior Delta flows.

To complement the Bay-Delta plan update effort, DWR and CDFW are developing voluntary agreements among stakeholders in the Sacramento and San Joaquin river watersheds that, if implemented, will improve instream habitat conditions for fisheries.

- The California Department of Food and Agriculture is implementing the **Healthy Soils Program** (HSP) that stems from the California Healthy Soils Initiative, a collaboration of State agencies and departments promoting the development of healthy soils on California's farmlands and rangelands. An HSP incentive program provides financial assistance for implementation of conservation management to improve soil health, sequester carbon, and reduce greenhouse gas (GHG) emissions. This program includes demonstration projects that build soil organic carbon and reduce atmospheric GHGs by funding on-farm demonstration projects and creating a platform that promotes widespread adoption of HSP conservation management practices.
- Proposition 1 — the **Water Quality, Supply, and Infrastructure Improvement Act of 2014** — was approved by the voters in 2014 and authorized \$7.5 billion to finance safe drinking water and water-supply reliability programs for California. The water bond provides public funding for public benefits associated with new surface water and groundwater storage projects; regional water-supply reliability; sustainable groundwater management and cleanup; water recycling; flood management; water conservation; and safe drinking water, including specific allocation of funds for disadvantaged communities.
- Proposition 68 — the **California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018** — was approved by voters in June 2018 and authorizes \$4 billion in general obligation bonds for State and local parks, environmental protection and restoration projects, water infrastructure projects, and flood protection projects. Items related to water management include river, creek, and waterway recreation and improvements; ocean, bay, and coastal protection; clean drinking water and drought preparedness; groundwater sustainability; flood protection and repair; regional sustainability for drought and groundwater; and water recycling. The measure requires 15 to 20 percent of the bond funds be dedicated to projects in communities with median household incomes of less than 60 percent of the statewide average.

Even with these important State initiatives, California still faces challenges from flooding, unreliable or unsafe water supplies, groundwater overdraft, habitat degradation, and species declines. As described in Chapter 2, many of California's ecosystems continue to decline, and much of the state's water supply and flood protection infrastructure either no longer functions as intended or has exceeded its design life (California Department of Water Resources 2014). If these trends continue, the state's water resources and prosperity will remain vulnerable to the consequences of droughts, floods, fire, environmental degradation, species extinctions, and climate change.

California's Diverse Water Supplies and Uses

Precipitation, specifically snowpack and snowmelt from the Sierra Nevada, is the primary source of water supply and natural groundwater recharge in California — though it varies from place to place, season to season, year to year. The timing, quantity, and location of precipitation in California are largely misaligned with agricultural and urban water uses. California's water is also managed for restoring and enhancing terrestrial, wetland, and aquatic ecosystems. Healthy ecosystems and watersheds provide benefits — such as better air quality, recreational opportunities, flood attenuation, groundwater recharge, and natural water filtration — to all Californians.

California residents are heavily dependent on healthy, forested watersheds. The federal government manages approximately 47 percent of California's 100 million-plus acres, which makes it the largest land manager in the state (California Department of Water Resources 2014). These watersheds provide much

of the state's water supply; they also protect water quality and buffer downstream regions from the severity of flooding. Water originating in these forests has economic value that equals or exceeds that of any other forest resource (Krieger 2001) such as timber, grazing lands, or outdoor recreation.

The statewide water balance for Water Years 2011–2015 (Figure 1-1) demonstrates the state's highly variable water use and water supply in the face of annual hydrologic extremes. California's water resources support cities and communities, agriculture, and the environment. *Applied water* refers to how water was applied and used by urban and agricultural sectors and was dedicated to the environment. *Water supply* details where the water came from each year to meet those uses.

Figures 1-2 and 1-3 depict water uses and supplies on a regional scale. These figures illustrate two hydrologic extremes and how water use changes, region by region, in response to changes in available supply. Figure 1-2 summarizes water balances for each of California's 10 hydrologic regions for Water Year 2011, a wet year. Figure 1-3 shows regional water balances for Water Year 2014, which was classified as a critically dry year statewide (based on California's [Water Year Hydrologic Classification Indices](#)). Comparing regional water uses and supplies with statewide amounts underscores the diversity around the state.

Each region has unique and variable characteristics and needs that must be addressed locally with a unique set of programs and projects. California's hydrologic regions are the size of some states, where characteristics — including precipitation, runoff, developed water supplies, and water use — can vary greatly between years, even within a single region.

For more information about California's water use and water supply, including regional water balances for additional years, hydrologic summaries, regional inflows and outflows, and data for smaller analysis areas within each region, refer to the [Water Portfolios](#) section of the California Water Plan webpages and the [Update 2018 Supporting Documents](#) webpage.

Figure 1-1 California Water: How It Was Used and Where It Came From, 2011–2015

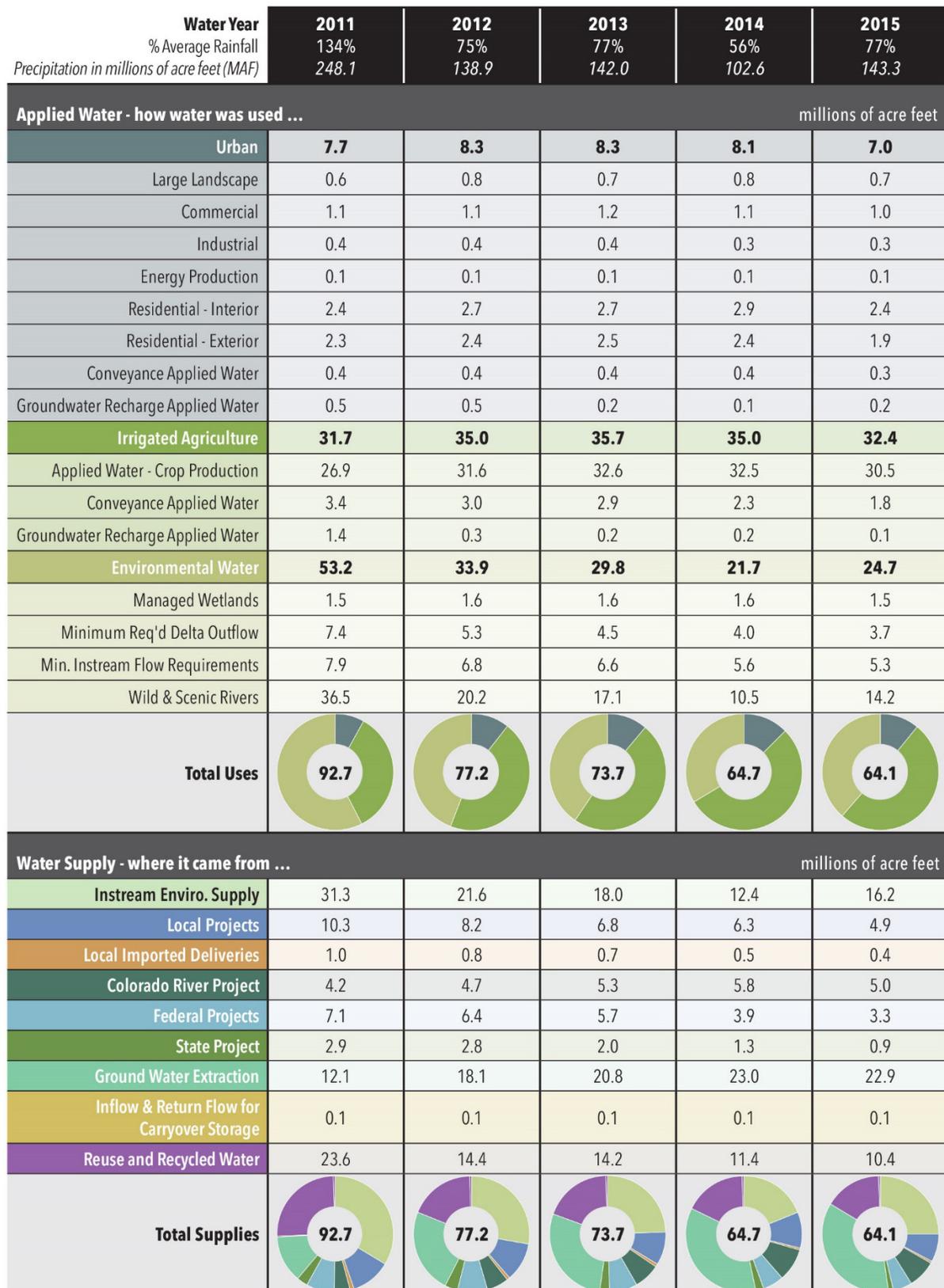


Figure 1-2 Regional Water Uses and Supplies in Water Year 2011 (Wet Year)

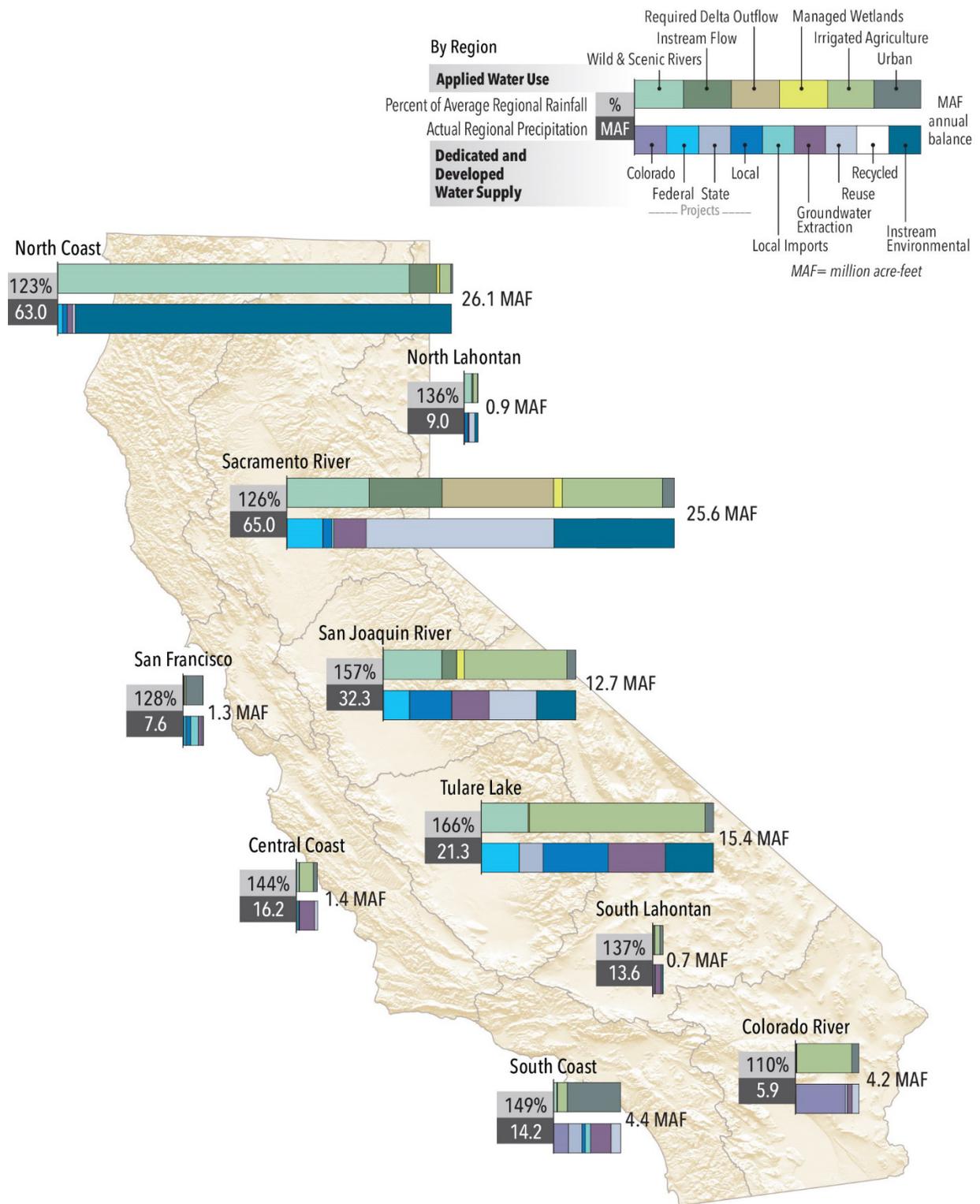
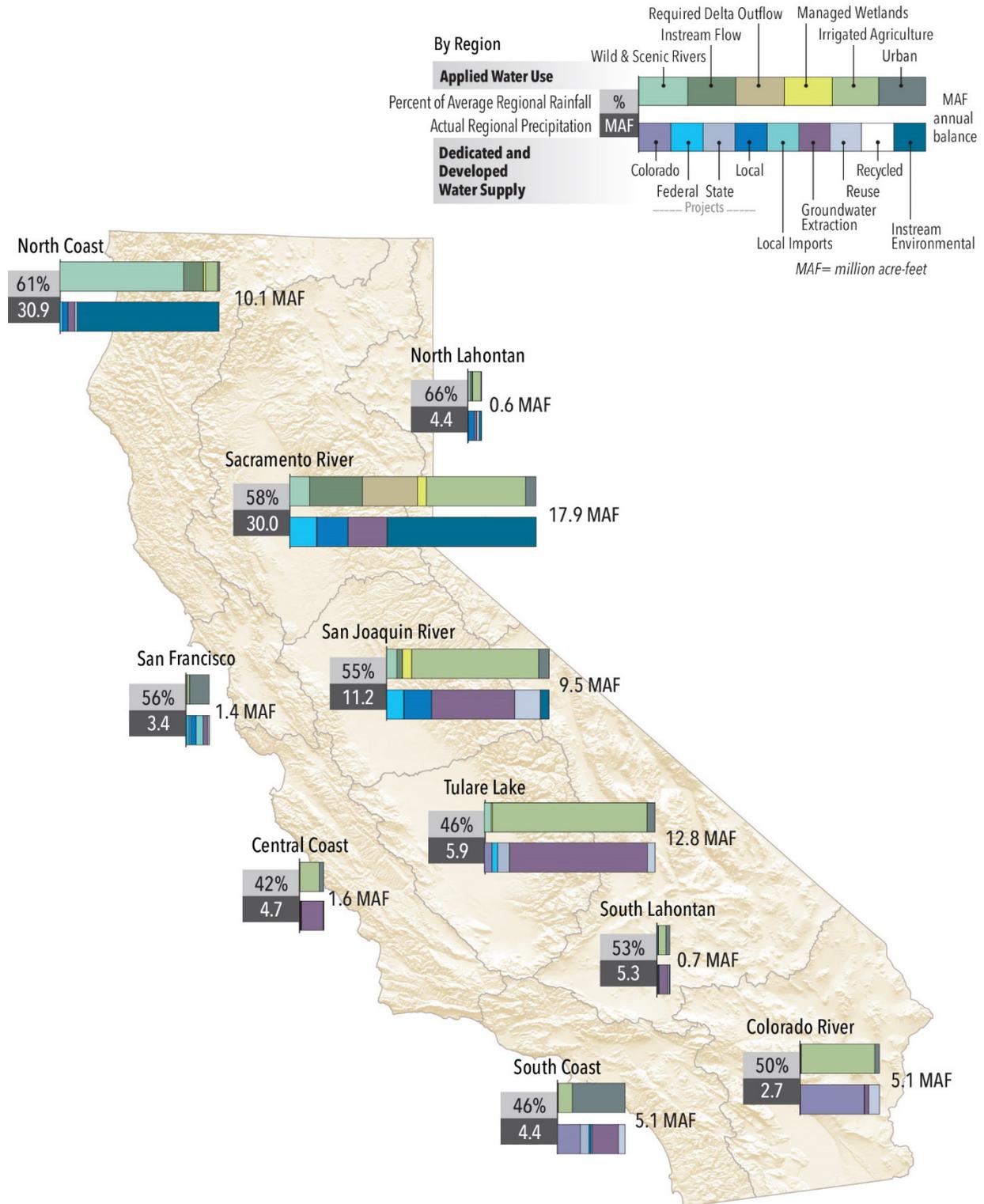


Figure 1-3 Regional Water Uses and Supplies in Water Year 2014 (Critically Dry Year)



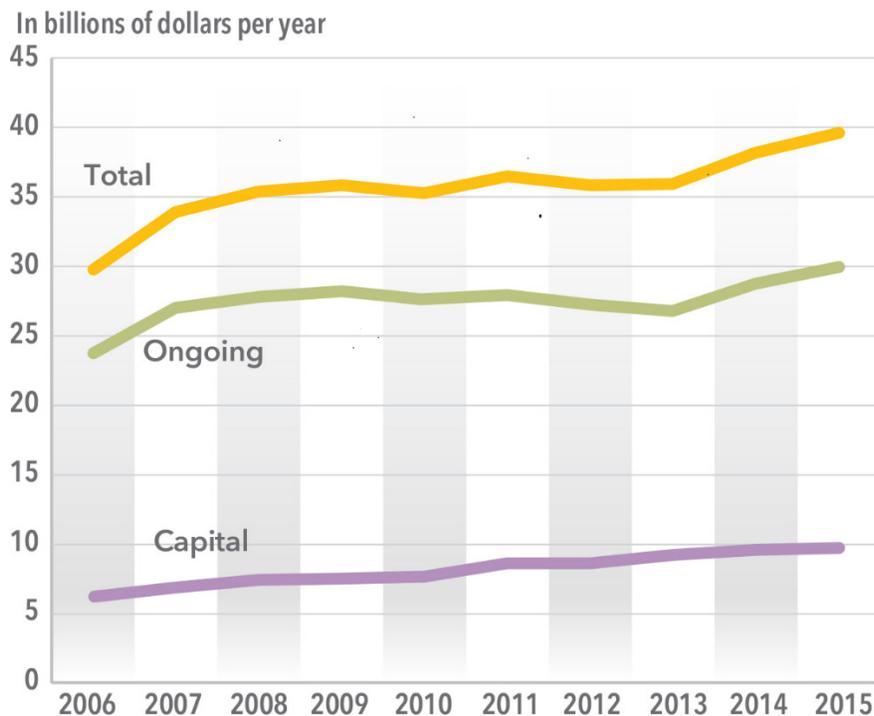
Historical Investment in Water Management

From 2006 through 2015, total investment in capital and ongoing expenditures (operation, maintenance, and administration) by local, State, and federal agencies averaged more than \$35 billion per year (Figures 1-4a, 1-4b, and 1-4c). Capital expenditures averaged more than \$8 billion per year during the same period, with most of the funds coming from local agencies. Capital expenditures have continued to be made largely in reaction to emergencies and extreme events. For example, the increase in spending in the late 2000s for flood management was in response to Hurricane Katrina, and the upward trend in spending starting in the mid-2010s was in response to extended drought conditions (CH2M Hill 2018).

Local agencies provided approximately 85 percent of all funding for water management in California, with capital and ongoing expenditures increasing to keep pace with the issuance of State grant programs (Hanak et al. 2014). While this reflects the overall water community, flood and ecosystem restoration sectors have been relatively more dependent on State and federal funding. Although the State has funded capital improvements in disadvantaged communities, those communities often lack the ability to fund ongoing operations and maintenance (Hanak et al. 2014). In addition, State expenditures from the State General Fund have decreased as general obligation bond issuance has increased. This shift has led to water resource management sectors having to rely on bond funding, an unstable and uncertain source.

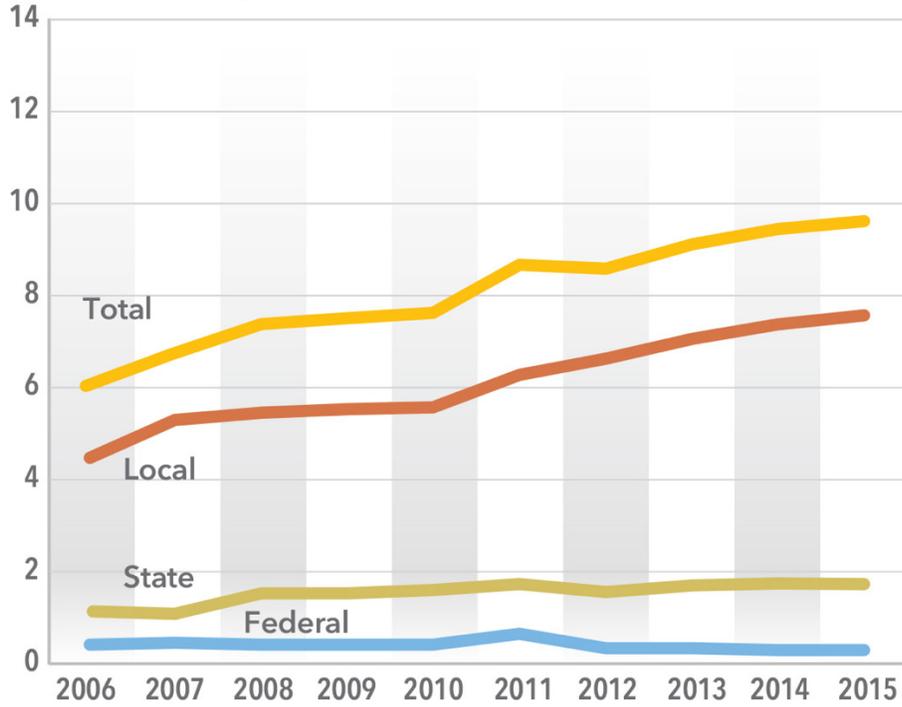
Figure 1-4 Historical Local, State, and Federal Expenditures (2006–2015)

(a) Total Expenditures



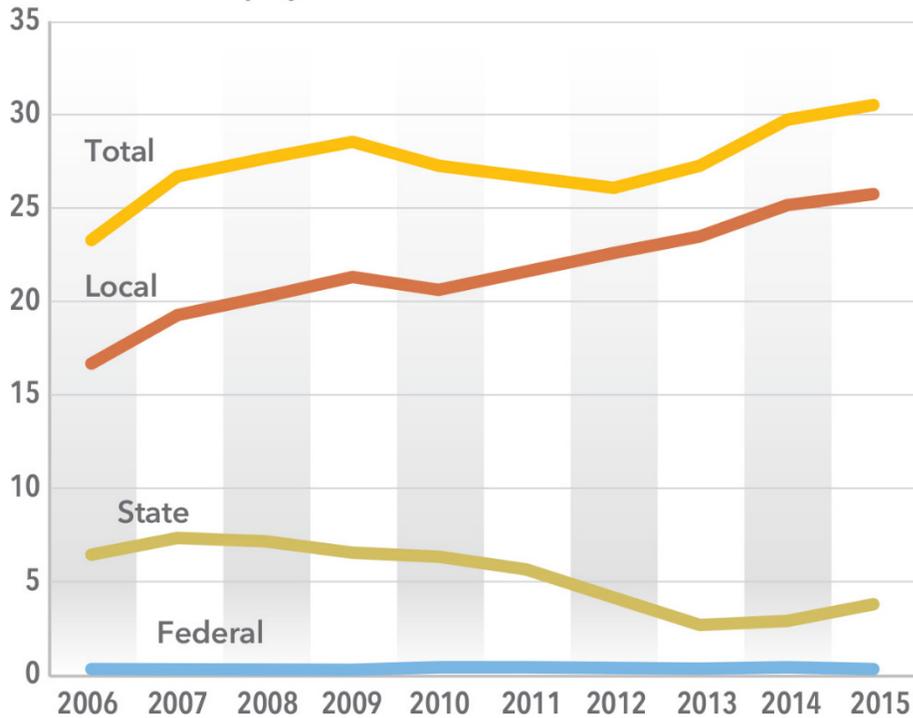
(b) Capital Expenditures

In billions of dollars per year



(c) Ongoing Expenditures

In billions of dollars per year



Chapter 2. Challenges to Sustainability

Critical, Systemic, and Institutional Challenges

Challenges that affect the state’s ability to manage water resources for sustainability cannot be resolved with stopgap measures or by making minor adjustments. California’s interconnected systems for using and managing water are extremely complex and subject to continually changing natural and human-made conditions. Climate change, demographic changes, and other variables underscore the need to manage these valuable water resources for sustainability. California has realized many successes in water resource management over the past several decades, driven by State-level policy initiatives and programs as well as local and regional actions. Even so, California faces foreseeable risks and unanticipated threats to sustainability. Evidence of vulnerability of the state’s water resources is occurring in nearly all regions, and conflicts between ecological and human needs are increasing. Recognizing the trends and causes of these challenges will allow Californians to proactively manage and recover from droughts, floods, and other disruptive events.

What Is Sustainability?

Sustainability of California’s water systems means meeting current needs — expressed by the water community as public health and safety; healthy economy; ecosystem vitality; and opportunities for enriching experiences — without compromising the needs of future generations.

From 2012 through 2016, California experienced severe drought accompanied by accelerated groundwater depletion and overdraft, continued habitat and species declines, and a massive die-off of trees within California’s headwaters. This dry period was followed by the second wettest year on record and extreme hydrology. These events threatened the lives and property of people protected by levees, and jeopardized Tribal cultural resources in many areas. Although some communities that proactively planned and invested in water management strategies have shown considerable resilience, many communities remain vulnerable. Communities with limited income and capacity suffer the most severe impacts (Hanak et al. 2017).

Many challenges that regions and communities face are particularly vexing and increasingly undermine the well-being of Californians. Although local, regional, and State water managers tackle the following challenges daily, they experience varying degrees of success.

Critical Challenges

- More-Extreme Hydrologic Events:** In any given year, the state can experience extreme hydrologic events. In times of drought, there is not enough water to meet all uses; during floods, the excess water threatens human lives, property, and economic well-being. Severe drought conditions in the western United States, followed by extreme precipitation in 2017, directly affected the health and livelihoods of Californians. The wide swings in climatic conditions are exposing the vulnerability of the state’s water systems and ecosystems. Seasonal, year-to-year, and geographical variability among water sources and locations of water uses, particularly affecting disadvantaged communities, is also a complicating factor.
- Increasing Flood Risk:** Current risk of catastrophic flooding is exceptionally high throughout the state, with one in five Californians living in a floodplain and more than \$580 billion in assets

(i.e., crops, property, and public infrastructure) at risk (California Department of Water Resources and U.S. Army Corps of Engineers 2013). This risk is increasing as more precipitation falls as rain than snow, hydrologic events become more extreme, more communities are situated in floodplains, and maintenance is deferred on existing infrastructure. Every county in California has been declared a federal disaster area for a flooding event at least once in the last 20 years (California Department of Water Resources and U.S. Army Corps of Engineers 2013). This alarming statistic underscores the need to invest in the state's aging flood management infrastructure and in measures to modernize the flood system to adapt to climate change and increased extreme weather events. Modernizing the flood system to adapt to future needs includes recognizing that managed flooding in certain areas can produce beneficial effects and support natural functions (e.g., replenishing ecosystems with sediment and nutrients and helping to recharge groundwater aquifers). Flooding and floodplains also can provide beneficial habitat conditions; and yet, as people and structures have moved into floodplains, the need for flood management that benefits people and the environment has increased greatly.

- **Reduced Access to Clean, Safe, Reliable, and Affordable Water Supplies:** During the recent drought, many vulnerable communities were unable to provide reliable and safe water to their residents. Nearly 700 communities have water systems that rely on contaminated groundwater (State Water Resources Control Board 2013). Of the 3,399 public water systems (community systems and schools) in the state, more than 300 are not in compliance with safe drinking water standards (State Water Resources Control Board 2018), and many more lack access to affordable and reliable water supplies. This often results from degraded surface water and groundwater quality. Additionally, the rise of homelessness has led to homeless encampments along riverbanks and stormwater management systems, which has created additional challenges in protecting river ecosystems and riverine water quality (U.S. Department of Housing and Urban Development 2017; White 2013). To compound the situation, many disadvantaged communities must dedicate an increased portion of their budgets to providing human services, rather than to water infrastructure.
- **Declining Groundwater Levels:** Surface water and groundwater have largely been managed as separate resources when they are, in fact, a highly interdependent system of watersheds and groundwater basins. This historical separation in managing these resources has resulted in negative effects and missed opportunities to advance sustainability.

According to *California's Groundwater Update 2013*, the average annual groundwater withdrawal in California is about 16 million acre-feet (maf), which is nearly 40 percent of all water used in the state. Most of the groundwater withdrawal occurs in the Central Valley, where available data indicate that during the five-year period from spring 2005 to spring 2010, there was an average annual depletion of approximately 2.6 maf in groundwater storage from the underlying aquifers. The total depletion in groundwater storage in the Central Valley aquifers during that period was approximately 13 maf, which is nearly four times Lake Oroville's storage capacity (3.5 maf). The vast majority of the state's population and agricultural activity is dependent on stressed groundwater basins (California Department of Water Resources 2015). Driven by recent and extended drought, groundwater levels in some parts of the state are declining at unprecedented rates. These declines have led to land subsidence in some areas,

resulting in costly damage to water supply, transportation, and flood infrastructure (Water Education Foundation 2017).

- **Declining Ecosystems:** Even with increasing awareness of the benefits of natural infrastructure, relative to water supply and other sectors, restoration of terrestrial, wetland, and aquatic ecosystems has not been an investment priority of Californians. The same is true for forest and headwater management. The result is that many ecosystems and the services they provide continue to decline. More than 150 species are listed as Threatened or Endangered in California (California Department of Fish and Wildlife 2018).
- **Water Quality Degradation:** Changes in land use and water use have resulted in increased runoff of agricultural, industrial, and urban pollutants to surface water and groundwater. Increased agricultural and urban wastewater discharges, as well as changes in commercial and recreational activities, have negatively affected water quality. Higher temperatures, increasing rainfall, wildfire and forest management practices, and ecosystem degradation have further diminished water quality. As the quality diminishes, treatment costs increase.
- **Aging and Inadequate Built Infrastructure:** California's water systems are increasingly managed to provide benefits beyond their original purpose. Much of California's water-resource infrastructure is reaching the end of its design life, even as it comes under greater stress created by hydrologic extremes and increasing water demand. At the same time, costly maintenance and capital improvements have been deferred in some regions and water sectors because of lack of funding or regulatory challenges (Hanak et al. 2011).
- **Sacramento-San Joaquin Delta (Delta) Conflicts:** Increasing demand for the Delta's resources has contributed to escalating conflicts between water users, environmental outcomes, and local stakeholders. The Delta's future will be affected by increasing land subsidence; heightened seismic risk; and the effects of climate change such as rising temperatures, changes in runoff timing, sea level rise, and changes in storm timing, intensity, and frequency (California Department of Water Resources and U.S. Bureau of Reclamation 2016).
- **Declining Forest and Headwaters Health:** More extreme hydrologic events also directly affect forests through increased drought stress that makes trees more vulnerable to insect attack, with the resulting increased rates of tree mortality influencing wildfire frequency, size, and severity. California received record-breaking rains in the winter of 2016–2017, yet the previous five consecutive years of severe drought in California and rising temperatures led to a dramatic rise in bark beetle infestation and tree die-off. Since November 2016, 27 million trees have died throughout the state, bringing the total that have died because of drought and bark beetles to an historic 129 million (U.S. Forest Service 2017). The dead trees continue to pose a hazard to people and critical infrastructure.

Along with other environmental pressures, this historic die-off is affecting forest resiliency, stream flows, and water quality buffering. Many perennial streams will likely become intermittent, resulting in degraded meadows and the loss of riparian areas, wetlands, and other aquatic habitats.

- **Catastrophic Wildfires:** Californians increasingly face the disastrous consequences of catastrophic wildfires. In 2017, there were 46 fire-related deaths (and more from fire-induced landslides); 1,436,558 acres burned; 10,822 structures destroyed and another 1,238 damaged (McLean 2018); and tens of billions of dollars in losses and associated costs. As of December 2, 2018, approximately 1.7 million acres have been consumed by 7,510 wildfires (California Department of Forestry and Fire Protection 2018). California is primed for more frequent and more catastrophic wildfires as a result of extreme tree mortality, increased fuel loads, climate change leading to more extreme droughts and flooding, and continued urban development in and near wildlands.
- **Unstable Regional Economies:** As water supplies have become less reliable, local and regional economies are more volatile, especially in agricultural and rural communities. For example, direct agricultural costs statewide from the drought total more than \$1.8 billion, with a loss of approximately 10,100 seasonal jobs (Howitt et al. 2015). Often these economic downturns disproportionately harm people who have the least capacity to respond to changes.
- **Changing Demands for Water:** Future water scenarios published in Update 2013 show an increase in urban water demand ranging from 1 maf to 7 maf per year by the year 2050 (depending on population growth). The high end of this range is equivalent to twice the storage capacity of Lake Oroville. The scenarios show a decrease in agricultural water demand ranging from 2 maf to 6 maf for the same planning horizon. California's population is expected to increase from 39.4 million in 2016, to 51.1 million by 2060 (California Department of Finance 2018). Improving conservation and water use efficiency, along with shifts in agriculture to permanent crops, will also make it more difficult to reduce water use during droughts and periods of low supply (i.e., "demand hardening").

Systemic and Institutional Challenges

- **Fragmented and Non-Coordinated Initiatives and Governance:** The ability to efficiently and sustainably manage water resources at a watershed scale is often impaired by lack of shared intent and alignment. Holistically managing California natural resources will require unprecedented collaboration among State agencies, California Native American Tribes, water districts, land-use entities, flood districts, resource conservation districts, and groundwater sustainability agencies, especially when they share jurisdictional areas, watersheds, ecoregions and groundwater basins.
- **Inconsistent and Conflicting Regulations:** Regulations are an integral part of public health and safety, and environmental protection. Yet at times, some regulations, particularly those developed in institutional silos, do not achieve their intended outcomes, much less balance environmental needs and human activities. For the most part, existing statutes focus on avoiding, minimizing, or mitigating environmental impacts caused by discrete projects or protecting a single species. Existing laws also largely lacks the discretion needed to manage adaptively on a watershed or ecoregion scale — including managing for ecosystem restoration and the services it provides. A changing regulatory environment poses challenges for sustainably managing water resources and associated project development.

- **Insufficient Capacity for Data-Driven Decision-Making:** Information, data, and tools are essential for ensuring that decisions and actions result in intended outcomes, as well as measure progress toward accomplishing those outcomes. Yet, water resource planners and managers often do not have access to the technical information, tools, and facilitation services needed to support regional efforts toward sustainable integrated water management (Canto et al. 2018). Data may be abundant statewide but are collected, used, and stored by numerous agencies and are not coordinated or shared. Although this is a statewide challenge, the consequences of inadequately informed decisions are experienced to a much greater degree in under-represented and economically disadvantaged communities.

Data management, planning, policy-making, and regulation must occur in a collaborative, regionally based manner. Data must be accessible, sufficient, quality controlled, and usable. Effective decisions must also be based on the appropriate use and interpretation of data. The ultimate data-sharing and management system needs to utilize an authoritative, open-access platform that informs the decisions of elected officials, opinion leaders, stakeholders, scientists, and subject experts. Subject expertise (e.g., hydrology, climatology, environmental sciences) and stakeholder perspectives woven together into comprehensive, regionally appropriate policies and implementation decisions are necessary to manage for sustainability.

- **Insufficient and Unstable Funding:** Current mechanisms and how they are used to fund State government are often inadequate, unpredictable, and inflexible, and thus fail to effectively fund all mandated, water-related State responsibilities (including local assistance and cost-sharing). Many other factors, such as changing public priorities, deferred maintenance, and responses to declining ecosystems and catastrophic events, have compounded today's State funding needs. Other challenges to sufficient and stable funding occur at all levels of government. These include competition with other public services for available resources, reduced revenue collection during periods of required water conservation, legal constraints related to assessment increases (e.g., Proposition 218), and geographical or jurisdictional limitations on generation and use of funds (California Department of Water Resources 2014).

Flood management and ecosystem management face additional funding challenges because they rely heavily on State general obligation (GO) bond funding and federal funding. State funding for protecting public trust assets, as well as for ensuring that communities with limited resources have clean and reliable water supplies, is also frequently inadequate and unstable. For example, only 6 percent of total water resource funding is allocated to flood management and ecosystem functions (Hanak et al. 2012). Sporadic funding in response to floods or droughts lacks the predictability and reliability required for effective long-term change. At the same time, levels of State GO bond debt are near an all-time high (California Department of Water Resources 2018a).

- **Inadequate Performance Tracking of State and Local Investment:** One basic long-standing challenge to water resource resilience and reliability in California is the lack of a consistent and practical method for assessing current and future sustainability (California Department of Water Resources, in prep.). Decision-makers often lack the means to identify needed analytical tools and data gaps, expand on the information available to make decisions, and set future water management priorities.

These systemic challenges place significant risks on public safety, vulnerable ecosystems, and the state's economy. To some degree, all Californians are affected by these challenges. Careful consideration of the risks posed by these challenges is an important aspect of managing water resources for sustainability. Progress continues at both the State and local levels, but these concerns are urgent and more needs to be done. Chapter 3 describes recommended actions for infrastructure and ecosystem improvements, as well as actions to overcome institutional, statutory, and data deficiencies and other root causes of the state's water challenges.

The Sustainability Outlook

The Sustainability Outlook was developed to provide a well-organized and consistent approach for tracking local, regional, and State actions and investments. It is an evolving method of informing the strategic planning and prioritization of water management actions. This method, or tool, involves evaluating status and trends of conditions within a watershed or region, setting intended outcomes consistent with societal values, and determining whether actual outcomes are consistent with intended outcomes. Through progressive application of the Sustainability Outlook, decision-makers should be able to identify needed analytical tools and data gaps, build capacity to make decisions and set priorities, and describe how individual and collective actions have affected the management of water resources for sustainability. The Sustainability Outlook was informed by stakeholder input and initial pilot projects, as described in *The Sustainability Outlook: A Summary* (California Department of Water Resources 2018b).

Chapter 3. Actions for Sustainability

Managing water resource systems for sustainability requires changing the status quo, addressing challenges, and strategically planning for long-term resiliency. State government must address challenges related to aging infrastructure, ecosystem decline, decision-making, and public funding.

This chapter describes recommended actions needed to meet the goals of California Water Plan Update 2018 (Update 2018). The actions, if implemented, would result in multiple benefits across water management sectors. They would involve assisting and empowering local and regional communities to plan, fund, implement, and report on their accomplishments and lessons learned.

The State plays a unique role in water management and should lead substantive actions to achieve the stated overarching goals and statewide initiatives.

Recommended Actions to Accomplish Update 2018 Goals

The following goals and actions support the larger State initiatives referenced in Chapter 1. Many of the actions are intended to work together by leveraging value from one action to augment the value of another. Each recommended action is intended to be implemented in close collaboration with State, Tribal, regional, and local entities to leverage existing statutes, resources, programs, and initiatives. The actions will enable these entities to overcome challenges and to manage water resources for sustainability.

Goal 1 — Improve Integrated Watershed Management

California's vision of sustainable water management relies on the continued support of innovative and inclusive integrated water management strategies. Healthy watersheds, headwaters and working landscapes provide critical water supply and ecosystem services.

Recommended Action 1.1 — Address the Water Management Needs of California's Most Vulnerable Communities.

Provide base-level support to help long-term stability of integrated regional water management programs, including support for disadvantaged communities, Tribes, and other vulnerable communities. The California Department of Water Resources (DWR), in coordination with the Tribal Advisory Committee and Water Plan State Agency Steering Committee (SASC), will prepare recommendations to strengthen timely and meaningful communication with vulnerable communities to inform water resources management.

Recommended Action 1.2 — Support the Role of Working Landscapes.

Given the importance of well-managed public and private lands in a changing climate, the State should support and consider expansion of existing working landscape stewardship programs.

Recommended Action 1.3 — Promote Flood Managed Aquifer Recharge.

DWR will provide technical, planning, and facilitation assistance for local and regional entities to evaluate and execute managed aquifer recharge opportunities.

Goal 2 — Strengthen Resiliency and Operational Flexibility of Existing and Future Infrastructure

Water managers must make plans to address aging infrastructure and impacts associated with climate change, population growth, ecosystem stressors, and funding constraints.

Recommended Action 2.1 — Improve Infrastructure and Promote Long-Term Management.

Continue and build upon recent efforts to evaluate and maintain State-owned and State-regulated water supply infrastructure and State Plan of Flood Control infrastructure. Identify and evaluate opportunities to expand surface and groundwater storage capacity in the state. Increase information sharing and public awareness of flood risk and assist local entities through DWR's Floodplain Management program. Consider opportunities to assist and support local managers to invest in continued operations, maintenance, and rehabilitation of infrastructure.

Goal 3 — Restore Critical Ecosystem Functions

California is one of the world's great biodiversity hotspots. Anthropogenic influence — water management included — has impacts on natural resources; and environmental protections for many species has impacts on water management.

Recommended Action 3.1 — Address Legacy Impacts.

The State is committed to directly addressing — and aiding local agency actions to address — legacy water management impacts as well as current conflicts between water management and natural resources. Integration of ecological principles into infrastructure planning and project design is critical. It complements the incorporation of climate change mitigation and adaptation strategies.

Recommended Action 3.2 — Facilitate Multi-Benefit Water Management Projects.

Pursue large-scale multi-benefit projects that efficiently address multiple public needs, such as the reduction of flood risk and the recovery of fish and wildlife populations.

Recommended Action 3.3 — Quantify Natural Capital.

The State should work with non-governmental, private sector, and academic partners to quantify the societal and economic values of functional ecosystems. This action will assist with the development of innovative restoration efforts and the measurement of progress toward restoration goals.

Goal 4 — Empower California's Under-Represented or Vulnerable Communities

Equitable water management means reliable, affordable, and safe water supplies and management for all Californians.

Recommended Action 4.1 — Improve Tribal Involvement in Regional Planning Efforts.

Consistent with Recommended Action 1.1, and in coordination with the Tribal Advisory Committee and SASC, DWR will improve engagement and consultation with Tribes to better inform water resources management decisions.

Recommended Action 4.2 — Engage Proactively with Disadvantaged Community Liaisons.

In coordination with Recommended Action 1.1, State agencies should identify opportunities to leverage existing disadvantaged community liaisons and watershed coordinators, and support additional liaisons, as needed. The liaisons would engage proactively and consistently with local, regional, State, and federal agencies and Tribes to promote more effective integration and collaboration. Liaisons would provide technical, managerial, and financial expertise and services; prepare proposals for infrastructure and operations and maintenance improvement programs; and facilitate disadvantaged community involvement in regional water management efforts (e.g., regional water management groups and groundwater sustainability agencies).

Goal 5 — Improve Inter-Agency Alignment and Address Persistent Regulatory Challenges

Improved alignment and communication will more effectively deliver public benefits. Strengthening links between regulation and strategic planning, as well as utilizing restoration management on an ecosystem scale, will help balance environmental needs and human activities over the long term.

Recommended Action 5.1 — Incorporate Ecosystem Needs into Water Management Infrastructure Planning and Implementation.

Continue implementation of Assembly Bill (AB) 2087 (Levine, 2016) by developing regional conservation investment strategies and associated mitigation credit agreements to assist infrastructure development and ecosystem restoration program outcomes. Explore additional opportunities to pursue public-private partnerships that result in innovative mechanisms for the delivery of ecosystem outcomes.

Recommended Action 5.2 — Streamline Ecosystem Restoration Project Permitting.

DWR and other State agencies should continue to support stakeholder efforts to develop and implement programmatic approaches to restoration project permitting. This work is intended to simplify and accelerate the completion of critically needed habitat restoration projects across the state.

Recommended Action 5.3 — Address Additional Regulatory Challenges.

Upon completion of Recommended Actions 5.1 and 5.2, DWR should work with other State agencies and stakeholders to identify and address additional watershed management regulatory challenges.

Goal 6 — Support Real-Time Decision Making, Adaptive Management, and Long-Term Planning

Effective water management requires access to data and information necessary to understand current conditions, historic challenges, and future challenges. It also requires stable funding sufficient to support State and local sustainability goals.

Recommended Action 6.1 — Facilitate Comprehensive Water Resource Data Collection and Management Program.

As required by AB 1755 (Dodd, 2016), State agencies will publish and update State water and ecological datasets on an easily accessible federated water-data platform. State agencies should also maintain data management best practices and work with local agencies to improve data gathering, accessibility, quality, and related decision-support tools.

Recommended Action 6.2 — Coordinate Climate Science and Monitoring Efforts.

State agencies should consider further coordination of critical climate science and monitoring efforts. The effort would support and expand ongoing research collaborations designed to track atmospheric rivers, rain/snow percentage trends, high-elevation snow water content, upland watershed monitoring, paleohydrology, sea level rise, seasonal winter outlooks, and changes in streamflow and stream temperatures. This action includes implementation of *Safeguarding California Plan: 2018 Update* (California Natural Resources Agency 2018) and the development of the *Indicators of Climate Change in California* report.

Recommended Action 6.3 — Improve Performance Tracking.

DWR will consider assessing State progress toward Update 2018's goals by using the Sustainability Outlook, a method to uniformly track outcomes and value of water system investments (California Department of Water Resources 2018). DWR will also consider assisting regional and local water agencies with implementing the Sustainability Outlook to help measure local progress and inform future decision-making.

Recommended Action 6.4 — Develop Regional Water Management Atlas.

DWR will continue to develop and implement the Regional Water Management Atlas, a new interactive mapping tool providing users transparent access to critical water management data such as groundwater basin boundaries, groundwater sustainability agency jurisdictions, integrated regional water management planning boundaries, and water infrastructure investment opportunities.

Recommended Action 6.5 — Bolster Reporting Requirements for State Financial Assistance.

State agencies should require articulation of intended outcomes for all local water projects funded or partially funded by the State. This action would require tracking and reporting on project outcomes and providing information as may be required by State grant programs and funding source requirements.

Recommended Action 6.6 — Expand Water Resource Education.

State agencies should work with school districts, universities, and foundations to attract more students to the field of water resource management. Efforts should also be made to expand related curricula and programs to educate the public.

Recommended Action 6.7 — Explore Ways to Develop Stable and Sufficient Funding.

Water community stakeholders are encouraged to explore new funding mechanisms to support long-term state and local/regional sustainability. Foundations, academia, public agencies, the Legislature, non-governmental organizations, and others should take into consideration opportunities to expand upon existing funding mechanisms, as well as opportunities to develop new funding mechanisms.

To implement these recommended actions, investment will need to be increased over historical levels. Chapter 4 describes the additional funding, as well as potential new funding mechanisms, needed to implement the recommended actions.

Chapter 4. Investing in Water Resource Sustainability

In light of the critical, systemic, and institutional challenges to water resource sustainability, annual historical funding will not support the level of investment needed to implement the recommended actions of *California Water Plan Update 2018* (Update 2018). This chapter describes the additional funding needed to implement the recommended actions in Chapter 3. It also describes an analysis of funding scenarios.

The State investment called for in Update 2018 will lead directly to public benefits and leverage local investment. Funding invested in Update 2018 actions would result in:

- Clearly articulated intended outcomes of investments and policies.
- Increased infrastructure and ecosystem integrity and resiliency.
- More accurate, comprehensive information to estimate the full cost of implementing all recommended actions over 50 years.
- Increased likelihood that investments will produce intended outcomes.
- Greater efficiency and capacity in the administration of programs.
- More accountability for expenditures of public monies.

Scope and Setting

Although local, federal, and other stakeholders play a crucial role in funding water management actions, the scope of Update 2018's funding recommendations focus on State government obligations, roles, responsibilities, and incentives, as well as on local assistance for sustaining California's water resources. Comprehensive in its scope, Update 2018 supports the 10 actions of the Governor Brown's *California Water Action Plan 2016 Update*.

Some types of water resource management activities, such as water supply and wastewater treatment, are predominately funded by ratepayer revenues, as well as through local revenue bonds for larger capital investments. On the other hand, many other activities — such as managing flood and stormwater, statewide planning and data, statewide infrastructure, remediating legacy impacts, and recovering ecosystems — are neither sufficiently nor stably funded (Hanak et al. 2012). State government has an important role in performing and funding these other activities, and more so in disadvantaged communities. In many cases, historical funding has been insufficient to sustain the benefits of past investments (e.g., operation and maintenance) and secure benefits from future investments (e.g., data, knowledge, skills, tools). State government has been spending approximately \$2 billion per year (CH2M Hill 2018a) from the State General Fund and general obligation (GO) bonds on water management. In comparison, this is approximately 10 percent of the total local, State, and federal annual expenditures on water resource management (CH2M Hill 2018a). Although State cost-shares will vary among water sectors, Update 2018 proposes maintaining this approximate proportion of State cost-share.

On average, from 2006 to 2015, less than 2 percent of annual State budget (including State General Fund, GO bonds, and GO bond debt service) was allocated for water resource management (CH2M Hill 2018a). Because the State General Fund serves a vast array of critical needs, and GO bonds are subject to voter approval and debt service limitations (for Fiscal Year 2017–2018 debt service on water GO bonds was \$1 billion), water resource funding is subject to competing and shifting priorities. These constraints make funding for sustainably managed water resources variable and uncertain.

An effective method for State government to invest in statewide sustainability has been providing local and regional financial assistance. Local and regional entities can determine the best way to accomplish State goals based on local/regional priorities, conditions, and available solutions. Integrated regional water management, as a program and a practice, has delivered significant value and continues to be an effective way for the State to fund local and regional activities. Regional water management groups are well-positioned in many areas to interact with the State to explore planning and funding innovations.

Although the total local, State, and federal funding needed for water management actions planned in California is more than \$350 billion over the next 50 years, the State investment needed to implement the actions in Chapter 3 (approximately \$90 billion) is a small portion of this total estimated need (CH2M Hill 2018a).

Funding to Implement Recommended Actions

Identifying, analyzing, and recommending ways to implement and fund the recommended actions described in Chapter 3 is essential to putting California on a more sustainable path. Table 4-1 shows total State funding needed to implement Update 2018's recommended actions, as represented by the goals for the near term and the long term. The total projected 50-year capital and ongoing cost is approximately \$90.2 billion, of which \$77.8 billion (more than 85 percent) is for financial and technical assistance to regional and local entities, \$9.7 billion is for State-managed water infrastructure, and approximately \$2.7 billion (less than 3 percent) is to resolve systemic challenges (California Department of Water Resources 2018).

Funding Mechanisms

A mix of funding mechanisms would provide stable and sufficient funding for capital (large magnitude, short duration) and ongoing (small magnitude, long duration) management actions. Stable funding helps increase efficiency and return on investment. Specifically, it reduces deferred maintenance; avoids costs associated with disruptions to planning, research, and implementation; and minimizes stranded investment from data inaccessibility and gaps.

Each funding mechanism has a unique set of characteristics, including applicability to capital and ongoing investments, feasibility, inter-annual reliability, and limitations and applications to different water management sectors. These characteristics were used to analyze the feasibility and trade-offs of funding mixes, or scenarios. Each scenario is comprised of a mix of funding mechanisms and levels.

Table 4-1 State Funds Needed to Implement the Recommended Actions, Organized by Goals (2016 Dollars)

Goals	Years 1–5 2019–2023 (\$ millions)	Years 6–10 2024–2028 (\$ millions)	Years 11–30 2029–2048 (\$ millions)	Years 31–50 2049–2068 (\$ millions)	50-Year Total (\$ millions)
Goal 1^a Improve Integrated Watershed Management	86	235	960	960	2,241
Goal 2^{b, c} Strengthen Resiliency and Operational Flexibility of Existing and Future Infrastructure	2,200	4,400	24,800	27,600	59,000
Goal 3^{b, c} Restore Critical Ecosystem Functions	142	815	11,565	14,000	26,522
Goal 4^a Empower California's Under-Represented or Vulnerable Communities	9	10	40	40	99
Goal 5^a Improve Inter-Agency Alignment and Address Persistent Regulatory Challenges	8	13	50	50	121
Goal 6^a Support Real-Time Decision-Making, Adaptive Management, and Long-Term Planning	188	231	895	895	2,209
	\$2,633	\$5,704	\$38,310	\$43,545	\$90,192^d

Notes:

^a All costs are expected to be ongoing (e.g., planning, data, improvement of State operations).

^b Nearly all costs are capital expenditures.

^c Depends on participation in voluntary State cost-sharing programs and refinement of funding needs in Water Plan updates.

^d A sizeable portion (more than 85 percent) of the additional State funding is intended for use by local and regional water management entities to implement local activities and projects.

Table summarized from information in *Funding Assumptions for Approximating Costs of Recommended Actions* (California Department of Water Resources 2018).

Current Funding Mechanisms

This list of current funding mechanisms describes their respective characteristics.

- State General Fund:** A fund used for the daily and long-term operations of State, local, or federal agencies. The State General Fund is typically supported with revenues, primarily income and sales taxes, that are collected on a regular basis with few restrictions on the use of those funds. The State General Fund can be used for capital, operations and maintenance, and ongoing actions. Increases in State General Fund expenditures for infrastructure investments are more feasible during periods of economic growth.
- General Obligation Bond:** A common type of municipal bond in the United States that is secured by a state or local government's pledge to use legally available resources, including tax revenues, to repay bond holders. The GO bond is generally used to fund capital actions. A State GO bond requires a statewide vote. Time is required to prepare language for the bond measure for the statewide vote, as well as a time lag before funds would be available after passage. The State

must pay back the principal (amount raised), plus bond issuance cost, and interest over the life of the bond. Fiscal Year 2016–2017 interest on debt for State GO bonds was more than \$678 million.

- **Greenhouse Gas (GHG) Cap-and-Trade Program Fund:** A market-based program to reduce GHG emissions by using a cap-and-trade program that includes an annually declining limit on GHG emissions. The State sets an annual cap on total emissions and auctions off emission allowances to GHG emitters, who may subsequently buy or sell allowances among themselves. For the auction proceeds to be used to fund water resources management actions, the action must show a nexus in reducing GHG emissions.
- **Public-Private Partnerships:** Long-term contractual agreements between a private party and a government entity, for providing a public asset or service, in which the private party bears significant risk and management responsibility. Repayment is linked to performance.
- **User Fees:** A fee based on the principal of either a beneficiary paying for a service or good, or a polluter paying for costs associated with damages to the environment. Examples include State Water Resources Control Board Drinking Water, Water Quality, and Water Rights fees; local development fees; and water rates. A user fee requires legislation that stipulates the types of benefits that can be assessed.

Table 4-2 shows the historical maximum and average funding from the State General Fund and GO bonds. Table 4-3 lists the attributes of current funding mechanisms for State investments.

Table 4-2 Historical Funding Levels of Current Funding Mechanisms
(Based on Average and Maximum Historical Expenditures 2006–2015^{a, b})

Funding Mechanism	Historical Annual Average (\$ millions)	Historical Annual Maximum (\$ millions)	2015 Actual Expenditures (\$ millions)
General Fund	254	405	247
GO Bond	1,603	2,289	1,862
State Interest on GO Bond Debt ^b	491	695	667
Designated Special Fund ^c	4,980	7,122	3,366
Local Agency ^d	27,823	33,382	33,382
Federal Government ^e	788	1,074	616

Notes:

GO = general obligation

^a Table columns and row totals may not sum correctly because of rounding.

^b Interest on water related general obligation bonds debt from the California Department of Finance (<http://www.ebudget.ca.gov/2015-16/pdf/GovernorsBudget/8000/9600.pdf>).

^c Designated special fund mechanism includes fees, assessments, taxes, and other revenue sources with a designated purpose.

^d Local agency funding is from city, county and special district general funds, user fees, and GO bonds for water resources associated capital and some ongoing actions (excludes administrative and local agency operation and maintenance activities).

^e Federal government funding is from congressional appropriation for the Bureau of Land Management, Federal Emergency Management Agency, National Oceanic and Atmospheric Administration, U.S. National Park Service, Natural Resources Conservation Service, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, and U.S. Forest Service, water resources management associated capital and some ongoing actions (excludes administrative and federal operation and maintenance activities).

Table 4-3 Attributes of Current Funding Mechanisms for State Investments

Funding Mechanism	Inter-Annual Reliability (High, Moderate, Low)	Capital and Ongoing Applicability (High, Moderate, Low)	Ongoing	Cost-Share Range (Minimum – Maximum)	Revenue Sources
General Fund	Moderate: dependent on State budgeting	Low	High	20% to 100% for capital, data, tools, and planning actions Up to 100% for ongoing and policy actions	Income taxes, corporate taxes, sales and use taxes, other State General Fund revenue sources
General Obligation Bond	Low	High	Low	20% to 100% for capital, data, tools, and planning actions Cost shares for qualified ongoing actions depends on bond language.	Income taxpayers, corporate taxes, sales and use taxes, other State General Fund revenue sources
Greenhouse Gas (GHG) Cap-and-Trade Program Fund	Moderate: dependent on market factors	High: ecosystem and other actions that reduce GHGs N/A: capital, OMRR&R, ongoing actions unrelated to GHG reduction	High: ecosystem and other actions that reduce GHGs N/A: capital, OMRR&R, ongoing actions unrelated to GHG reduction	Up to 80% of capital and planning actions that show nexus to GHG reductions	Qualified bidders in California's Cap-and-Trade Program
Public-Private Partnership (P3)	High	High	High	Dependent on the agreement that establishes P3	Dependent on establishment of P3 but could include private entity(s), ratepayers, property owners, other identified beneficiaries
User Fees	High	High: actions related to benefit N/A: capital, OMRR&R, ongoing actions unrelated to identified fee benefit	High: actions related to benefit N/A: capital, OMRR&R, ongoing actions unrelated to identified fee benefit	Up to 80% of capital and planning actions related to benefit	Water use ratepayers (urban and/or agricultural)

Notes:

N/A = not applicable; OMRR&R = operations, maintenance, repair, rehabilitation, and replace
Historically, different water management sectors have relied on different funding mechanisms.

Table summarized from information in *Funding Mechanism Inventory and Evaluation* (CH2M Hill 2018b).

Novel Funding Mechanisms

Recommended Action 6.7 encourages the broader water stakeholder community to individually or collectively consider additional financing mechanisms to support sustainability. Novel funding mechanisms could provide the State with additional options for funding water resource management. They would generate revenues outside of the current State funding mechanisms and could be applied individually or in various combinations. Combined with current funding mechanisms, novel mechanisms could augment funding levels, provide more stability, and more directly link revenues and expenditures to the beneficiaries of water management activities.

This discussion of novel mechanisms is intended to help balance funding decisions with prevailing policy considerations, such as the amount of debt the State will tolerate, the feasibility of novel mechanisms in any given legislative session, and urgency of infrastructure needs relative to the multitude of other State government roles and responsibilities.

Integral to the authorization and administration of any novel mechanism would be consideration and application of shared funding tenets, described in *California Water Plan Update 2013*. For example, a novel mechanism must improve cost effectiveness and administrative efficiency for it to be considered. In applying any novel mechanism, the ability and willingness of the public, or local agencies, to pay must be considered. That willingness can increase when those entrusted with public funding are seen as good stewards who provide transparency, accountability, and clarity of purpose in their novel mechanism decisions. Table 4-4 lists the attributes of these novel funding mechanisms.

Novel mechanisms can be administered by local, regional, or State government. State-administered novel mechanisms should be designed to minimize the impact on local agencies' ability to generate revenue.

The novel mechanisms, as summarized from *Funding Mechanism Inventory and Evaluation* (CH2M Hill 2018b), include the following:

- **Watershed Assessment:** An assessment at a watershed or similar scale, on water ratepayers, property owners, and other beneficiaries, could be used to fund water management actions within the assessment area.
- **Water Surcharge Fee:** A water use surcharge on retail water sales could be used to generate revenue for water projects. The fee could support actions, including integrated water resource management. Revenue generated by a water use surcharge would require actions funded to demonstrate a nexus to the fee.
- **Risk Reduction Insurance:** Risk reduction insurance could be used to support funding of management actions to reduce risks from flooding. Implementation could involve the State partnering with private insurers and underwriters to effectively develop a State insurance program that would either replace or augment existing traditional flood insurance programs. The State would use a portion of the insurance premiums to implement risk-reduction management actions. The remaining revenues would support policy holders in the event of a flood (California Department of Water Resources 2017).
- **Water Markets:** Water markets allow willing buyers and sellers to shift the use of water through exchanges, one-time purchases, short-term leases, long-term leases, or permanent sale of water rights or contract quantities. Revenue could be generated from water markets by assessing a fee or per unit charge for each transfer, which could be used to implement management actions.

Table 4-4 Attributes of Novel Funding Mechanisms for State Investments

Funding Mechanism	Inter-Annual Reliability (High, Moderate, Low)	Capital and Ongoing Applicability (High, Moderate, Low)	Cost-Share Range (Minimum – Maximum)	Revenue Sources
Novel Mechanisms				
Watershed Assessment	High	High	High	Up to 100% for State services and policy actions Up to 80% of infrastructure and planning actions Cost shares for qualified ongoing actions depends on bond language.
Water Surcharge Fee	Moderate: dependent on resource usage	Moderate: dependent on nexus to fee	Moderate: dependent on nexus to fee	Up to 80% of capital, ongoing, and policy actions related to benefit
Risk Reduction Insurance	Moderate: dependent on number of insurance policies purchased	Moderate: dependent on linkage to risk reduction actions	Moderate: dependent on linkage to risk reduction actions	Up to 100% of risk reduction related capital, ongoing, and policy actions
Water Markets	Variable/Moderate: dependent on market factors	Moderate: dependent on nexus to resource benefit	Moderate: dependent on nexus to resource benefit	Up to 80% of capital, ongoing, and policy actions
Enhanced Infrastructure Finance Districts (EIFDs)	High	High	High	Dependent on EIFD establishment language; Up to 100% of capital and ongoing

Notes:

Historically, different water management sectors have relied on different funding mechanisms.

Table summarized from information in *Funding Mechanism Inventory and Evaluation* (CH2M Hill 2018b).

- Enhanced Infrastructure Finance Districts (EIFDs):** EIFDs were established in 2014 to enable local governments (counties, cities, and special districts) to jointly use a variety of funding and financing powers that they may not possess individually. The new authority is applicable to a watershed-wide project financing because the boundaries of the EIFD may include the watershed. These funding and financing authorities include capturing a portion of the growth in the property tax and/or sales tax, use of benefit assessments for specifically benefited property, and the levy of special taxes through the Mello-Roos authority. The EIFD can fund and finance a wide variety of public infrastructure and private facilities that benefit the watershed.

Funding Scenarios

Several funding scenarios were developed to evaluate the plausibility and trade-offs of different combinations of current funding mechanisms. Each scenario represents a different contribution of mechanisms to provide the additional funding called for in Chapter 3. These scenarios were compared with current funding trends, assuming that average annual State, local, and federal funding levels remain unchanged (Table 4-2). By comparing the scenarios with current trends, a common frame of reference is established to examine how benefits and impacts vary among the scenarios.

These scenarios are focused on State funding and, for the purposes of identifying trade-offs, do not consider variations in local or federal funding. Table 4-5 summarizes the funding level assumed for each mechanism under each scenario.

Table 4-5 Funding Mechanisms Utilized by Each Scenario

Funding Scenario	Assumed Funding Level by Mechanism	
	State General Fund	General Obligation Bonds
Scenario A – Emphasis on General Obligation Bonds	Average Historical	Significant Increase
Scenario B – Emphasis on State General Fund	Significant Increase	Average Historical
Scenario C – Increase in Both General Obligation Bonds and State General Fund	Significant Increase	Maximum Historical

Scenario A: Emphasis on General Obligation Bonds — This scenario depicts the debt, and interest on the debt, throughout the 50-year planning horizon, accompanied by increased borrowing. State general funding remains at the historical average level. State GO bonds increase to pay for recommended actions. Local funding and federal funding remain at historical annual averages.

Scenario B: Emphasis on State General Fund — This scenario explores increasing appropriations from the State General Fund without additional borrowing. State general funding increases to implement the recommended actions. State GO bonds remain at the historical average level. Local funding and federal funding remain at historical annual averages.

Scenario C: Increase in Both General Obligation Bonds and State General Fund — This scenario uses GO bonds at maximum historical levels and increases State general funding as needed to fund Update 2018 recommendations. Local funding and federal funding remain at historical annual averages.

Findings

There are many complexities, considerations, and uncertainties in determining appropriate, feasible, equitable, and cost-effective mechanisms to fund Update 2018 implementation. The funding scenario metrics and findings described in this section provide a common basis for evaluating trade-offs among the different scenarios.

Funding Scenario Metrics

These funding scenario metrics were used to analyze the funding scenarios.

- **Total Annual Funding by Funding Mechanism** — Represents annual amounts provided by each mechanism for both ongoing and capital funding needs. This helps derive the proportional funding amounts among of the mechanisms used in each scenario.
- **Total Funding Required over Planning Horizon** — Depicts the total State funding required to implement the recommended actions over the next 50 years. This metric is particularly useful for understanding the cost of borrowing.
- **Annual Fiscal Impacts of Funding Mechanisms** — Illustrates the relative magnitude of cost impacts from funding mechanisms and their distribution expressed in terms of households and individuals. These metrics are illustrative and not intended to signal a specific funding mechanism or literal distribution of costs among Californians.
 - **Cost per Household** — The equivalent cost per household, assuming 85 percent of households has the ability to pay.
 - **Equivalent Cost per Capita** — The equivalent cost per capita assumes 85 percent of the total population pays and 85 percent of the population has the ability to pay.

Funding Scenario Findings

For every scenario, total annual local and federal funding is assumed to remain at current levels of approximately \$28 billion and \$800 million, respectively.

Scenario A: Emphasis on General Obligation Bonds — Historical average funding from State GO bonds would need to be more than doubled to fully fund the recommended actions. Relative to current trends, this would significantly increase interest accrued on debt, for a total of more than \$64 billion in interest over the 50-year planning horizon. Because GO bonds are intermittent and unpredictable, they are not appropriate for funding ongoing activities. Moreover, borrowing to pay for ongoing State activities is inconsistent with several shared funding tenets, including good stewardship of State government monies, recognition of the cost of borrowing, and the risks of indebtedness.

Scenario B: Emphasis on State General Fund — This scenario would require a considerable increase (more than eight times the historical average) in State General Fund appropriations to implement the recommended actions. State General Fund appropriations have a lower inter-annual reliability because they must compete with other State services for funding. Because it is highly unlikely the State would increase State General Fund appropriations by more than eight times, this scenario is inconsistent with the shared funding tenet that calls for reasonable assumptions about future revenues.

Scenario C: Increase in Both General Obligation Bonds and State General Fund — This would require an increase of more than five times the historical average of State General Fund appropriations, while sustaining the historical maximum funding from GO bonds. There are several shared funding tenets

that would be integral to the authorization and administration of such a large increase in State General Fund appropriations. They include no redirection of GO bond or other existing mechanisms, as well as assurances regarding value, cost effectiveness, and efficiency.

A Shared Vision for California’s Water Future

Update 2018 envisions a future where all Californians benefit from reduced flood risk, more reliable water supplies, reduced groundwater depletion, and greater habitat and species resiliency. It suggests actions to help align decision-making processes, track outcomes and adaptively manage programs and investments to achieve the sustainability goals.

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Supporting Documents

California Water Plan Update 2018 draws from and builds on reference documents related to water resources to enhance the content and produce a better plan with each succeeding update. These documents provide the methodology, assumptions, data, estimates, and other information used in the development of this update.

California Regional Water Management Planning (in preparation)

The water management planning tool or “Regional Atlas,” is an online information platform for local entities to continuously update information about integrated water management projects in their representative area.

Funding Mechanism Inventory and Evaluation

This document provides a description of the current and novel funding mechanisms, as well as assumptions used in the funding analysis in Update 2018.

Funding Scenario Analysis

This document provides a description of the funding analysis as well as the scenarios evaluated by the funding analysis in Update 2018.

Future Water Scenarios (in preparation)

Future water supply and demand scenarios developed by the California Water Plan to analyze long-term future climate, urban growth, and land use conditions and their effect on long-term water demand conditions.

Historical Expenditures and Current and Future Funding Needs

This document provides a description of California’s water resources management historical expenditures and the current and future funding needs in the state.

Incorporating Remote Sensing for Land Use Information (in preparation)

This document provides a description of how land use information is used by various users and the current and potential future methods for collecting, managing and distributing this information to meet those needs.

Strategic Data Framework (in preparation)

The Strategic Data Framework aims to connect the California Department of Water Resources programs to support achieving the sustainable water management goals of the Water Plan, the California Water Action Plan, and the Sustainable Groundwater Management Act of 2014.

The Sustainability Outlook: A Summary

The Sustainability Outlook establishes a comprehensive method, or tool, for tracking and reporting the progress and the effectiveness of implementing water management actions and policies, as well as return on investment. By doing so, the Sustainability Outlook provides shared agreement and consistency across State government and local governments throughout California’s diverse regions.

Sustainability Outlook Indicator Descriptions and Methodology

The Sustainability Outlook relies on identified indicators to track status and progress toward sustainability, including the effectiveness of State water policies and return on investments. This document details the process for developing the indicators.

Sustainability Outlook Pilot Project: Russian River Watershed (in preparation)

The Russian River watershed was selected as a pilot area because of established relationships. In addition, the innovative and participatory local entities involved have fewer distinctive jurisdictions or agencies compared with other watersheds in the state. As planned, this pilot is applying the outcome-based planning concepts advanced by Update 2018 at a watershed scale.

Sustainability Outlook Pilot Project: Santa Ana River Watershed (in preparation)

The Santa Ana River watershed was selected as a pilot area because of established relationships, as well as the innovative sustainability planning of the One Water One Watershed (OWOW) plans coordinated by the Santa Ana Watershed Project Authority. The OWOW 2.0 Plan (2014) created an indicators-based tool for assessing integrated regional water management plan performance, based on earlier California Department of Water Resources grant-supported work at the Council for Watershed Health and California Water Plan Update 2013 work at University of California, Davis. This pilot draws from the earlier work and the experience in the region with application of the Water Foundation's Sustainability Water Management Profile.

Water Budget Development Practitioner's Handbook (in preparation)

The Water Budget Handbook will provide a tool to develop water budgets for any geographic area and time period, using data and models, or a combination thereof. This will allow local agencies to develop their own water budgets.

Water Budget Pilot Projects (in preparation)

A proof of concept for the Water Budget Handbook, pilot projects for the Tulare Lake and Central Coast hydrologic regions demonstrate the value of water budgets to achieve and manage water resources sustainability.

Water Portfolios and Balances (in preparation)

Water portfolios and balances describe the distribution of water throughout the hydrologic cycle, water use by the urban and agricultural sectors, water in the environment, and water supply sources used to meet these uses at the statewide and regional level.

Featured Companion State Plans

These State government plans, related to water resources, were used to inform policy recommendations and short- and long-term actions in California Water Plan Update 2018.

2010 Strategic Fire Plan for California (California Department of Forestry and Fire Protection) (2010)

2015 Statewide Comprehensive Outdoor Recreation Plan (California Department of Parks and Recreation) (2015)

2016–19 Strategic Action Plan (Sierra Nevada Conservancy) (2015)

2017–2022 Delta Conservancy Strategic Plan (Sacramento-San Joaquin Delta Conservancy Board) (2017)

2018 Energy Policy Report Update (California Energy Commission) (2018)

2018 State Hazard Mitigation Plan (Governor’s Office of Emergency Services) (Public Review Draft, 2018)

Bulletin 118 — Interim Update 2016 (California Department of Water Resources) (2016)

California Agricultural Vision Update (California Department of Food and Agriculture, State Board of Food and Agriculture) (2017)

California Drought of 2012–2016 (California Department of Water Resources) (in preparation)

California EcoRestore (California Natural Resources Agency)

California Native American Tribal Engagement in the California Water Plan Update 2013 — Tribal Engagement Plan (California Water Plan, Tribal Communication Committee) (2010)

California Ocean Protection Council Five-Year Strategic Plan 2012–2017 (California Ocean Protection Council)

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California Strategic Growth Council Strategic Plan 2012-2014 (Strategic Growth Council) (2012)

California Transportation Plan 2040 (California Department of Transportation) (2016)

California Water Action Plan (California Natural Resources Agency, California Department of Food and Agriculture, California Environmental Protection Agency) (2016)

California Water Commission Strategic Plan 2012 (California Water Commission) (2012)

California WaterFix (California Natural Resources Agency)

California's 2017 Climate Change Scoping Plan Update (California Air Resources Board) (2017)

California's Forests and Rangelands: 2010 Strategy Report (California Department of Forestry and Fire Protection) (2010)

California's Forests and Rangelands: 2017 Assessment (California Department of Forestry and Fire Protection) (2017)

Central Valley Flood Protection Plan 2017 Update (California Department of Water Resources) (2017)

Delta Plan (Delta Stewardship Council) (2017)

Department of Toxic Substances Control 2014-2018 Strategic Plan (California Department of Toxic Substances Control) (2014)

Division of Safety of Dams Strategic Plan (California Department of Water Resources) (in preparation)

Environmental Goals and Policy Report (Governor's Office of Planning and Research) (Draft, 2015)

General Plan Guidelines (Governor's Office of Planning and Research) (2017)

Investing in California's Flood Future (California Department of Water Resources) (in preparation)

Making Water Conservation a California Way of Life: Implementing Executive Order B-37-16 (California Department of Water Resources, California State Water Resources Control Board, California Public Utilities Commission, California Department of Food and Agriculture, California Energy Commission) (2017)

Making Water Conservation a California Way of Life: Implementing SB 606 and AB 1668 (California Department of Water Resources, California State Water Resources Control Board, California Public Utilities Commission, California Department of Food and Agriculture, California Energy Commission) (in preparation)

Recycled Water Policy (State Water Resources Control Board) (2013)

Regional Water Quality Control Plans (Basin Plans) (State Water Resources Control Board) (various)

Rising Seas in California: An Update on Sea-Level Science (California Ocean Protection Council) (2017)

Safe Drinking Water Plan for California (State Water Resources Control Board) (2015)

Safeguarding California: Implementation Action Plans (California Natural Resources Agency) (2016)

Safeguarding California Plan: 2018 Update – California’s Climate Adaptation Strategy (California Natural Resources Agency) (2018)

San Francisco Bay/Sacramento – San Joaquin Delta Estuary Water Quality Control Plan (State Water Resources Control Board) (in preparation)

Stakeholder Perspectives — Recommendations for Sustaining and Strengthening IRWM (California Department of Water Resources) (2017)

State Coastal Conservancy Strategic Plan 2018–2022 (California State Coastal Conservancy) (2017)

State of California Emergency Plan (Governor’s Office of Emergency Services) (2017)

Strategic Plan for AB 1755, the Open and Transparent Water Data Act (California Department of Water Resources, State Water Resources Control Board, California Department of Fish and Wildlife, Water Quality Monitoring Council, Governor’s Office of Planning and Research, California Government Operations Agency, Delta Stewardship Council, California Natural Resources Agency) (2018)

Strategic Plan Update 2008–2012 (State Water Resources Control Board) (2008)

Strategy to Optimize Resource Management of Storm Water (State Water Resources Control Board) (2016)

Threat, Hazard Identification and Risk Assessment 2017 (Governor’s Office of Emergency Services) (in preparation)

Vision 2030 Strategic Plan (Delta Protection Commission) (2015)

Water Action Plan (California Public Utilities Commission) (2010)

Useful Web Links

California Biodiversity Initiative: A Roadmap for Protecting the State's Natural Heritage
<http://opr.ca.gov/docs/20180907-CaliforniaBiodiversityActionPlan.pdf>

California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018
https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB5

California EcoRestore
<http://resources.ca.gov/ecorestore/>

California Environmental Quality Act (CEQA)
<http://resources.ca.gov/ceqa/>

California's Groundwater Update 2013
<https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Water-Basics/GroundWater/Files/Resources-And-Reports/Californias--Groundwater-Update-2013.pdf>

California State Wildlife Action Plan
<https://www.wildlife.ca.gov/SWAP/Final>

California Water Action Plan
http://resources.ca.gov/docs/california_water_action_plan/Final_California_Water_Action_Plan.pdf

California WaterFix
<https://www.californiawaterfix.com/>

California Water Plan resource management strategies
<https://water.ca.gov/Programs/California-Water-Plan/Water-Resource-Management-Strategies>

California Water Plan Update 2013
<https://www.water.ca.gov/Programs/California-Water-Plan/Water-Plan-Updates>

California Water Plan Update 2018 (Public Review Draft)
<https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2018/PRD/California-Water-Plan-Update-2018-Public-Review-Draft.pdf>

California Water Plan Water Portfolios
<https://www.water.ca.gov/Programs/California-Water-Plan/Water-Portfolios>

Featured Companion State Plans
<https://water.ca.gov/Programs/California-Water-Plan/Water-Plan-Updates>

Flood-Managed Aquifer Recharge (Flood-MAR)

<https://www.water.ca.gov/Programs/All-Programs/Flood-MAR>

Healthy Soils Program

<https://www.cdfa.ca.gov/oefi/healthysouils/>

Indicators of Climate Change in California

<https://oehha.ca.gov/climate-change/report/2018-report-indicators-climate-change-california>

Integrated Regional Water Management Grant Programs

<https://water.ca.gov/Work-With-Us/Grants-And-Loans/IRWM-Grant-Programs>

Regional Conservation Investment Strategies Program

<https://www.wildlife.ca.gov/conservation/planning/regional-conservation>

Research and Data Development Framework (Discussion Draft, Flood-MAR)

<https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Flood-MAR/2018-Flood-MAR-Development-Framework.pdf?la=en&hash=303A3499F166005F3817BCFEF5A79BD21E20057B>

Safeguarding California Plan: 2018 Update

<http://resources.ca.gov/docs/climate/safeguarding/update2018/safeguarding-california-plan-2018-update.pdf>

Stakeholder Perspectives: Recommendations for Sustaining and Strengthening Integrated Regional Water Management

https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Integrated-Regional-Water-Management/Files/stackholder_perspectives_IRWM_Recommendations.pdf

State Contracting Manual

<http://www.dgs.ca.gov/ols/Resources/StateContractManual.aspx>

The Sustainability Outlook: A Summary

<https://water.ca.gov/Programs/California-Water-Plan/Water-Plan-Updates>

Sustainable Groundwater Management Act (SGMA) of 2014

<https://www.water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management>

System Reoperation Study (California Department of Water Resources report)

<https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/System-Reoperation-Program/Files/Assessment-of-Reoperation-Strategies.pdf?la=en&hash=63D60B5425EB65AB16D8AA4C314D6053A229E7BC>

Update 2018 Supporting Documents

<https://water.ca.gov/Programs/California-Water-Plan/Water-Plan-Updates>

Water Available for Replenishment (California Department of Water Resources report)

<https://www.water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Data-and-Tools/Files/Statewide-Reports/WAFR/Final/Water-Available-for-Replenishment---Final-Report.pdf>

Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary

https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/wq_control_plans/2006wqcp/docs/2006_plan_final.pdf

Process for updating Water Quality Control Plan

https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/

Water Quality, Supply, and Infrastructure Improvement Act of 2014

http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1471

Water Year Hydrologic Classification Indices

<http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST>

