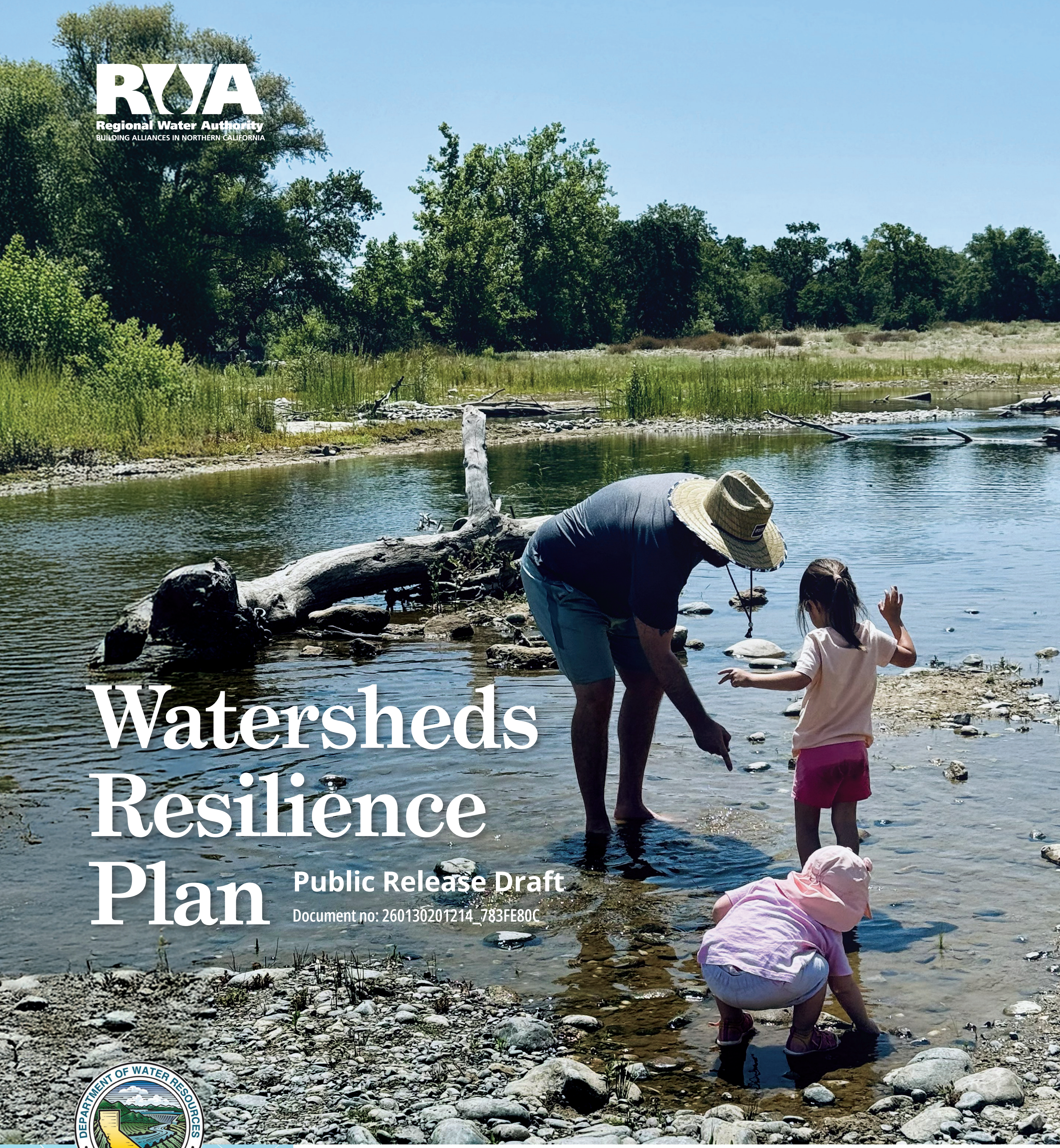
RWA
Regional Water Authority
BUILDING ALLIANCES IN NORTHERN CALIFORNIA



Watersheds Resilience Plan

Public Release Draft

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DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

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Prepared by Jacobs with Support from Valley Vision and Khadam Consulting

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RWA Watersheds Resilience Plan

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Acronyms and abbreviations

Acronym	Description
°F	degree(s) Fahrenheit
American-Bear	American River and Bear River watersheds
AMO	Atlantic Multidecadal Oscillation
AR	atmospheric river
ARBS	American River Basin Study
BRIC	Building Resistant Infrastructure and Communities
CalEPA	California Environmental Protection Agency
CHIRP	California Heritage: Indigenous Research Project
cm	centimeter(s)
CMIP6	Coupled Model Intercomparison Project Phase 6
CNRA	California Natural Resource Agency
CoSANA	Cosumnes-South American-North American (model)
CWSRF	Clean Water State Revolving Fund
Delta	Sacramento-San Joaquin Delta
DWR	California Department of Water Resources
DWSRF	Drinking Water State Revolving Fund
ENSO	El Niño–Southern Oscillation
EPA	U.S. Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRO	Forecast-Informed Reservoir Operations
FY26	Fiscal Year 2026
GIS	Geographic Information System
HD	Hot-Dry
HUC-8	Hydrologic Unit Code-8
NOAA	National Oceanic and Atmospheric Administration
OBBBA	One Big Beautiful Bill Act
PDO	Pacific Decadal Oscillation
Reclamation	US Department of the Interior, Bureau of Reclamation
RWA	Regional Water Authority
RWA WRP	Regional Water Authority Watersheds Resilience Plan
SLR	sea level rise

Acronym	Description
SWE	Snow Water Equivalent
TEC	California Tribal Engagement Coalition
TEK	Traditional Ecological Knowledge
VCP	Vulnerable Communities Platform
VIC	Variable Infiltration Capacity
WCB	Wildlife Conservation Board
WRFP	Water Recycling Funding Program
WSIP	Water Storage Investment Program
WW	Warm-Wet

Acknowledgements

The RWA Watersheds Resilience Pilot Project is the result of a broad regional effort supported by many organizations and individuals who contributed their insight, time, and commitment throughout the planning process. This initiative reflects collaboration across water agencies, Tribal partners, community organizations, technical experts, and watershed residents—these valued collaborators helped shape a shared understanding of climate vulnerabilities and opportunities for long-term resilience.

We recognize the California Department of Water Resources (DWR) for funding and supporting this pilot under the Watershed Resilience Program. Their investment allowed the project team to integrate climate science, vulnerability assessment, and watershed-scale collaboration across the American, Bear, and Cosumnes River watersheds.

We acknowledge the RWA and its members for its leadership and coordination in carrying this Pilot forward. RWA played a central convening role, bringing together Advisory Committee members, Watershed Network participants, and project partners to examine climate vulnerabilities, shape adaptation strategies, and refine the overall planning direction. RWA ensured that a wide range of local, regional, and community viewpoints were reflected in the planning process, through facilitation of discussions, follow-through on action items, and commitment to transparent decision-making.

Watershed Network, Tribal Partners, and Community Contributors

We thank the Watershed Network members who contributed perspectives across sectors including groundwater, forest health, flood management, community resilience, and ecosystem stewardship. Their involvement supported the development of a truly collaborative watershed vision. We also acknowledge the Tribal partners who participated in meetings and consultations, sharing insights, stewardship practices, and community priorities. Their involvement remains essential as the region continues to advance watershed resilience. We also extend our appreciation to the many community-based organizations, technical experts, and local residents who participated in workshops, reviewed materials, provided comments, and contributed local knowledge throughout the pilot process.

Advisory Committee

The Advisory Committee played an essential role by offering detailed expertise, practical experience, and regional insight that strengthened the technical analysis and enhanced the relevance of the adaptation strategies. We express our sincere thanks to each of the following members for their participation throughout the Pilot's development:

Alice Towey, East Bay Municipal Utility District
Ashlee Casey, Water Forum
Austin Miller, Sacramento County / Sacramento County Department of Water Resources
Brett Ewart, City of Sacramento
Brian Sanders, City of Sacramento
Chris Brown, Sacramento Climate Coalition / Environmental Council of Sacramento (ECOS)
Clyde Macdonald, Save the American River Association
Ethan Livingston, Sacramento County
Gary Bardini, Sacramento Area Flood Control Agency
Greg Jones, Nevada Irrigation District
Laura Rodarte, Placer County Water Agency (PCWA)
Michael Saunders, Georgetown Divide Public Utility District
Rebecca Guo, El Dorado Water Agency
Sean Bigley, City of Roseville
Ted Rauh, ECOS
Tony Firenzi, PCWA

Their thoughtful guidance strengthened the Pilot's technical rigor, shaped refinements to vulnerability assessment methods, and helped align proposed strategies with real implementation needs in the region.

Project Team

Lastly, we would like to thank the project team members from RWA, Jacobs, Valley Vision, and Khadam Consulting who supported development, facilitation, engagement, modeling, and plan integration. Their work provided the science-based foundation and collaborative framework needed to advance a comprehensive watershed resilience plan.

Tribal Land Acknowledgement

The Regional Water Authority (RWA) Watersheds Resilience Pilot study area encompasses the American, Bear, and Cosumnes River watersheds, as well as the eastside tributaries of the Feather and Sacramento Rivers between the Bear River mouth and Mokelumne River mouth, and the City of West Sacramento.

We acknowledge and honor the original stewards of this region: the Indigenous peoples who have lived in and cared for these lands and waterways for centuries. This study area includes the ancestral homelands of the Me-wuk, Nisenan, Miwok, Maidu, Paiute, Pit River, Washoe, and Yokut peoples. For generations, these Tribal Nations and communities have passed down cultural traditions, ecological knowledge, and land management practices that continue to shape the health of the region today.

The history of this region bears the impacts of displacement, violence, and systemic injustices that have profoundly disrupted Indigenous peoples and their ways of life. These injustices have led to the mismanagement and over-extraction of natural lands and resources, causing ecological degradation that threatens the resilience and wellbeing of all communities. We are called to return to traditional knowledge and stewardship practices to honor Indigenous leadership, uphold equity, and restore ecological balance essential to the wellbeing of us all.

We honor the presence and leadership of Tribal communities and recognize our responsibility to work in partnership with Tribal communities toward a more sustainable and equitable future. Efforts like the Watershed Resilience Pilot are a step forward in addressing these legacies, centering Indigenous knowledge, and advancing collaborative stewardship that supports the wellbeing of the natural environment and all who depend on it.

1. Introduction

The Regional Water Authority (RWA) Watersheds are a critical component of California's water system, supplying drinking water to over 2 million people, supporting agriculture, sustaining ecosystems, and providing recreational and cultural value to communities across the region. The RWA Watersheds also contribute approximately 8% of California's total human water use, serving a rapidly growing population in the Sacramento metropolitan region. However, the watersheds are increasingly vulnerable to the impacts of climate change, including prolonged droughts, declining snowpack, catastrophic wildfires, and more frequent and intense flood events.

Recognizing the urgent need for integrated, climate-resilient watershed management across the State, the California Department of Water Resources (DWR) launched the Watershed Resilience Pilot Program in 2024. This initiative supports regional efforts to develop comprehensive, community-informed strategies that enhance watershed resilience through collaboration, science-based planning, and multi-benefit solutions.

The RWA Watersheds Resilience Plan (WRP), led by RWA in partnership with local, Tribal, State, and Federal stakeholders, was selected as one of five pilot regions. This report presents the outcomes of the overall planning process, including a shared vision for resilience, a suite of prioritized adaptation strategies, and a roadmap for implementation that reflects the region's unique hydrology, governance, and community needs.

1.1 Plan Purpose and Objectives

The purpose of this plan is to provide a comprehensive, science-based, collaborative framework for addressing climate vulnerabilities and guiding long-term resilience actions across the American, Bear, and Cosumnes River watersheds. It is designed to align with the vision established by regional interests and DWR's Statewide objectives, verifying that the strategies reflect local priorities while meeting broader resilience goals. The plan seeks to assess climate risks across multiple sectors; engage diverse partners and community members; and develop adaptation strategies to balance ecological health, economic vitality, and cultural values. Equity is embedded throughout the process, prioritizing the needs of disadvantaged and frontline communities and incorporating diverse perspectives into technical analysis. By establishing measurable performance indicators, the plan confirms accountability and provides a roadmap for future investments that sustain the resilience of communities and ecosystems under changing climate conditions.

1.2 Background

Building on the need for proactive climate adaptation, the DWR's Watershed Resilience Pilot Program represents a new approach to integrated water management in California. It seeks to move beyond traditional, sector-specific planning by fostering collaboration across water, land, forest, and ecosystem management while embedding equity and community participation at every stage. This program provides a framework for regions to identify vulnerabilities, prioritize multi-benefit strategies, and create actionable plans that strengthen resilience for both people and ecosystems.

1.2.1 Watershed Resilience Pilot Program Overview

DWR launched the Watershed Resilience Pilot Program in 2024 to support regional efforts in developing science-based, community-informed strategies for climate resilience. The RWA Watersheds were selected as one of five pilot regions due to its strategic importance, diverse stakeholder landscape, and high exposure to climate hazards. Watershed Resilience Pilot Program was designed to achieve the following:

- **Advance integrated watershed-scale planning** that aligns water, land, forest, and ecosystem management.
- **Foster inclusive governance** by engaging a broad range of stakeholders, including underrepresented communities and Tribal governments.
- **Identify and prioritize resilience strategies** that deliver multiple benefits—such as water supply reliability, wildfire risk reduction, habitat restoration, and community resilience.
- **Develop a replicable planning framework** that can inform future watershed resilience efforts across California.

1.3 Planning Approach and Methodology

The planning approach for the RWA WRP followed DWR's framework for watershed resilience planning, displayed on Figure 1-1, which emphasizes integrating technical analysis with community input to develop multi-benefit strategies. The process began with a comprehensive review of existing studies and data within the planning area to identify gaps and inform vulnerability assessments across various sectors. This gap analysis also provided the foundation for the selection of climate scenarios and identification of potential modeling approaches, verifying that quantitative analyses address current information gaps and provide adequate resources for adaptation strategy development.

Figure 1-1. Watershed Resilience Planning Framework

Source: DWR 2023

Climate modeling and sector-specific risk analysis risk analysis was complemented by a qualitative analysis and input from regional community members. Watershed Network meetings, surveys, and targeted discussions provided opportunities for regional participants to shape priorities and strategies throughout the process. Community input was integrated alongside hydrologic and climate data to confirm that locally informed solutions were considered and represented. Interactive tools and continuous feedback verified transparency and adaptability throughout the overall process, producing strategies that integrated rigorous technical analysis with local knowledge and community priorities.

1.4 Focus Sectors of Assessment

The RWA Watersheds are a critical hydrologic and ecological system in Northern California, spanning over 2,000 square miles from the Sierra Nevada to the Sacramento Valley. The watersheds support a wide range of interconnected water resource functions, including municipal and agricultural water supply, groundwater recharge, flood management, ecosystem services, hydropower generation, and recreation. The RWA WRP is designed to evaluate climate vulnerability and resilience across a broad set of interrelated water and land resource sectors. These sectors were selected based on their critical role in watershed function, their sensitivity to climate change, and their alignment with DWR's Watershed Resilience Program framework. The assessment focuses on the following key sectors:

- **Water Supply**: Evaluates the reliability and variability of surface water availability under changing precipitation and snowpack conditions
- **Groundwater**: Assesses recharge potential, historical overdraft, and the role of aquifers in supporting drought resilience
- **Flood Management**: Analyzes exposure to extreme precipitation events, levee vulnerabilities, and the capacity of flood infrastructure
- **Ecosystems**: Examines the health and connectivity of aquatic and riparian habitats, including flow-dependent species such as Chinook salmon and steelhead
- **Water Quality**: Considers the impacts of wildfire, drought, and land use on sedimentation, temperature, and contaminant loading
- **Recreation**: Considers the effects of changing flow regimes and reservoir levels on river- and lake-based recreation
- **Hydropower**: Assesses the implications of altered runoff timing and volume on energy generation from key facilities
- **Agriculture and Urban Water Supply**: Considers agricultural and urban water uses, demands, surface water and groundwater deliveries, and supply-demand imbalances

These sectors form the foundation of the vulnerability and risk assessments and are used to guide the development of adaptation strategies and performance metrics throughout the planning process.

1.4.1 Equity Considerations

Communities facing systemic inequities—particularly in the lower portion of the planning area—are disproportionately exposed to climate hazards such as flooding, drought, and extreme heat. These include historically underserved neighborhoods in Sacramento, rural communities, and California Native American Tribes. Many of these groups lack adequate infrastructure, representation in water governance, or access to adaptation resources. Addressing these disparities through inclusive planning, targeted investments, and equitable governance is essential to building resilience across the watershed.

1.4.2 Water Supply

Climate projections indicate a shift in precipitation patterns, with more falling as rain and less as snow, reducing natural snowpack storage and increasing early-season runoff. This shift is expected to intensify the conflict between flood control and water supply operations. Even with conservation measures, regional water demand is projected to increase by 7 to 8% due to longer, hotter summers (USBR 2022).

1.4.3 Groundwater

The RWA Watersheds includes three major groundwater basins: the North American, South American, and Cosumnes Subbasins, which are located within the lower basins (valley floor). Groundwater from these three aquifers is essential for environmental, domestic, urban, and agricultural supply users and uses. During drought periods, groundwater use is intensified to compensate for the reduction in surface water supplies. However, historical overdraft—especially in the Cosumnes and South American Subbasins—has led to declining groundwater levels and reduced baseflows to the Cosumnes River. Future recharge opportunities may be further constrained by reduced snowmelt and more intense, less infiltrative precipitation events.

The upper basins do not contain formally recognized groundwater basins; instead, groundwater occurs primarily within fractured rock aquifers that are discontinuous and highly localized. These aquifers have limited storage and variable yields, making them inherently unreliable as a consistent water supply source. As a result, they are generally not used for municipal supply and instead serve primarily individual landowners and small water systems.

1.4.4 Flood Management

Flooding is a persistent hazard in the RWA Watersheds, driven by atmospheric rivers, snowmelt, and aging infrastructure. Major flood events in 2017 and 2023 underscored the vulnerability of the Lower American River, where urban development limits options for levee setbacks or floodplain expansion. Earlier and more intense runoff is expected to increase flood risk, particularly in Sacramento and surrounding communities.

1.4.5 Ecosystems

The RWA Watersheds support diverse ecosystems, from alpine forests and coldwater streams in the upper portions of the planning area to riparian corridors and wetlands in the lower regions of the planning area. These habitats are home to over 43 fish species, including threatened steelhead and Chinook salmon, as well as countless terrestrial species. The American River Parkway provides a critical ecological and recreational corridor through Sacramento. However, climate-driven changes in flow, temperature, and sedimentation threaten the health and connectivity of these ecosystems.

1.4.6 Water Quality

Upper watershed streams are typically cold, clear, and nutrient-poor, but are increasingly impacted by erosion, wildfire, and legacy mining contamination—particularly for mercury in the South Fork American

River. Across the planning area, climate change is expected to exacerbate water quality issues through increased sedimentation, reduced dilution during droughts, and post-fire runoff. Tree mortality and land disturbance from extreme events further compound these risks.

1.4.7 Recreation

The RWA Watershed offers extensive recreational opportunities, including whitewater rafting, hiking, fishing, boating, and snow-based sports and activities. Folsom Reservoir and the American River Parkway are major regional destinations. However, recreation is highly sensitive to hydrologic conditions. Reduced flows in upper watershed areas may limit rafting seasons, low reservoir levels can restrict boating and shoreline access, and reduced snowpack will impact snow-based recreation.

1.4.8 Hydropower

The RWA Watersheds host several major hydropower projects, including Sacramento Municipal Utility District's Upper American River Project, Placer County Water Agency's Middle Fork Project, and Pacific Gas & Electric's Chili Bar facility, as well as other smaller hydropower projects. These systems rely on snowmelt-driven flows and reservoir storage. Climate-induced changes in runoff timing and volume will affect generation capacity, operational flexibility, and water supply coordination. Folsom Powerplant operations are also expected to be impacted by shifting reservoir release patterns.

1.4.9 Agriculture and Urban Water Supply

Agriculture and urban development and corresponding water demands within the RWA Watersheds are primarily consolidated within the lower elevation areas of the western half of the region, with additional growth and development extending into the foothill areas. Demands are met through both surface water and groundwater supplies from various sources throughout the RWA Watersheds. As populations increase, demands and land uses will change in response. Decreases in the availability of surface water supplies and increasing demands may increase reliance on groundwater supplies and the potential for water shortages throughout the planning area.

2. Watershed Planning Area

This section describes the development of the study area boundary that will be used for the RWA WRP. The watershed planning area was delineated in coordination with DWR and the Watershed Network.

This boundary builds upon the 2022 study area boundaries developed for the *American River Basin Study* (ARBS) by the US Department of the Interior Bureau of Reclamation (Reclamation) (Reclamation 2022) and DWR's *California Watershed Resilience Assessment* (DWR 2024). The boundary developed for the RWA WRP is in line with the watershed-level focus of the *California Water Plan Update 2023* (DWR 2023).

This section describes the differences between the proposed study area boundary and those developed by Reclamation and DWR for their respective studies (see Appendix J for more details).

2.1 Study Area Boundary Delineation

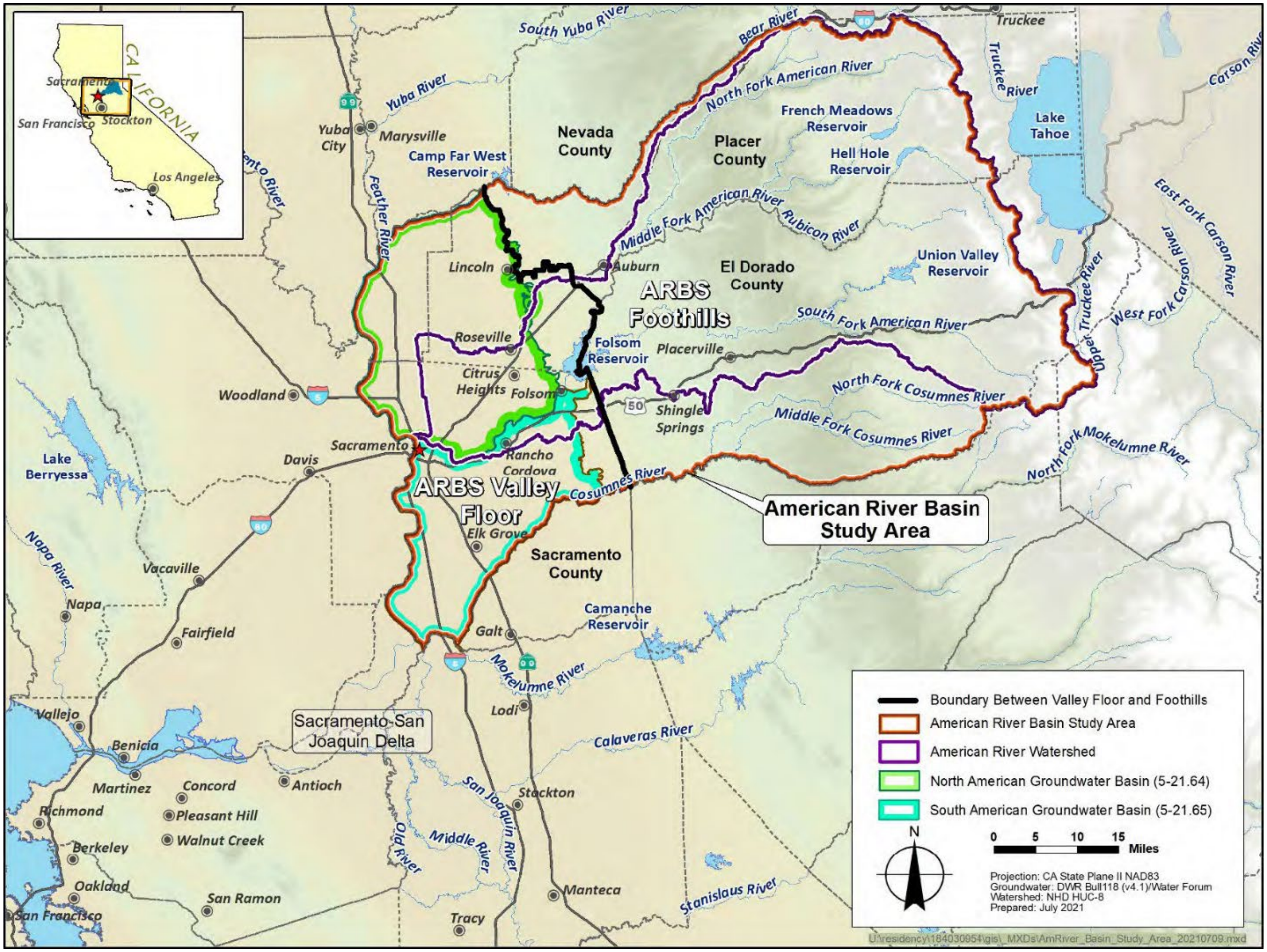
The delineation process has considered a wide range of hydrologic and systemic factors, including upstream headwaters, outlet locations, groundwater basins, interconnected water-related systems, climate risk sources, cross-watershed influences, and opportunities for systemwide adaptation. Where boundary adjustments have been proposed, Jacobs has documented justifications to explain deviations from DWR's original hydrologic boundaries.

2.2 Description of Previous Study Area Boundaries

2.2.1 American River Basin Study

Reclamation developed the ARBS as part of the WaterSMART Basin Studies program, which is a series of watershed studies that evaluated future supply and demand and proposed resiliency strategies. Figure 2-1 shows the study area boundary. The study area boundary includes the American River watershed, with the addition of the Bear River watershed south of the Bear River, Feather River, and Sacramento River eastside tributaries between the mouths of the Bear and Mokelumne rivers, and the Cosumnes River watershed north of the Cosumnes River. This boundary was intended to include non-Federal partners outside of the American River watershed that receive American River water, as well as the two groundwater basins that overlap with the American River watershed (Reclamation 2022).

Figure 2-1. American River Basin Study Boundary



Source: Reclamation 2022.

2.2.2 California Watershed Resilience Assessment

California Water Plan Update 2023 recommends a watershed-scale approach to developing solutions to California's water management challenges (DWR 2023). In response, DWR proposed a series of watershed resilience assessments. A total of 48 watersheds was delineated across the State, following US Geological Survey Hydrologic Unit Code (HUC)-8 boundaries. The program of assessments combined the American River and Bear River watersheds, referred to as "American-Bear." Figure 2-2 shows the American-Bear study area, which consists of the following HUC-8s:

- 18020129: South Fork American
- 18020128: North Fork American (includes Middle Fork)
- 18020126: Upper Bear
- 18020108: Lower Bear

Figure 2-2. American-Bear Watershed

Source: DWR 2024

For the RWA WRP, the proposed boundary largely builds on the Reclamation ARBS boundary. The boundary includes the entire American River, Cosumnes River, and Bear River watersheds; eastside tributaries of the Feather River and Sacramento River between the mouths of the Bear and Mokelumne rivers; and the City of West Sacramento.

Figure 2-3 shows the proposed watershed study area, superimposed on the Reclamation ARBS boundary and the DWR study areas. The blue line delineates the revised watershed study area, the red line delineates the boundary of the Reclamation ARBS study area, and the purple lines delineate the HUC-8 boundaries that make up the DWR study area.

The proposed study area includes the following HUC-8s:

- 18020128: North Fork American (includes Middle Fork)
- 18020129: South Fork American
- 18020111: Lower American
- 18020126: Upper Bear
- 18040013: Upper Cosumnes

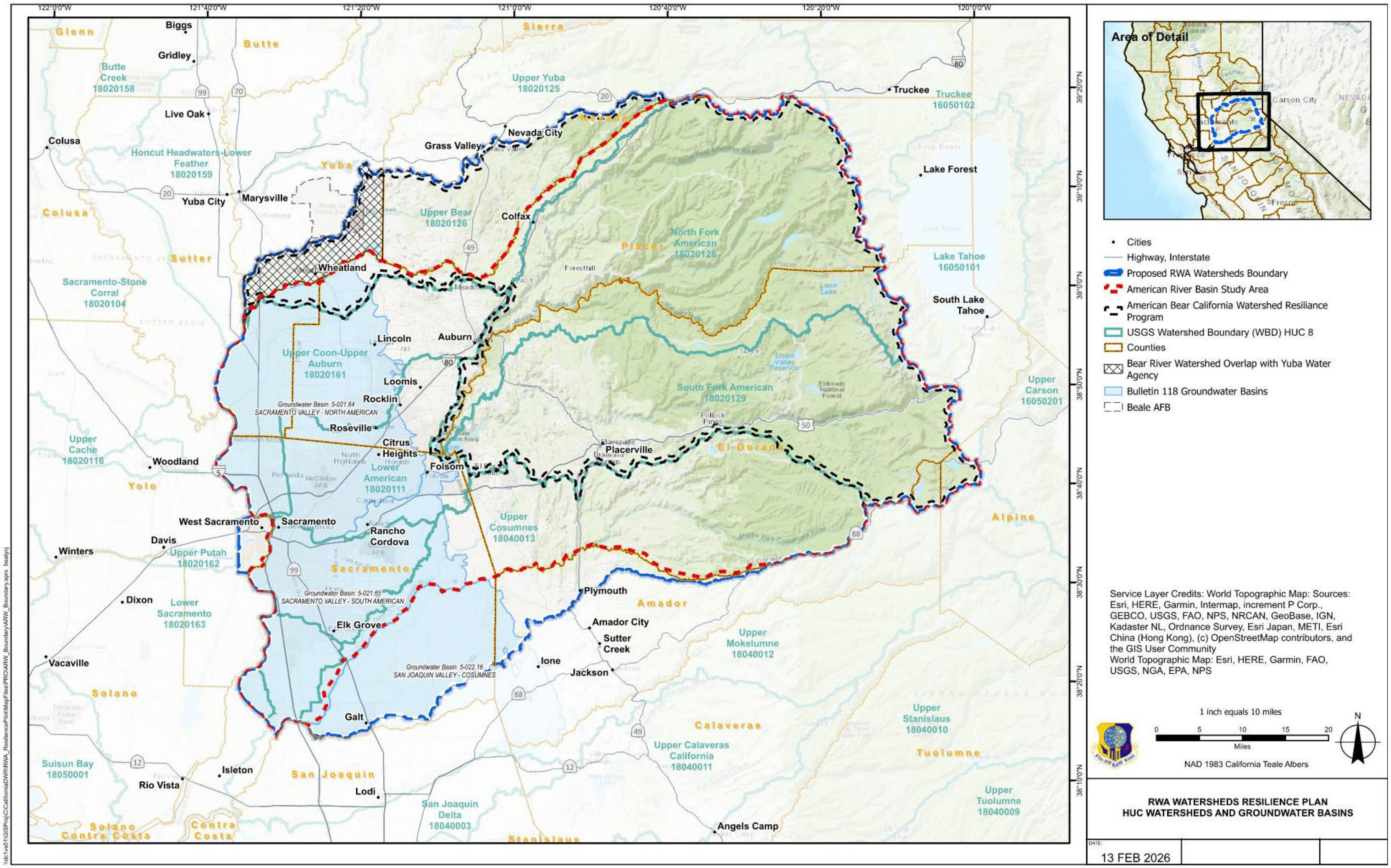
- 18020161: Upper Coon-Upper Auburn
- Portion of 18020163: Portion of Lower Sacramento that is east of the Sacramento River
- Portion of 18040012: Portion of Upper Mokelumne

The Cosumnes River watershed is included because it supplies water to Sacramento County and interacts with groundwater basins that overlap with the American River watershed. Unlike in the ARBS (Reclamation 2022), the north slope of the Bear River and the south slope of the Cosumnes River watersheds are included to capture all inflows.

Figure 2-3 shows the portion of the lower Bear River watershed that lies in Yuba County. This area is in the Yuba Water Agency service area and includes a portion of Beale Air Force Base.

The revised study area also includes the City of West Sacramento. The boundary line follows the south levee of the Sacramento Weir, because flood waters from the American River and eastside tributaries drain into the Sacramento River and contribute to high flows. Additionally, the Sacramento Weir provides major flood protection for the City of Sacramento.

Figure 2-3. Proposed RWA Watersheds Resilience Pilot Study Area



2.3 Summary of Differences Between Study Area Boundaries

2.3.1 American River Basin Study

The revised watershed study boundary differs from the ARBS in that it includes the north slope of the Bear watershed, the south slope of the Cosumnes watershed, and the City of West Sacramento. These changes fully encompass the hydrologic and hydrogeologic conditions that affect the American River service area.

2.3.2 California Watershed Resiliency Assessment

The revised watershed study area differs from DWR's American-Bear watershed study area in that it includes the Cosumnes River watershed; eastside streams south of the Bear River and north of the Mokelumne River; the lower American River; and the City of West Sacramento. This incorporates the hydrologic and hydrogeologic conditions that affect service area and includes the most populous areas of the region.

3. Watershed Network

3.1 Existing Regional Network Assessment

Prior to the launch of the RWA Watersheds Resilience Pilot Project, the RWA Watersheds already had a strong foundation of collaborative networks focused on water management, environmental stewardship, and community engagement. Regional water agencies and purveyors have long worked together through formal agreements and joint powers authorities to coordinate water supply reliability, groundwater management, and conservation programs. For example, RWA and the Water Forum have long provided a platform for balancing water supply needs with ecological protection of the Lower American River. These partnerships were complemented by resource conservation districts and watershed groups that have implemented on-the-ground projects to improve forest health, reduce wildfire risk, and enhance water quality.

Community-based organizations and nonprofits have played an important role in habitat restoration, land protection, and public education. Groups like the American River Conservancy and the Save the American River Association have been active in conservation and advocacy in the watershed area for decades. Tribal representatives have contributed traditional ecological knowledge and cultural perspectives to planning discussions, verifying that resilience strategies respect heritage and community priorities. Collectively, these networks created a collaborative environment that the pilot project could build upon, enabling a more integrated and equity-focused approach to climate adaptation across the watershed.

3.2 Watershed Network Development and Partner Engagement

The development of the Watershed Network for the RWA WRP was guided by an inclusive, multi-step engagement process. Beginning in 2024, outreach was initiated through personalized email invitations, public webinars, and community announcements to encourage broad participation. The messaging emphasized the purpose of the network: to create a collaborative forum for addressing climate vulnerabilities and developing community-driven adaptation strategies. Invitations targeted water agencies, local governments, resource managers, conservation organizations, and community members, as well as historically underrepresented groups such as Tribal Nations and frontline communities. To reduce barriers to participation, stipends were offered for participants, and multiple feedback channels, including surveys, virtual meetings, and one-on-one consultations, were provided.

To confirm meaningful engagement throughout the planning process, the project team established a series of Watershed Network meetings as the primary forum for collaboration and input. These meetings were designed to be iterative and inclusive, beginning with a kickoff session in early 2025 and continuing at key milestones to align with major project phases (such as vulnerability assessment, adaptation strategy development, and implementation planning). Each meeting provided opportunities for participants to review progress, share local knowledge, and influence decision-making. Interactive tools, such as live polling and surveys, were used to capture priorities and concerns, while presentations highlighted technical analyses and invited feedback on vision statements, equity integration, and adaptation options. Meetings were held virtually to reduce barriers to participation and supplemented by in-person events, such as habitat tours and cultural gatherings, to strengthen relationships and trust. Representation included water agencies, local governments, conservation organizations, Tribal Nations, and frontline community advocates, confirming that diverse perspectives shaped the resilience plan. This ongoing engagement process created a transparent and collaborative environment, allowing partners to remain informed and actively involved from project initiation through plan development.

3.2.1.1 Watershed Network Event Spotlight: Nimbus Basin Tour

As part of the Watershed Network's commitment to inclusive and hands-on engagement, RWA hosted the Nimbus Basin Tour and Lunch in November 2025. This event exemplified how collaborative outreach can strengthen connections between technical planning and community priorities.

The tour began at the Nimbus Basin, where participants observed the Water Forum's 2022 salmon habitat enhancement project. Standing alongside restored side channels and gravel beds, attendees learned how these improvements support fall-run Chinook salmon and steelhead trout while contributing to broader watershed resilience. This experience (shown on Figure 3-1) provided a tangible link between ecological restoration and climate adaptation strategies discussed throughout the planning process.

Figure 3-1. Nimbus B

Source :RWA

Following the tour, participants gathered for a hosted lunch featuring interactive exhibits designed to translate technical concepts into accessible, engaging activities (Figure 3-2). Four stations invited attendees to participate as follows:

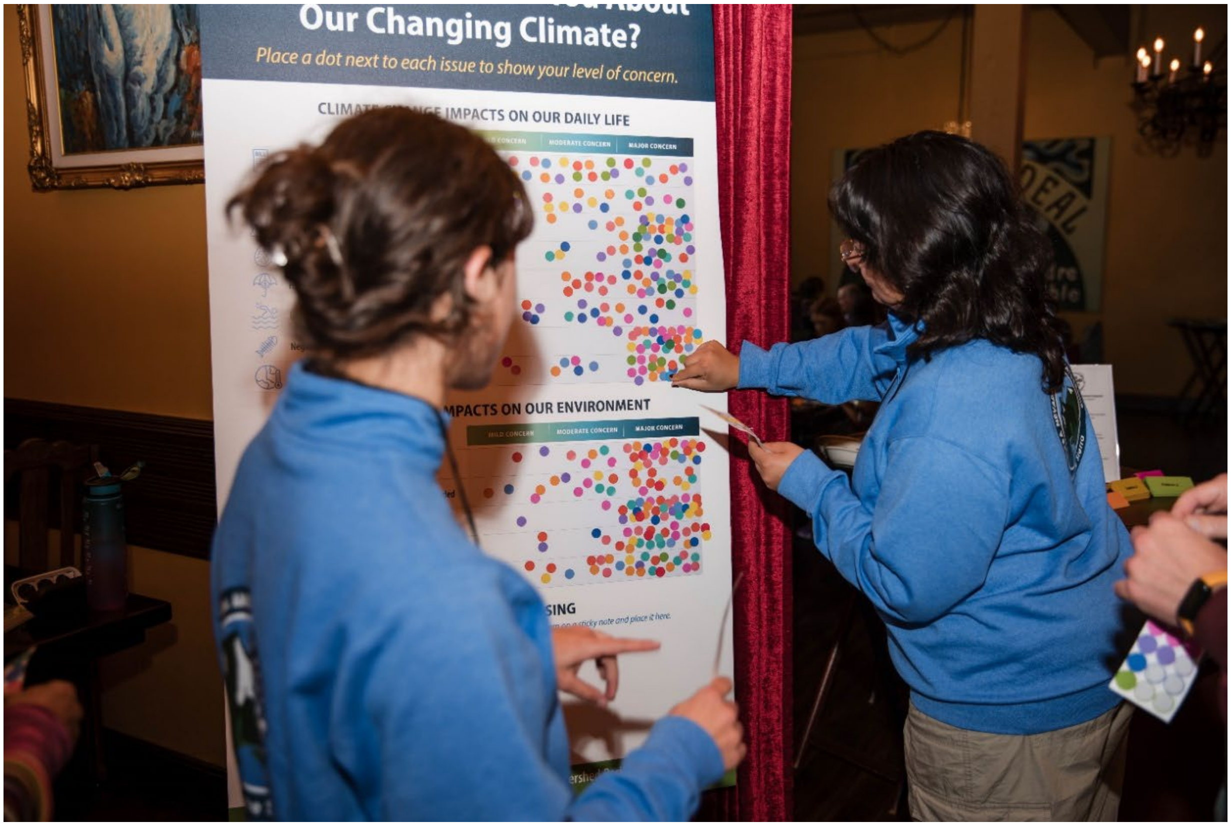
- Rank climate concerns and adaptation strategies.
- Explore success stories across the American, Bear, and Cosumnes watersheds.
- Submit project ideas via a QR-enabled tool.
- Join the Watershed Network for continued collaboration.

These activities generated valuable insights into community priorities, highlighting strong interest in water quality, wildfire risk reduction, and habitat enhancement. The event drew
80 attendees from local governments, water agencies, nonprofits, Tribal representatives, and community

organizations; 64 attendees expressed their interest in joining the Watershed Network, signaling growing momentum.

Media coverage amplified the event’s impact, with four television segments reaching nearly 48,000 viewers. Stories emphasized the connection between salmon restoration, climate resilience, and regional water management and highlighted the Watershed Network’s role as a collaborative platform for advancing regional resilience.

Figure 3-2. Interactive Exhibit to Gain Community Feedback



Source: RWA

3.2.1.2 Advisory Committee

To complement the broader Watershed Network, an Advisory Committee was established to provide expert guidance and technical review throughout the planning process. The Advisory Committee was formed to confirm that subject matter experts from across the RWA Watersheds could offer feedback on technical analyses, draft deliverables, and proposed adaptation strategies. Members included representatives from water agencies, conservation organizations, local governments, irrigation districts, and more, bringing expertise in hydrology, water supply reliability, flood management, ecosystem health, and climate science.

The Advisory Committee met at key milestones aligned with major project phases, including gap analysis, vulnerability assessments, and adaptation strategy development. Discussions included the following:

- Reviewing the climate scenario selection and modeling approach used in the vulnerability assessment

- Providing input on sector-specific vulnerabilities, including water supply, flood management, and ecosystem health
- Offering feedback on adaptation strategy categories, emphasizing multi-benefit solutions for water supply reliability, agriculture, habitat restoration, and wildfire risk reduction
- Identifying priority areas for future planning, including forest health treatments, floodplain restoration, and groundwater sustainability

The Advisory Committee played a critical role in strengthening the foundation of the planning process. Its feedback informed revisions to analytical methods and adaptation strategies, verifying that the plan delivers practical, science-based solutions that can guide resilience actions across the watershed.

3.3 Watershed Resilience Website: A Hub for Collaboration

To complement in-person and virtual engagement, the Watershed Resilience Website (https://rwawatershedsresilience.com/) was developed as a central hub for collaboration throughout the planning process. The website (Figure 3-3) provides a transparent and accessible space where the community and partners can stay informed, review materials, and actively participate in shaping watershed resilience strategies.

The website serves as the primary repository for project documentation, including meeting materials and draft work products. By making these resources publicly available, the platform confirms that collaborators can follow progress and provide informed feedback at every stage. Beyond document sharing, the site incorporates interactive tools designed to capture local knowledge and priorities. Visitors can submit comments and share project ideas directly online, as shown on Figure 3-4, helping to maintain ongoing dialogue and verifying that community perspectives shape every stage of the planning process.

Additionally, the website aids in encouraging participation in the Watershed Network. A dedicated section invites individuals and organizations to sign up for the network and explore opportunities for collaboration. By combining information access with opportunities for feedback and participation, the website has become an essential tool for supporting inclusive engagement.

Figure 3-3. Watershed Resilience Website

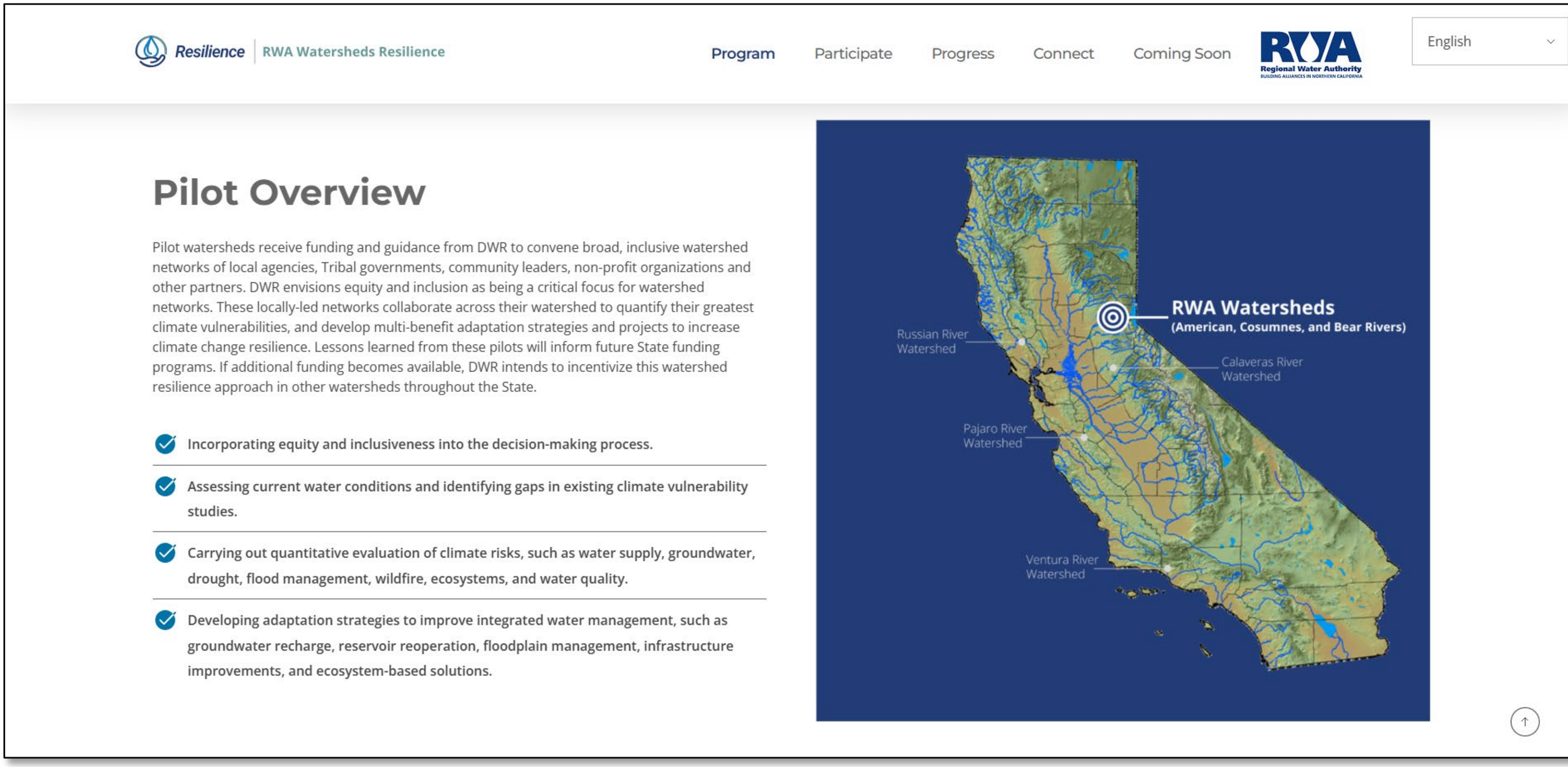
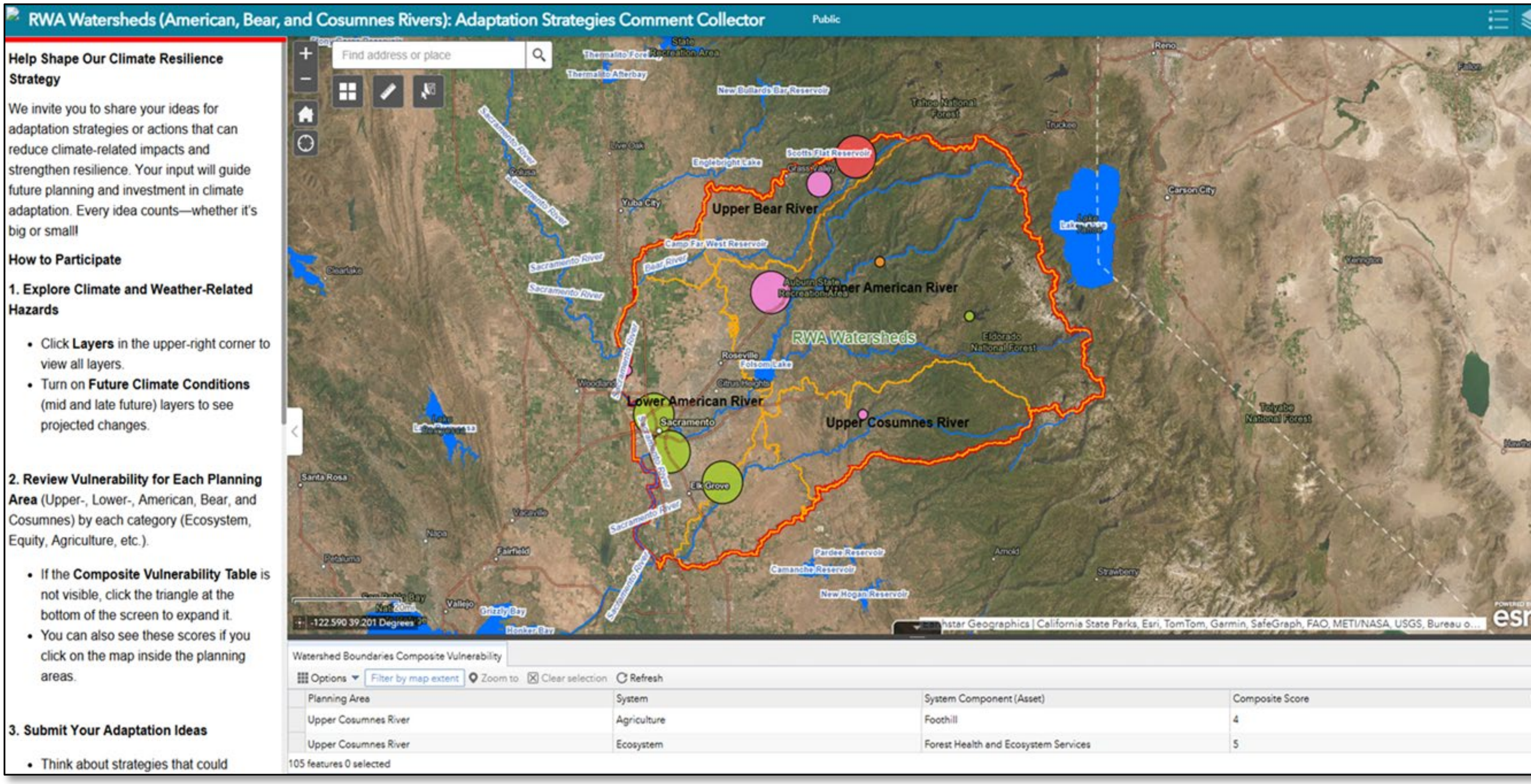


Figure 3-4. Adaptation Strategies Comment Collector



4. Tribal Considerations

4.1 Acknowledgement and Purpose

The RWA WRP is based on a science-based, collaborative, and inclusive approach that aims to incorporate traditional knowledge to guide the region in sustaining long-term resilience of local communities and ecosystems. The RWA WRP's vision is a commitment to both environmental stewardship and social equity, acknowledging that resilience requires intentional, active engagement with people and partnerships as much as it requires a scientific understanding of strong infrastructure and ecosystems. This section is intended to recognize the presence of Tribal Nations connected to the RWA Watershed and provide context for the consideration of traditional knowledge in the development of the RWA WRP's strategies and recommendations. The application of traditional knowledge can help to improve conditions in the watershed. In the limited discussions with representatives of Tribal Nations, the RWA learned about ideas that would be helpful for the ecology of the watershed.

Equity was embedded as a core principle throughout the development of the Watersheds Resilience Pilot. From the start of the project, engagement with historically underrepresented groups was prioritized, including Tribal Nations, disadvantaged communities, and frontline populations most vulnerable to climate impacts. Outreach strategies were designed to reduce barriers to participation by offering stipends for representatives of Tribal groups, hosting virtual meetings to increase accessibility, and providing multiple avenues for input such as surveys, one-on-one consultations, and community events. Meeting discussions emphasized language access, cultural sensitivity, and the integration of Traditional Ecological Knowledge (TEK) into planning. Equity was not treated as a separate component; rather, it was woven into all phases of the process, from visioning and vulnerability assessments to adaptation strategy development. This practice confirmed that resilience solutions reflect diverse perspectives and deliver benefits to communities that have historically faced inequities in access to resources and in felt impacts of climate change. With that said, the RWA staff believes more needs to be done to build trust with Tribal Nations, learn from them and incorporate their knowledge. The RWA Watershed Resilience Pilot acknowledges Tribal Nations whose ancestral and contemporary homelands overlap with the RWA watersheds. This chapter recognizes Tribal Nations who have stewarded the lands and waterways of this region; provides cultural context for the geography of the watershed; and affirms a commitment to intentional, respectful, long-term engagement, consultation, and collaboration with Tribal perspectives.

4.2 Traditional Ecological Knowledge and Stewardship

TEK is acquired through direct contact with the natural environment, establishing a relationship with nature and its seasons that guides appropriate identification, gathering, processing, and use of natural resources. Unique definitions of TEK are understood by each Tribe through millennia of interactions and generations of experience with a specific place or environment. Much of the information on TEK in this chapter reflects information shared by the TEK office of The Shingle Springs Band of Miwok Indians, Cultural Resource Division.

The purpose of TEK is to teach Tribal Members about traditional ways people utilize waterways and natural resources to continue cultural revitalization, as well as the importance of preserving and passing down this knowledge.

Indigenous knowledge systems emphasize connectedness between humans, geographic lands, and ecological systems, balancing long-term sustainability with sufficient resource use for meeting community needs. Practices based on these intergenerational knowledge systems have guided traditional land stewardship since time immemorial, sustainably balancing the role of humans within Earth's natural ecological systems for generations before more anthropocentric- and capitalist-based social systems dominated—systems that have since caused severe imbalances in natural functions. Extractive western practices have resulted in damage to the health, resilience, and longevity of natural ecosystems, impacting the wellbeing of plants, animals, and human communities alike.

Today, gathering necessary plants and supplies for TEK activities, including the creation of traditional regalia, clothing, food, shelter, and more, can be dangerous and challenging. Materials are hard to access because of public and privately owned land, and many plants are covered in dangerous pesticides. The Shingle Springs Band of Miwok Indians offer solutions to gathering availability in establishing and maintaining healthy relationships with State, county, and local park agencies to form agreements and seek permits that support access to land containing traditional plants. For example, Sacramento County issued a permit to the Shingle Springs Band of Miwok Indians that grants access to the American River Parkway, Dry Creek Parkway, and Indian Stone Corral, allowing the Tribe to gather necessary materials for traditional practices and activities. This permit has provided the Tribe with access to their original village site and, as such, the possibility to gather plants and animals from that site to make traditional items and regalia pieces.

Nisenan mythology and folklore, particularly from the valley people, indicates great natural abundance prior to colonization, including species of fresh-water fish, shellfish, and waterfowl. Native stewardship and land management in the Sacramento-San Joaquin Delta (Delta), which sustains numerous plant, animal, and natural resources, is well documented. The Delta has historically been used for ceremony, hunting and gathering food, and harvesting materials. However, the Delta's native plant life, fish, and animal populations are declining due to a host of impacts from western practices. One of the Delta's once abundant native plant species, Tule, acted as a natural water filtration system in the Delta ecosystem, improving water quality by cleaning rivers and waterways. Recent ecological reports identify only 14% of the Delta's 725,600 acres as able to support native trees, shrubs, and herbaceous plants. Diminishing Tribal access to these materials can prevent cultural practices and the knowledge of how to perform them from being passed to future generations.

Pakan'yani (meaning "people of the water") Maidu of Strawberry Valley Rancheria's approach to decision-making honors the traditional Indigenous principle of considering the impact of our actions on seven generations into the future. This principle guides environmental stewardship, economic development, cultural preservation, and Federal recognition strategy.

TEK and maintained Indigenous practices can be integrated into planning processes through intentional community inclusion, consultation, and relationship-building to directly contribute to watershed resilience. This is particularly important since interrelated economic, ecological, and social stability is increasingly threatened by the impacts of climate change, wildfire damage, and water insecurity.

Indigenous perspectives align with RWA watershed and climate resilience goals, offering essential insights for developing sustainable adaptation strategies. Understanding and incorporating these perspectives strengthen RWA WRP climate solutions and support outcomes that benefit ongoing contributions to regional social, economic, and environmental wellbeing.

4.3 Tribal Nations Connected to the Watershed

The region is home to diverse tribal nations representing Miwok, Maidu, Nisenan, Washoe, and multi-Tribal communities, with deep ancestral ties to the Sierra Nevada foothills, the Sacramento Valley, and surrounding watersheds. Each Tribe, community, and family holds unique and distinct histories and practices, while many share enduring relationships to the lands and waterways that make up the American River watershed.

Several Tribal Nations maintain cultural, ecological, and collaborative ties to the region that extend beyond current geographic boundaries. The RWA WRP recognizes the value of these connections and aims to respectfully seek engagement with groups whose ancestral or contemporary ties overlap with the project boundary. Some Nisenan and multi-Tribal communities maintain enduring cultural and territorial connections to the region despite lacking a formal land base or Federal recognition. The Nisenan people of the Maidu Tribe of California Indians historically identified themselves by village rather than Tribal name. Nisenan were known to occupy the drainages of the American, Bear, and Yuba rivers, from the Sacramento River in the west to the Sierra Crest in the east. Their distinct dialect identified them from the Northern Maidu, and they diverged into two distinct cultural groups known as the Valley Nisenan and the Mountain Nisenan.

Since the United States government, through the Department of the Interior, recognizes political entities and not anthropological entities, many Tribal groups seek political and economic leverage through the formation of proxy organizations. In 2021, a group of local “Delta Tribes” convened as the California Tribal Engagement Coalition (TEC). Participating Tribes include the Shingle Springs Band of Miwok Indians, Wilton Rancheria, Ione, Buena Vista, Central Valley Miwok, United Auburn, and Yocha Dehe. The common goal of TEC is to protect cultural resources, sacred sites, traditional plant life, and traditional foods from water management practices that will further threaten the existence of fish and wildlife. Similarly, the California Heritage: Indigenous Research Project (CHIRP) is a Tribally guided nonprofit working to address ongoing social, environmental, and racial injustices brought to the homelands of the Nevada City Rancheria Nisenan Tribe as a result of the Tribe’s Federal termination in 1964.

Tribal nations with ties to lands that overlap with the watershed boundary include both Federally recognized and non-Federally recognized Tribes, acknowledging ongoing efforts to restore recognition, land access, and sovereignty for many Tribal communities. Federal recognition status reflects complex impacts from systematic displacement, colonizer settlements, enforcement of Federal policies and jurisdictional boundaries, and historical efforts to erase traditional Indigenous culture and practices. This plan recognizes and honors the presence, leadership, and value of Tribal Nations connected to the watershed, regardless of Federal recognition status.

According to Public Resources Code Section 21073, a California Native American Tribe “means a Native American tribe located in California that is on the contact list maintained by the Native American Heritage Commission for the purposes of Chapter 905 of the Statutes of 2004.” The following list of Native American Tribes in Table 4-1 was provided by the Native American Heritage Commission to locate areas of potential adverse impact and appropriate contacts with whom to consult and request information regarding cultural resources within the project area.

Table 4-1. Native American Tribes Information Provided by the Native American Heritage Commission

Tribal Name	Cultural Affiliation	Geographic Ties	History	Today
Buena Vista Rancheria of Me-Wuk Indians	Southern Sierra Miwok	The Me-Wuk Indians of the Buena Vista Rancheria lived in and around what is now Amador County for thousands of years. The Buena Vista Rancheria is located just outside the town of Buena Vista	The Federal government purchased the Buena Vista Rancheria in 1927 with money appropriated by 34 Stat. 325-328 and 35 Stat. 70-76. The Oliver family occupied the land prior to the government purchase.	Today, the Federally recognized Tribe is governed by a Tribal Council and operates as a sovereign nation.
Calaveras Band of Mi-Wuk Indians	Central Sierra Miwok	Ancestral territory includes areas within present-day Calaveras County and the central Sierra foothills.	This Tribe traditionally occupied a large part of the central Sierra Nevada range, generally the watersheds between and including the Merced and Cosumnes Rivers. Known Mi-Wuk villages were clustered along the Mokelumne, Calaveras, and Stanislaus river drainages.	Formal governance and Federal recognition were re-established following decades of advocacy.

Tribal Name	Cultural Affiliation	Geographic Ties	History	Today
Chicken Ranch Rancheria of Me-Wuk Indians	Southern Sierra Miwok	Original hunting and gathering territories stretched from the Table Mountain area of New Melones to the rolling hills of the lower Red Hills area. The Rancheria is located near Jamestown.	Mining and logging operations, intertwined with western settlers purchasing land, reduced the Chicken Ranch Rancheria territory to 2.85 acres. The Rancheria was established as part of Federal efforts to consolidate surviving Miwok families following displacement and land loss.	Federal recognition was received in 1985. Today, this Tribe operates as a sovereign government with an elected Tribal Council and is an active regional economic partner.
Ione Band of Miwok Indians	Plains Miwok and Sierra Miwok	Ancestral territory includes areas of the Sacramento Valley and Sierra foothills.	The Ione Band of Miwok Indians includes Northern Sierra Miwok and Nisenan peoples. The Tribe was restored to Federal recognition in 1994.	This Tribe maintains Tribal leadership and governance structures and continues advocacy for recognition, land, and resources.
Jackson Rancheria Band of Miwuk Indians	Northern Sierra Miwok	Ancestral territory is the Sierra foothills of Amador County. The Jackson Rancheria is located near the City of Jackson.	The Rancheria was established during Federal efforts to provide lands to displaced Miwok families. A formal government was first established in 1979.	This Tribe is governed by Tribal Council and operates a range of community, health, housing, and economic programs.

Tribal Name	Cultural Affiliation	Geographic Ties	History	Today
*Shingle Springs Band of Miwok Indians	Miwok and Maidu	Ancestral territory spans areas of El Dorado County and the Sierra Nevada foothills.	The Tribe represents descendants of Miwok and Maidu people who survived displacement and land loss during westward expansion.	The Federally recognized Tribe practices self-governance and sovereign immunity, providing social, health, economic and educational resources, opportunities and services.
United Auburn Indian Community of the Auburn Rancheria	Miwok and Maidu	The historic Auburn Rancheria is in the Sierra Nevada foothills in Auburn, California. Ancestral homelands include areas of Placer County and the Sierra foothills.	This Tribe was formed through the consolidation of Miwok and Maidu families displaced by colonization and Federal land policies.	This Tribe is governed by Tribal Council and is a major regional economic and philanthropic partner.
*Wilton Rancheria	Bay Miwok, Plains Miwok and Sierra Miwok (referred to as the Eastern Miwok); Tribal citizens also descend from both Valley and Hill Nisenan	Ancestral territory includes areas of Sacramento County and the Sacramento Valley.	Foreign incursions and genealogical blending resulted in an amalgamated cultural group with collective ancestry, who later formed the Wilton Rancheria as it is known today. The first constitution of Wilton Rancheria was established in 1935.	The Tribe was restored to Federal recognition in 2009.

Tribal Name	Cultural Affiliation	Geographic Ties	History	Today
Colfax-Todds Valley Consolidated Tribe	Maidu, primarily Nisenan and Mountain Maidu, and Miwok	Ancestral homelands are in Sierra Nevada foothills, particularly within present-day Placer County. Currently, the Tribe is located in the Colfax/Placer County area.	This Tribe represents a consolidation of families descending from Maidu families who experienced displacement, land loss, and fragmentation during the gold rush and subsequent settlement. The Tribe maintained community ties despite the absence of a formal rancheria or reservation.	This Tribe continues to pursue Federal recognition and land access. It engages with regional partners, local governments, and community organizations.
Pakan'yani Maidu of Strawberry Valley Rancheria	Mountain Maidu	Ancestral territory encompasses the drainage of the Feather and American Rivers, from the Sacramento Valley east to the crest of the Sierra Nevada (including areas around Strawberry Valley, Woodleaf, and Challenge in Yuba County).	The name "Pakan'yani" means "people of the water" in traditional language, reflecting a deep connection to the watersheds of the Feather and American Rivers. The Strawberry Valley Rancheria was established to provide land for surviving Maidu families following widespread displacement and population loss during the mid-19th century.	This Tribe is currently pursuing Federal recognition restoration.

Tribal Name	Cultural Affiliation	Geographic Ties	History	Today
TSI-AKIM Maidu of the Taylorsville Rancheria	Mountain Maidu	Ancestral territory is the northeastern Sierra Nevada, primarily within present-day Plumas County. The Taylorsville Rancheria is situated in Indian Valley.	Taylorsville Rancheria was established as part of Federal efforts to consolidate surviving Maidu families following displacement, violence, and loss of land during early settlement.	The California Federal Court rejected the Tribe's administrative recognition effort.
**Nevada City Rancheria Nisenan Tribe	Nisenan	The southern boundary of the ancestral territory begins below the Cosumnes River. From there, it runs east to Kyburz and includes both banks of the Sacramento River to the west. From Kyburz, the boundary winds its way north to Gold Lake then west to the south fork of the Feather River. From there, it moves southwest to the Sacred Mountain (Marysville Buttes) and finally, finds its way back down the Sacramento River.	The Nisenan people who today identify with the Nevada City Rancheria come from two language "districts" with vast east-to-west orientation and abundant landscape and ecological diversity.	This Tribe continues to face challenges related to land access and recognition.
Nashville Enterprise Miwok-Maidu-Nishinam Tribe	Miwok, Maidu, and Nisenan	Ancestral territory is the Sierra Nevada foothills, with present-day El Dorado County and surrounding areas.	The Nashville Enterprise Miwok-Maidu-Nishinam Tribe represents descendants of multiple Tribal communities who were displaced and fragmented by settlement, mining, and Federal land policies.	This Tribe maintains community identity despite absence of a consolidated reservation or rancheria.

Tribal Name	Cultural Affiliation	Geographic Ties	History	Today
Susanville Indian Rancheria	Atsugewi, Maidu, Paiute, and Pit River. Anthropological Tribes associated with the Susanville Indian Rancheria are Maidu, Paiute, Pit River, and Washoe.	Ancestral connections span northeastern California, including areas of present-day Lassen County and surrounding regions. The Susanville Indian Rancheria serves as the Tribe's land base.	This multi-Tribal community was formed through shared history and survival from Native families from multiple Tribal backgrounds who were displaced. The original 30 acres of the Rancheria were purchased in 1923 under the *Landless and Homeless Act*.	The Susanville Indian Rancheria, though made up of various Tribes, is recognized as a distinct political entity from the Tribes who make up the Susanville membership. There is no dual membership allowed in the Constitution.
Washoe Tribe of Nevada and California	Washoe	The Wá·šiw people are a distinct people who share commonalities with both the Great Basin and the California Cultures. Geographic ties are to the Lake Tahoe Basin and surrounding areas of the Sierra Nevada, spanning present-day California and Nevada.	The Wá·šiw were recognized by what part of the territory they came from. Family units, as the core of the Tribe, comprised local groups, and the local groups made up a band. The four directions of Wá·šiw territory were occupied by different bands of the Wá·šiw that made up the whole of the Tribe. Although one Tribe, each band was unique in its own area of occupation with subtle differences in cultural diversity and language patterns.	This Tribe maintains ties to the Lake Tahoe region despite displacement, restricted access to traditional lands, and jurisdictional challenges created by State boundaries. It is an active partner in regional environmental stewardship, land management, and cross-jurisdictional collaboration, particularly related to watershed health and climate resilience.

Tribal Name	Cultural Affiliation	Geographic Ties	History	Today
Tule River Indian Tribe	Yokuts (with additional historical affiliations)	Ancestral territory is California's southern Sierra Nevada and San Joaquin Valley (present day Tulare County).	About 50 Yokut-speaking dialect groups occupied territory along waterways flowing from the Sierras and around Tulare Lake.	The Tule River Tribe is currently engaged in Water Rights settlement negotiations with the United States acting as trustee for the Tribe, and downstream users of water from the South Fork of the Tule River. The purpose of the ongoing negotiations is to confirm under law the Federally reserved Water Rights of the Tribe and to secure Federal funding to enable the Tribe to put its Water Rights to use.

* Indicates Tribes that participated in specific engagements regarding the American River Watersheds Resilience Pilot Project

** Engaged through conversation with native-led proxy organization, CHIRP

4.4 Legal History of Native California

The process of displacement and dispossession of Indigenous peoples in the Sacramento region began with early Spanish missions, continued through labor exploitation on Sutter's Fort, and accelerated during the gold rush. In California, the Legislature created laws that controlled occupied lands, as well as the lives and livelihoods of Tribal people, while enforcement occurred at county and local levels.

In 1847, James Marshall built a sawmill in partnership with John Sutter on the Maidu village of Collumah. Sutter's Mill forever altered the lives of native populations, which were estimated to be roughly 200,000 in 1848, the year gold was discovered. The discovery of gold resulted in an influx of people and was known as the California gold rush, bringing disease and causing destruction for the original inhabitants of the region.

Within a few years, more than half of California's native population was dead due to violence, epidemic, or starvation. From the early 1850s through the 1860s, native and other non-white individuals were barred from testifying in court against white individuals, preventing protection from abusive and exploitative treatment. Indigenous children were sold into slavery, allowed by California's sanctioned "apprentice system" that brought homeless or dispossessed native people into a form of indentured servitude until the age of 30. Native people were jailed and auctioned in a systemic cycle of arrests and indentures for working off their bail.

In 1851, Congress ordered Federal agents to negotiate treaties of "peace and friendship" with 402 California Tribal leaders. By 1852, 18 treaties were written and signed by groups that were considered Tribes, with promises of 8.5 million acres across 10 protected reservations in exchange for the remainder of California's territory. However, these treaties were not ratified by the Senate and had an injunction of secrecy imposed until the 20th century.

In the late 1800s, the United States began establishing small, scattered "rancherias" or village homes. Special Federal appropriations and Congressional acts were passed in the early 20th century to fund the purchasing of small tracts of land in central and northern California for landless and homeless Indigenous people. These acquisitions resulted in today's Rancheria System in California. Figure 4-1 shows these Tribes represented at the 2025 Native American Day.

In recent decades, California has adopted new laws and executive orders that focus on building and sustaining stronger partnerships with California Native American Tribes. Assembly Bill 52, passed in 2014, amended the *California Environmental Quality Act* and created requirements for proposed projects to include an analysis of impacts to Tribal cultural resources. This bill also requires the lead agency of a project to consult with Tribes that have requested in writing to be informed and that are traditionally and culturally affiliated with the geographic area of the proposed project.

Figure 4-1. Tribes Represented at 2025 Native American Day, Sacramento, CA

Source: CTCA CA Tribal Chairpersons Association

4.5 Tribal Engagement Practices

Tribal engagement was conducted with respect for consultation protocols with the intention of integrating Tribal perspectives throughout the planning process. The RWA WRP acknowledges that native communities are living nations, not just historical entities, affirming an understanding of the importance of continued relationship-building and consultation with Tribal perspectives beyond a singular project term. Engagement with Tribal Nations and representatives will continue to be prioritized as essential while the plan moves from strategy to implementation. Tribal leadership are encouraged to participate in regional conversations that affect their communities and homelands. Engagement not only serves the purpose of allowing opportunities for consultations with Tribes to vet proposed actions but also is a listening opportunity to deepen understanding of their unique connections to, and knowledge of, the environment and natural resources that are connected to the RWA Watersheds.

The Watersheds Resilience Pilot has followed guidelines set by the California Natural Resource Agency's (CNRA's) Tribal Consultation Policy and Best Practices (CNRA 2025), which emphasize the value of meaningful, ongoing consultation over one-time engagements. CNRA's Tribal Consultation Policy provides guidance on how to conduct consistent, appropriate, and respectful consultations with California Native American Tribes, recognizing cultural learning to be a lifelong goal and process. Tribal engagement is recommended to follow CNRA's "early, often, and meaningful" policy to maximize potential collaboration and confirm that Tribal input can effectively inform and be incorporated into decision-making processes.

Liaisons are encouraged to approach conversations with humility and respect toward other cultures, intentionally seeking to understand and address Tribal priorities, interests, needs, and concerns in the development of policies, projects, and programs.

Throughout the project, communication opportunities have been offered and conducted in both formal and informal meetings, in-person and virtually, and through attendance of native-led engagement and education events (shown on Figure 4-2), to actively endeavor to build trust and impact the ability to consider Tribal feedback and comments in development of the RWA WRP.

Figure 4-2. 2025 Native American Day, Sacramento, CA

Source: CTCA CA Tribal Chairpersons Association

4.6 Tribal Engagement Findings

During engagement with Tribal leaders in the region, they articulated that resilience requires protecting the integrity of the whole system, recognizing interdependence between plants, animals, water, and people. Representatives from the DWR advised RWA staff that an important distinction is emphasized between Indigenous perspectives and western mindsets when it comes to the approach taken regarding natural resource management. Traditional native cultures consider rivers to be part of their ancestral histories, treating natural systems with the same living respect given to community members. The connectedness between water, plants, animals, and humans is recognized as a larger, holistic system that requires comprehensive stewardship for overall wellbeing. Contemporary and political approaches to conversations on water management commonly frame water resources as commodified objects to own or otherwise control. Thus, collaborative conversations aiming to be culturally humble and respectful are encouraged to explore and frame water resources as something to nurture and work with rather than authoritatively manage.

Other Tribal priorities that were uplifted through the project's various communication channels include increasing opportunities for Tribes to purchase land, which will provide Tribal groups with greater decision-making agency in the harvesting and handling of different plant and animal species.

4.7 Engagement Challenges

A common challenge in Tribal engagement and relationship-building is limited capacity from both Tribal groups and program staff attempting to achieve frequent and meaningful consultation. Limited capacity can negatively impact the ability to consult and build relationships, particularly when under restrictions of a project term. To address this challenge, financial compensation was offered to Tribal representatives who attended Watershed Network or Advisory meetings, and specific opportunities for conversation and feedback were offered based on the preferences and capacity of engaged groups. Building and maintaining Tribal relationships will continue to be prioritized, allowing opportunities for input throughout the development and implementation of the RWA WRP.

Many California Native American Tribes may hesitate or refuse to share information with public agencies due to historical periods of settlement and colonialism, during which information about cultural resources and traditions was weaponized to eradicate Tribal ways of life. To address this challenge, the RWA WRP offered transparency regarding how information received through input opportunities has been documented, shared, and presented. Project liaisons practiced gestures of cultural humility and reciprocal communication, approaching conversations with the goal of consensus and deepened cultural understanding.

4.8 Continued Alignment Opportunities and Commitment Moving Forward

Proposed watershed strategies are strengthened when informed by consultation with Tribal representatives and traditional knowledge systems. The RWA WRP seeks continued alignment and collaboration with Tribal representatives as partners and co-leaders in the following:

- Mindfully considering Tribal presence that overlaps or interacts with infrastructure and water management strategies
- Grounding land stewardship and nature-based climate solutions in TEK

This section affirms a commitment to intentional improvement or creation of accessible, safe opportunities for Tribal engagement as it relates to watershed resilience efforts.

The resilience of our region's watersheds and interconnected communities are inseparable from the wellbeing and leadership of Tribal entities. This requires ongoing dialogue with no finish line or end point, focused on learning, listening, and building meaningful relationships grounded in respect, responsibility, and long-term collaboration.

This plan intentionally avoids proposing a one-size-fits-all solution for incorporating Tribal considerations, instead affirming a commitment to ongoing collaboration, partnerships, and relationship building with Tribal governments and organizations. Ongoing commitment to appropriate Tribal consultation is essential to implementing watershed resilience and adaptation strategies that create benefits and positively contribute to advancing regional ecological health, economic resilience, and social wellbeing.

The acknowledgement and commitment outlined in this chapter do not claim to repair devastating impacts endured by Indigenous peoples as a result of colonialism and exploitation of natural resources from the lands presently known as the United States. But rather, they emphasize the urgent necessity to continue pursuing inclusive engagement and consultation moving forward. Meaningful collaboration with Tribal groups is essential to building a resilient, adaptive, and equitable watershed system that can withstand increasing climate variability.

5. Watershed Vision and Goals

The RWA WRP is part of DWR's Statewide effort to address climate change impacts at the watershed scale. This approach emphasizes collaboration, equity, and science-based planning to develop strategies that reduce vulnerabilities and enhance resilience for communities and ecosystems. The vision and goals outlined in this chapter provide the foundation for the RWA WRP, guiding actions that balance ecological health, economic vitality, and cultural values.

5.1 Development of the Vision Statement

Through a series of Watershed Network meetings, the network collaboratively drafted the vision statement from the RWA Watersheds. Participants, including water agencies, conservation groups, Tribal representatives, and frontline community members, worked through interactive processes such as live polling, surveys, and open discussion to align the statement with both local aspirations and the objectives of the pilot program. Stakeholder contributions emphasized the need to integrate TEK, elevate voices from disadvantaged communities, and treat watershed resilience as a living system that intertwines economic and ecological outcomes. The inclusion of these elements mirrored DWR's requirement that visions and strategies reflect equity, multi-sector coordination, and scientific rigor. The final statement reflects broad consensus across technical experts and community advocates, ready to guide the implementation phase.

5.2 Watershed Vision

The vision of the RWA Watersheds Network is as follows:

Sustainably manage the American, Bear, and Cosumnes River watersheds using a science-based, collaborative, and inclusive approach that incorporates traditional knowledge and balances ecological and economic needs to sustain the long-term resilience of our local communities and ecosystems.

This vision conveys a balanced, ecosystem-based approach that leverages TEK and formal science, emphasizes equitable stakeholder engagement, and seeks harmony between environmental integrity and economic prosperity.

Figure 5-1 illustrates the values and priorities expressed by the Watershed Network members during the development of the vision statement. When asked to describe "in one word, why is water important to you?", words like life, connectivity, and sustainability were among the most frequently mentioned responses, underscoring the essential role water plays in supporting ecosystems, communities, and cultural identity. Other frequently mentioned terms, such as equity, health, and habitat, reflect the importance of these aspects to the resilience planning process. These insights informed the vision and goals of the Watershed Network, confirming that they resonate with community perspectives and lived experiences.

Figure 5-1. In One Word, Why Is Water Important to You?

Source: Results from poll of Watershed Network participants

5.3 Watershed Goals

Building on this vision and DWR's Statewide objectives, the Watershed Network adopted the following goals:

- Advance equity and inclusion by confirming meaningful participation of Tribal Nations, disadvantaged communities, and frontline populations.
- Assess climate vulnerabilities using science-based methods to evaluate risks from drought, wildfire, flooding, and other stressors.
- Develop multi-benefit adaptation strategies that improve water reliability, protect ecosystems, enhance public safety, and support economic resilience.
- Integrate traditional knowledge and local expertise alongside technical data to inform decision-making.
- Establish performance metrics aligned with DWR's framework to track ecological, social, and economic outcomes (DWR 2023).

Together, these goals provide a roadmap for building a resilient watershed that supports thriving communities and ecosystems under changing climate conditions.

6. State of the Watershed and Historical Hazards

6.1 Review of Existing Information and Resources

As an early step in the RWA WRP, a broad review of existing literature was undertaken to better understand the current landscape of technical studies, data, and modeling tools relevant to climate resilience planning. This review encompassed more than 70 studies, plans, and modeling efforts across the American, Cosumnes, and Bear River watersheds, as well as adjacent areas such as West Sacramento and the eastside tributaries of the Feather and Sacramento Rivers.

The intent of this review was not only to take stock of the substantial work already completed in the region, but also to reflect on how well existing tools and knowledge align with the emerging needs of the RWA WRP—particularly in relation to the following:

- Climate vulnerability and risk assessment
- Water budget development
- Adaptation and implementation strategy design
- Performance tracking and monitoring

In comparing recent efforts—such as the ARBS—with the evolving scope of the pilot, several areas emerged where additional refinement or complementary analysis could enhance the planning process. These included the following:

- Opportunities to improve representation of localized groundwater-surface water interactions in existing models
- The potential value of incorporating updated climate scenarios that reflect recent emissions trajectories and hydrologic trends
- The importance of more deeply integrating equity metrics and community-scale vulnerability indicators into technical assessments

These observations were shared and discussed in coordination with RWA and other regional partners to verify alignment with ongoing planning efforts and to avoid duplication. Their input helped shape a shared understanding of where future technical work might be most beneficial.

The findings are summarized in Appendix A: Gap Analysis. Rather than prescribing a fixed set of tasks, this document is intended to inform the next phase of technical exploration—confirming that future work is grounded in the best available science, responsive to regional priorities, and reflective of the diverse needs and values of communities across the RWA Watersheds.

6.2 Gap Analysis Results

Review of existing studies and modeling efforts identified several areas where additional technical exploration, data gathering, or refinement may help strengthen the foundation for a comprehensive and equitable watershed resilience plan. These observations are organized by thematic focus areas aligned with the pilot's technical framework; detailed findings are included in Appendix A.

6.2.1 Geographic and Sectoral Coverage

Existing efforts—such as the ARBS and the California Watershed Resilience Assessment—offer a strong foundation for the core American River Basin. However, coverage is more limited in newly included areas, particularly the Cosumnes River watershed, West Sacramento, and the north slope of the Bear River watershed.

While water supply and flood management have been well studied in previous efforts, other sectors—such as ecosystem health, water quality, recreation, and wildfire risk—are less consistently represented, especially outside the original ARBS boundary.

6.2.2 Assessment of Available Climate Vulnerability and Risk Information

Detailed climate vulnerability assessments are limited for areas newly brought into the planning scope, including the Cosumnes watershed and West Sacramento. Additionally, wildfire risk is not yet fully integrated into sectoral vulnerability assessments, and the cascading impacts of wildfire on water quality, hydrology, and ecosystems warrant further attention.

Equity considerations are also underrepresented in prior assessments. There is limited analysis of how climate impacts may disproportionately affect low-income, minority, and Tribal communities, or how adaptive capacity varies across populations.

6.2.3 Assessment of Available Water Budget Tools and Data

Historical water budget data is available for much of the RWA Watersheds, but coverage is more limited in the Cosumnes watershed and other newly included areas. Cosumnes-South American-North American (known as CoSANA), an integrated surface water-groundwater model, serves as a useful tool for simulating detailed surface water and groundwater budgets for the Cosumnes, South, and North American subbasins. Other modeling tools, such as CalSim 3, may be able to supplement CoSANA and provide coverage for several historical watershed processes across majority of the planning area (see Appendix I for details).

Recent changes in land use, water management practices, and climate conditions suggest a need to revisit and update underlying datasets to verify relevance and accuracy. However, updating these considerations is likely to be a cumbersome process and may not be feasible for this effort.

6.3 Equity Considerations

The RWA Watersheds Region is home to remarkable racial and ethnic diversity, reflecting a wide range of cultural backgrounds, traditions, and spoken languages. This diversity, and the environmental risks residents face, are not distributed evenly across the region. Many communities of color are concentrated in areas that continue to face long-standing disinvestment, resulting in a systemic compounding of economic vulnerabilities, limited access to resources, and disproportionate exposure to climate-related hazards. Identifying where vulnerable communities are located within the watershed boundary, and understanding the conditions they face, is essential to developing responsive and effective resilience strategies.

6.3.1 Engagement and Community Input

Excluding vulnerable communities from planning processes perpetuates injustice, and for this reason, it is imperative to understand their unique challenges and to incorporate direct input from community members when shaping solutions. RWA's engagement efforts aim to build long-term relationships based in trust by practicing transparent information sharing and creating inclusive opportunities for public participation.

In addition to the use of quantitative data, direct input from community members on their lived experiences, particularly from climate-vulnerable, historically disinvested communities, is honored as an important source of information to inform processes and outcomes. Engagement efforts are designed to address barriers to participation by offering participant compensation, opportunities for feedback in both virtual and in-person formats and adapting often complex and technical information into accessible language. These approaches aim to reduce obstacles related to access, capacity, and prior experience in planning processes, recognizing that marginalized communities most impacted by climate risks hold invaluable perspectives essential to informing effective and equitable solutions. Community engagement is an ongoing practice, and RWA is committed to encouraging participation from diverse voices, including those often least engaged, through accessible and meaningful opportunities demonstrating that participation is valued, supported, and influential throughout decision-making processes.

Climate-related threats are increasing across the region, but the severity of impacts vary by geography and population. For example, Latino and Indigenous workers, who make up a significant share of the region's agricultural and natural resource workforce, are more likely to work outdoors, and therefore experience disproportionate exposure to extreme weather conditions and poor air quality. Economic disparity is also connected to climate-related risk exposure, as climate impacts are expected to exacerbate existing inequities, placing additional strain on communities already facing health, housing, and economic challenges. According to the Capital Region Economic Assessment, at least 37% of Capital Region residents live in families whose household incomes do not cover basic needs, and nearly 44% of children are growing up in households struggling to meet the cost of living. These populations often overlap with census tracts designated by the State as "disinvested," including California Environmental Protection Agency (CalEPA)-designated disadvantaged communities, low-income areas, high-poverty or high-unemployment areas, and lands managed by Federally recognized Tribes. An assessment of census tracts against CalEPA criteria reveals that people of color represent a disproportionate number of residents living in a CalEPA-designated disadvantaged community.

6.4 Critical Historical Weather-Related Events

Understanding historical climate hazards is foundational to assessing current vulnerabilities and informing future resilience strategies. Over the past two decades, the RWA Watersheds has experienced a series of extreme weather events—floods, droughts, wildfires, and heat waves—that have tested the limits of infrastructure, ecosystems, and community preparedness. These events offer critical insight into the watersheds' sensitivities to climate stressors and the adaptive capacity of their systems.

A review of publicly available data and regional studies identified the following key hazard types and representative events:

- **Flooding and Extreme Precipitation**: Atmospheric river events in 2017, 2019, and 2023 caused widespread flooding, infrastructure damage, and emergency reservoir releases. These events highlight the vulnerability of levee systems and the limited flood storage capacity of Folsom Reservoir.

- **Wildfire**: The Caldor (2021), Mosquito (2022), and King (2014) Fires collectively burned over 400,000 acres in the upper watershed, degrading forest health, increasing erosion, and impairing water quality in the South Fork American River.
- **Extreme Heat**: The 2022 and 2020 heat waves set temperature records and caused significant public health impacts, including hundreds of excess deaths and economic losses in the billions. These events also exacerbated wildfire risk and stressed aquatic ecosystems.
- **Drought**: The 2012 to 2016 and 2020 to 2022 droughts led to record-low reservoir levels, increased groundwater reliance, and significant agricultural and ecological impacts. These events exposed long-standing vulnerabilities in water supply reliability and groundwater sustainability.

6.5 Regional Climate Drivers and Trends

This section provides an overview of regional climate drivers, referring to the large-scale atmospheric and oceanic patterns—such as El Niño–Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), Atlantic Multidecadal Oscillation (AMO), and the increasing influence of atmospheric rivers—that shape seasonal variability and extreme events across the RWA Watersheds. It also summarizes regional climate trends, referring to the long-term observed changes in temperature, precipitation, snowpack, runoff timing, and the frequency of extremes like heat waves, droughts, and wildfire conditions. Together, these drivers and trends set the context for how water-related sectors—including water supply, flood management, ecosystem health, and interconnected systems such as groundwater, hydropower, and recreation—are impacted across the RWA Watersheds.

6.5.1 Climate Drivers in the RWA Watersheds

Extreme precipitation and hydrologic variability in the RWA Watershed are shaped primarily by atmospheric rivers (ARs), which deliver most annual precipitation and dominate flood risk for Folsom Reservoir and downstream levees. Secondary climate drivers that can contribute to dynamics in the watershed are as follows:

- **ENSO:** Influences storm sequencing but has weak correlation with seasonal precipitation in Northern California. Wet and dry winters occur under both phases—2017 and 2023 were notably wet despite La Niña.
- **PDO:** Modulates storm tracks and AR orientation over multi-decadal scales. Recent cool phases tend to tilt conditions drier, though AR variability often overrides simple PDO-to-precipitation links.
- **AMO:** Warm phases can favor subtropical ridging and episodic intense storms, but locally, AR behavior and shorter-term teleconnections exert greater control over orographic precipitation and runoff timing in Sierra headwaters.

6.5.2 Observed Trends in the RWA Watersheds

Long-term observations and ARBS (2022) projections reveal accelerating shifts in temperature, hydrology, and ecosystem stress:

- **Warming:** The basin has warmed by approximately 1.5 degrees Celsius (2.7 degrees Fahrenheit [°F]) since the mid-20th century, with increased heatwave frequency—roughly 20 additional days with temperatures great than 90 °F annually—and earlier frost dates. ARBS projects maximum temperatures to rise 4 to 7 °F by 2085, especially in the upper watershed. (USBR 2022)

- **Snowpack and Runoff Shifts:** Sierra snowpack is declining, and runoff now peaks 30 to 60 days earlier than historical norms, reducing natural water storage and complicating flood-space management at Folsom Reservoir. (USBR 2022)
- **Precipitation Variability:** While annual precipitation totals remain stable, the ARBS identifies a trend toward shorter, more intense wet seasons and increased "whiplash" between droughts and AR-driven floods. (USBR 2022; DWR 2024).
- **Ecological Stressors:** ARBS projections indicate a 4 to 10 °F increase in average August water temperatures in the Lower American River, posing significant risk to cold-water fisheries. Combined with rising drought frequency and groundwater overdraft in the Cosumnes basin, these trends threaten ecosystem resilience. (USBR 2022; DWR 2024).

6.6 Climate Resilience Challenges and Opportunities

The RWA Watersheds faces compounding climate resilience challenges that directly affect sectors such as water supply, agriculture and impact communities, resulting in cascading impacts to communities and ecosystems. Rising temperatures and worsening droughts are projected to reduce snowpack and shift runoff timing, increasing vulnerability of both surface and groundwater supplies—a critical concern given anticipated population growth of roughly 20% by mid-century (USBR 2022; DWR 2024). At the same time, intensifying atmospheric rivers and altered snowmelt cycles heighten flood risk for downstream basins and aging levee systems, underscoring lessons from regional crises such as Oroville Dam and Delta levee failures (DWR 2024). Extreme heat events compound public health risks, particularly in urban heat islands with limited canopy cover, and wildfire frequency and severity in headwater forests are degrading source-water quality, impairing reservoir operations, and creating episodic air quality emergencies (USBR 2022; DWR 2024). These hazards disproportionately impact disadvantaged communities, amplifying equity concerns and limiting adaptive capacity.

The RWA Watersheds are poised to benefit from a suite of integrated strategies that strengthen water security, ecological health, and community resilience under a changing climate. Building on the watershed-scale approach outlined in the *California Water Plan Update 2023* and the *American River Basin Study* (DWR 2024; USBR 2022), these opportunities emphasize coordination across headwaters, river corridors, and urban systems.

- **Forest and Meadow Restoration**: Expanding fuels reduction and meadow rewatering in upper watersheds to reduce wildfire severity, stabilize soils, and protect source-water quality
- **Multi-Benefit Floodplain and Levee Setback Projects**: Reconnecting rivers to their floodplains and creating setback levees to absorb high flows, reduce downstream flood risk, and restore riparian habitat
- **Managed Aquifer Recharge:** Capturing excess flows during wet periods to replenish groundwater basins, improving drought resilience and buffering surface supply variability
- **Operational Enhancements for Cold-Water Habitat**: Refining temperature control operations at Folsom Dam to sustain cold-water pools critical for salmonid survival and ecosystem health

These measures, coupled with regional collaboration, equity-focused adaptation policies, and active community engagement, position the watershed to advance a comprehensive resilience framework that safeguards water supply, ecosystems, and vulnerable populations. Together, they represent a forward-looking investment in climate resilience that delivers benefits across environmental, economic, and social dimensions.

At the Watershed Network meeting held in November 2025, participants shared their concerns and priorities through a live Mentimeter poll (Appendix F).

6.7 Watershed Historical Water Budget

As part of the RWA WRP, a comprehensive historical water budget was developed using existing data to support a deeper understanding of water systems across the planning area. This effort provides a means for visualizing and assessing how water moves through the landscape—across surface water, land, and groundwater systems—and offers context for characterizing the historical distribution of inflows, consumptive uses, imports, exports, and other factors that affect water supplies within the planning area.

This historical assessment is important for characterizing the existing state of the planning area and how climatological and extreme weather events have evolved over time. Understanding these trends is a key factor in identifying existing vulnerabilities within the RWA Watersheds and how the evolution of these trends may influence water management needs in the future. This water budget offers insight into how simulated hydrologic conditions over the last 100 years (water years 1922 through 2021) have influenced the relative contribution of individual water-related components across the planning area.

6.7.1 Methodology

The historical water budget was developed in accordance with guidance included in DWR's *Handbook for Water Budget Development*. As such, the planning area was divided into surface water, land, and groundwater system regions. Surface water and land systems share the same spatial domain and are largely developed based on HUC-8 watershed boundaries (Figure 6-1). Groundwater system regions are representative of Bulletin 118 groundwater basins for the North American, South, American, and Cosumnes subbasins, trimmed to the extent of the overall planning area (Figure 6-2).

The historical water budget relies on several different data sources to characterize individual water budget components. The primary sources of monthly timeseries data between water years 1922 and 2021 are CalSimHydro and the Variable Infiltration Capacity (VIC) models for valley floor and upper watershed areas, respectively. These sources are supplemented by CalSim 3 simulations from the 2023 Delivery Capability Report, outputs from the CoSANA Integrated Water Resources Model, assumptions noted in the CalSim 3 Report, and precipitation data from the extended Livneh et al. (2013, updated thereafter) dataset. Detailed documentation and additional information on each of these data sources, associated limitations, and relevant individual water budget components are provided in the Appendix I: Historical Water Budget.

Figure 6-1. Overview of Surface Water and Land Systems Water Budget Spatial Delineation

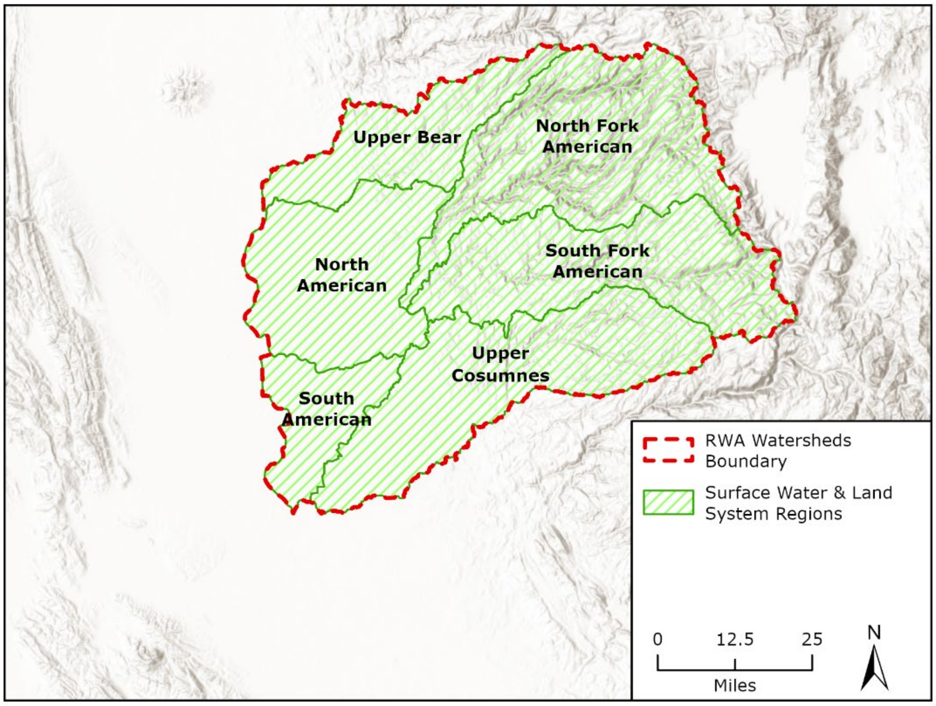
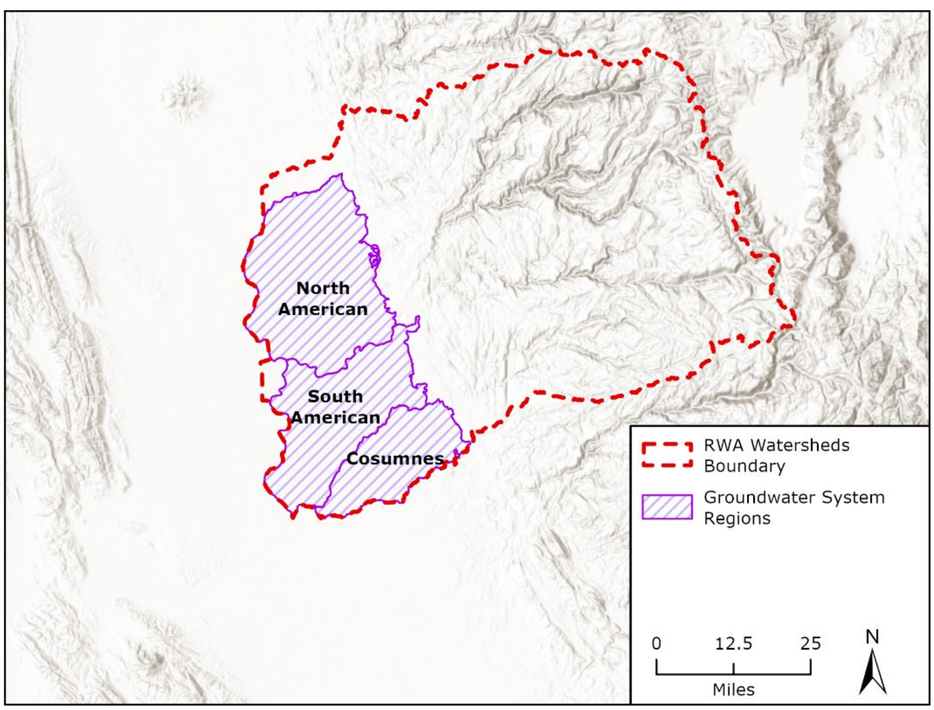


Figure 6-2. Overview of Groundwater System Water Budget Spatial Delineation Water Budget Terms and Equations



The following equations (largely informed by the Handbook for Water Budget Development) highlight individual water budget terms represented by each system and are used to estimate the net change (i.e., inflows minus outflows) in storage within a given water budget region over a selected period. Note that this change in storage can also be interpreted as a measure of uncertainty of mass balancing (i.e., accounting) between inflows and outflows. In most cases, inflows and outflows for each year are not perfectly balanced across systems due to the variety of data sources used to characterize individual components. Additionally, for systems such as the groundwater system, change in storage can be used to assess long-term trends in aquifer supplies:

- Surface Water System
  - Inflows: Stream Inflow + Imported Water + Runoff (and Baseflow, where relevant) + Tailwater + Wastewater + Operational Spill Conveyance Gain + Lateral Flow Conveyance Gain + Streamflow Gain
  - Outflows: Stream Outflow + Exported Water + Applied Water Diversions + Urban Surface Water Diversions + Reservoir Evaporation + Streamflow Losses + Environmental Flows
  - Change in Surface Water Storage: Total Surface Water Inflows – Total Surface Water Outflows
- Land System
  - Inflows: Precipitation + Applied Water + Urban Deliveries + Upper Watershed Subsurface Gains
  - Outflows: Evapotranspiration + Surface Runoff (and Baseflow, where relevant) + Deep Percolation + Evaporative Conveyance Losses + Deep Percolation Conveyance Losses + Operational Spill Conveyance Losses + Lateral Flow Conveyance Losses + Tailwater + Wastewater + Upper Watershed Subsurface Losses
  - Change in Land System Storage: Total Land System Inflows – Total Land System Outflows
- Groundwater System
  - Inflows: Deep Percolation + Deep Percolation Conveyance Gains + Streamflow Gain + Subsurface Inflow
  - Outflows: Applied Water Pumping + Urban Pumping + Streamflow Loss + Subsurface Outflow
  - Change in Groundwater System Storage: Total Groundwater System Inflows – Total Groundwater System Outflows
- Total Water Budget (Representative of inflows and outflows across all systems)
  - Inflows: Precipitation + Stream Inflows + Imported Water + Subsurface Inflow + Upper Watershed Subsurface Gains
  - Outflows: Evapotranspiration + Evaporative Conveyance Losses + Reservoir Evaporation + Stream Outflow + Environmental Flows + Exported Water + Subsurface Outflow + Upper Watershed Subsurface Losses
  - Change in Total Water Budget Storage: Total Water Budget Inflows – Total Water Budget Outflows

6.7.2 Key Findings and Results

Discussion of key findings from this assessment are highlighted in the following bullet points; additional commentary on observable trends is noted in Appendix I.

- Precipitation variability drives runoff, recharge, and overall system performance. Planning assumptions must account for increasing hydrologic volatility.
- The American River basin is significant contributor of surface flows to the downstream areas via the Sacramento River and the Delta, with most inflow leaving as stream outflow. Therefore, local resilience is not constrained by total annual volume but depends on storage and timing.
- Storage gains in wet years and drawdown in dry years highlight the importance of flexible, adaptive reservoir management.
- Evapotranspiration and human demands do not decline proportionally during drought, increasing stress on stored supplies.
- Environmental flow requirements and steady municipal demands consume a larger share of reduced supplies in dry years.
- Most aquifer replenishment occurs in wet and above-normal years. Policies that capture and store excess water during these periods are critical.

Long-term balance depends on sufficient recharge years. A shift toward more frequent drought could erode historical stability.

7. Climate Vulnerability Assessment

An integrated assessment of climate vulnerability and risk was conducted to better understand how climate-related hazards may affect key systems and communities across the watershed. The vulnerability assessment draws on both qualitative and quantitative methods that evaluated nine systems and sectors across the watershed: surface water supply, groundwater supply, water quality, flood management, ecosystem, agricultural, community and equity, recreation, and hydropower.

7.1 Qualitative Vulnerability Assessment

The qualitative vulnerability assessment (Appendix C) provides a structured, sector-specific evaluation of climate risks, capturing how different systems respond to stressors such as extreme heat, drought, flooding, and wildfire. This assessment emphasizes local context and planning-area nuance, recognizing that climate vulnerability varies across the Upper and Lower American, Bear, and Cosumnes watersheds due to differences in hydrology, infrastructure, ecosystems, and community capacity.

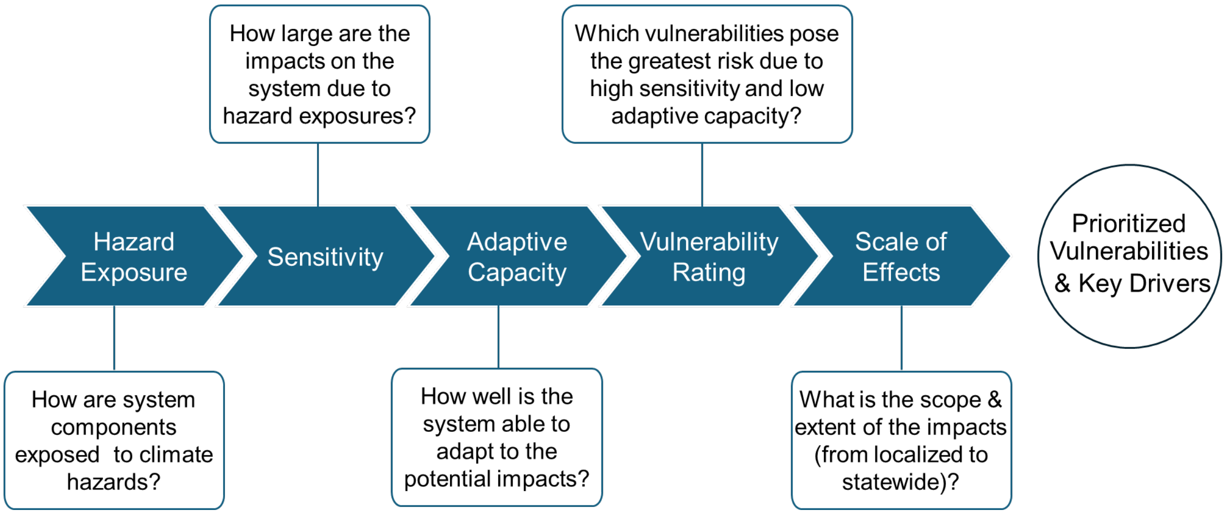
7.1.1 Approach

The qualitative vulnerability assessment approach recognizes that vulnerability is driven not by climate exposure alone, but also by the interaction between a system's sensitivity to climate stressors and its capacity to adapt or recover. These two dimensions, Sensitivity and Adaptive Capacity, are evaluated independently and then combined using a predefined prioritization logic to assign a Vulnerability Priority Rating. Through this process, the qualitative insights are translated into standardized scores that enable consistent comparison across sectors and assets; support prioritization of the most critical vulnerabilities; and inform where more detailed, scenario-based modeling is warranted.

In addition to published data and reports, the assessment incorporated broad stakeholder engagement to solicit input through agency-specific meetings and expert consultations to calibrate scores and verify consistency across sectors and planning areas. Particular attention was given to interpreting Adaptive Capacity in relation to institutional, operational, and ecological constraints, strengthening the credibility and defensibility of the results.

Figure 7-1 illustrates the qualitative assessment process, and its elements are described in the bullet points following Figure 7-1.

Figure 7-1. Vulnerability Assessment Process Applied to Planning Areas, Systems, and Sectors



- **Sensitivity:** Sensitivity describes how strongly a system or component is affected when exposed to climate stressors such as extreme heat, drought, flooding, or wildfire. It reflects the degree to which climate conditions influence system performance, function, or integrity. Sensitivity is rated on a 5-point scale, where low scores indicate minimal climate influence, and high scores indicate strong, direct sensitivity with potential for performance degradation or failure. Ratings are informed by physical characteristics, operational constraints, and established climate-response relationships, with intermediate values used to capture gradations in response.
- **Adaptive Capacity:** Adaptive Capacity reflects a system's inherent ability to respond to, cope with, or recover from climate impacts. This includes factors such as physical redundancy, operational flexibility, institutional authority, financial resources, regulatory protections, and availability of alternatives. Adaptive Capacity is also rated on a 5-point scale, but inversely, such that higher numeric values indicate lower capacity. This inverse structure confirms that systems with high sensitivity and limited capacity are appropriately identified as the most vulnerable.

- **Vulnerability Rating:** Rather than calculating vulnerability through a simple formula, the assessment uses a matrix (Figure 7-2) that explicitly defines how combinations of Sensitivity and Adaptive Capacity translate into a Vulnerability Priority Rating (1 to 5). This approach avoids false precision, supports consistent expert judgment across sectors, and confirms that systems with high sensitivity and low adaptive capacity receive the highest priority ratings. Vulnerability ratings of 4 or 5 indicate high to very high concern and signal areas for further analysis.

Figure 7-2. Vulnerability Prioritization Matrix

Low ← Sensitivity → High

Low ← Adaptive → High Capacity

1	1	1	1	3
1	1	1	3	3
1	2	3	4	5
1	2	4	5	5
1	2	5	5	5

- **Scale of Effects:** To capture not only how vulnerable a system is, but also how far its impacts extend, the assessment includes a Scale of Effects rating. This metric describes the geographic or systemic reach of consequences, ranging from localized impacts affecting a single facility or community to systemwide or Statewide impacts with cascading effects across multiple watersheds or sectors. The Scale of Effects is rated on a 1 to 5 scale and is critical for identifying vulnerabilities with the potential to propagate beyond their point of origin.
- **Composite Vulnerability Score:** The Vulnerability Priority Rating and Scale of Effects are combined to form a composite score, weighted 2:1, respectively. This composite supports rapid comparison across systems while retaining the underlying multi-dimensional information. The framework enables stakeholders to distinguish localized risks from systemwide threats, compare vulnerabilities across asset types, and identify systems warranting priority attention in subsequent quantitative analysis.

7.1.2 Key Vulnerability Drivers

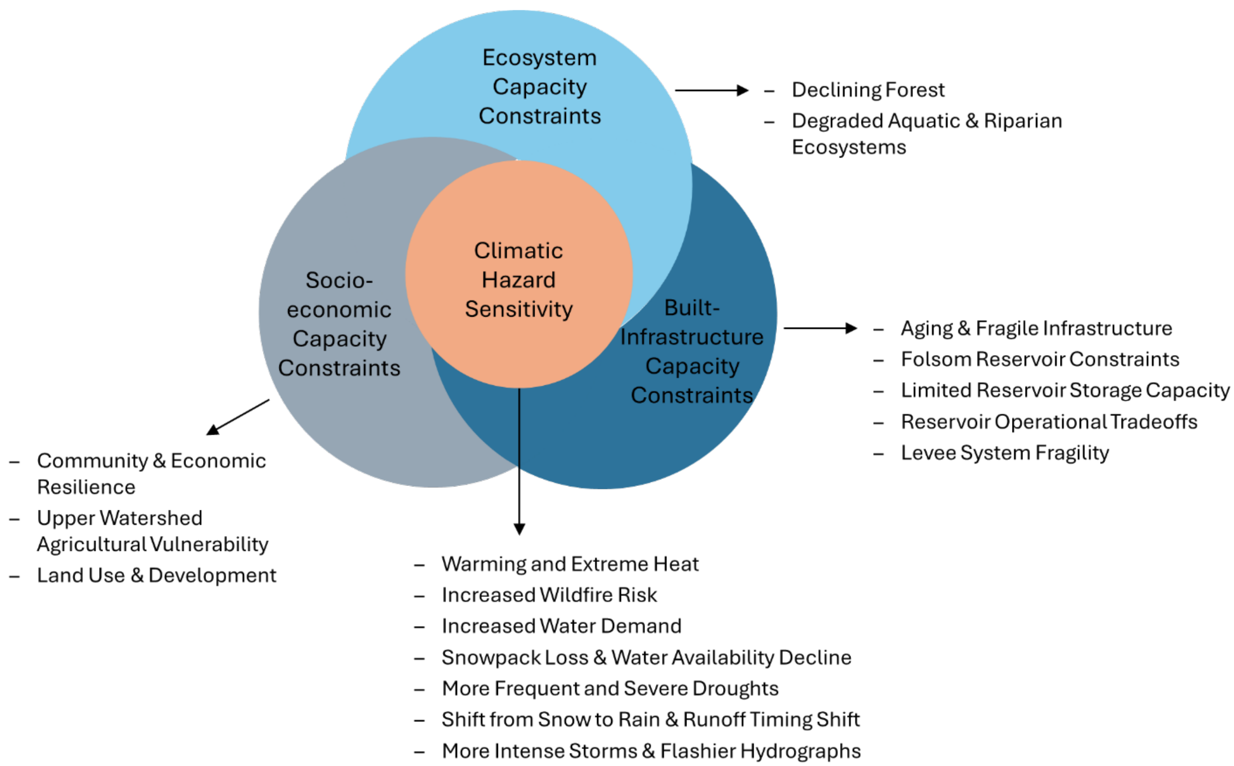
Key vulnerability drivers are the underlying factors that explain why certain systems and communities experience disproportionately high risk under climate stress. Rather than reflecting exposure alone, these drivers describe the mechanisms through which climate hazards translate into real impacts: by increasing sensitivity, creating single points of failure, or constraining the ability to adapt. Focusing on drivers captures system dependencies, infrastructure and institutional limitations, and the compounding effects of multiple stressors, providing a direct link between vulnerability ratings and actionable responses.

Across the watershed, vulnerability emerges from the interaction of climatic hazard sensitivity (including warming and extreme heat, snowpack loss and runoff timing shifts, more intense storms, prolonged drought, and wildfire) with capacity constraints that limit response options. Climate hazard sensitivity interactions with ecosystems, socioeconomic, and built-infrastructure factors are illustrated on Figure 7-3.

Ecological capacity drivers—particularly declining forest health and degraded aquatic and riparian ecosystems—amplify risk by altering runoff processes, increasing sediment and water quality stress, and constraining operational flexibility. Built infrastructure capacity drivers (including aging and fragile leaves, limited storage capacity, and operational constraints at key facilities such as Folsom Reservoir) further elevate vulnerability by creating critical points of failure under increasingly variable conditions.

Socioeconomic capacity drivers shape both the severity and distribution of impacts. Community and equity-related vulnerabilities are widespread, especially in rural, foothill, floodplain, and Delta-edge communities where exposure to multiple hazards overlaps with limited redundancy and institutional capacity. Groundwater systems illustrate a dual pattern of vulnerability, with regional-scale sustainability risks alongside acute, localized insecurity in small systems and private wells, underscoring equity concerns even where impacts do not cascade watershed-wide.

Figure 7-3. Key Drivers for Vulnerability in the American, Bear, and Cosumnes Watersheds



7.1.3 Qualitative Assessment Findings

Key findings from the qualitative vulnerability assessment are summarized in the following bullet points. They support the development of targeted climate adaptations.

- **Climate Hazards are the Primary Driver for Vulnerabilities:** Vulnerability is highest where climatic hazards intersect with degraded ecological systems, constrained infrastructure, and limited community capacity, particularly in systems that perform critical, watershed-wide functions. While many assets exhibit climate sensitivity, the assessment clearly differentiates these system-level risks from vulnerabilities that are more localized or buffered by stronger adaptive capacity. These results directly inform the adaptation framework, which is organized to address the key climatic, ecological, socioeconomic, and built infrastructure drivers responsible for the highest vulnerability across the watershed.
- **Systemwide Vulnerabilities Dominating Highest Risk Category**: The assessment identifies several assets and systems with very high vulnerability (rating of 5) and systemwide or multi-watershed effects (Scale of Effects 4 to 5). These include Folsom Reservoir; natural snowpack systems; forest health and ecosystem services; lower American River aquatic ecosystems; and major levee systems in the Cosumnes and Lower American Rivers. These systems consistently score at the top of the composite ranking (4.7 to 5.0), indicating that even moderate additional climate stress could result in cascading impacts across water supply, flood management, ecosystems, recreation, and communities. Their importance lies not only in their sensitivity, but in their central role within the watershed's interconnected systems.

- **Severe and Far-Reaching Ecosystem and Forest Health Vulnerabilities**: Ecosystem-related components, especially forest health and ecosystem services and aquatic ecosystems in the Lower American River, consistently rank among the highest vulnerabilities. Forest health systems in the Upper American, Upper Bear, and Upper Cosumnes Rivers score at the maximum vulnerability level with systemwide effects, reflecting the compounding influence of drought, wildfire, pests, and heat. These vulnerabilities have implications well beyond ecology: they affect erosion, sediment transport, water quality, reservoir operations, and long-term hydrologic function across the watershed.
- **Flood Management - a Critical and Widespread Vulnerability**: Flood-related assets—particularly levee systems, floodplains, and local drainage networks—emerge as a dominant vulnerability across the Lower American, Lower Cosumnes, and Lower Bear River planning areas. Levee systems in the Lower Cosumnes and Lower American Rivers are rated at the highest vulnerability level, reflecting high exposure to extreme precipitation and atmospheric rivers, combined with limited options for structural adaptation. These systems also exhibit high scale-of-effects scores, underscoring that flood failures would affect entire communities, transportation corridors, and agricultural areas, rather than isolated locations.
- **Surface Water Supply Vulnerabilities Driven by Snowpack Loss and Key Storage Constraints:** Surface water supply systems show elevated vulnerability where they depend on snowpack-driven hydrology or single, critical storage facilities. Natural snowpack in the Upper American, Upper Bear, and Upper Cosumnes Rivers consistently ranks as highly vulnerable with systemwide consequences, reflecting the foundational role of snowpack as the watershed's largest natural reservoir. Folsom Reservoir, assessed under both surface water supply and flood management, stands out as one of the most consequential vulnerabilities in the entire assessment due to its sensitivity to runoff timing shifts and regulatory constraints that limit operational flexibility.
- **Groundwater Vulnerabilities Reflecting both Regional and Localized Water Risks**: Groundwater systems display two distinct but equally important vulnerability patterns. At the regional scale, groundwater basins in the Lower American and Lower Bear River areas score high vulnerability with large scales of effect, indicating risks to long-term groundwater sustainability and regional water reliability. At the local scale, small water systems and private landowner wells, particularly in the upper watershed and Cosumnes areas, show very high vulnerability despite having localized impacts. These systems lack redundancy and financial capacity, making them especially sensitive to drought and wildfire, and highlighting equity concerns even when impacts do not immediately cascade watershed wide.
- **Widespread, but Often Subregional-Scale, Community and Equity Vulnerabilities**: Community and equity components show consistently high vulnerability scores (rating of 4) across multiple planning areas, including Delta-edge communities, Sacramento Metro East, floodplain communities, foothill towns, and upper watershed rural communities. While many of these impacts are subregional in scale, they represent concentrated risk to populations with limited adaptive capacity, particularly in areas facing overlapping hazards such as flooding, heat, wildfire, and water insecurity. Upper watershed rural communities stand out with the highest vulnerability scores, reflecting isolation, limited redundancy, and constrained institutional capacity.
- **Lower Vulnerability but not Low Importance**: Some systems—such as large conveyance infrastructure, major managed floodways, and certain municipal water systems—show lower vulnerability ratings due to higher adaptive capacity, even when exposed to climate stressors. These findings do not indicate absence of risk, but rather reflect that institutional strength, operational flexibility, and system design play a meaningful role in moderating climate impacts.

7.2 Quantitative Vulnerability Assessment

7.2.1 Approach

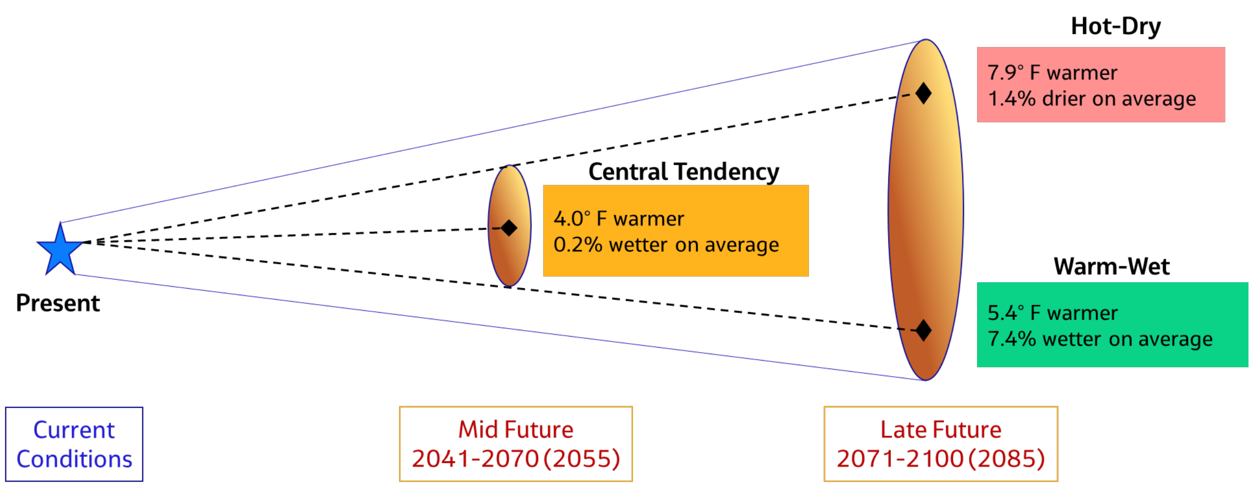
The quantitative vulnerability assessment evaluates how key water-resource systems respond to future climate stressors using a scenario-based framework. The approach translates a large ensemble of climate projections into a small, representative set of planning scenarios that capture both central tendencies and plausible extremes. These scenarios provide a consistent basis for assessing system sensitivity to climate hazards under mid- and late-century climate conditions. They support the qualitative assessment and provide comparative assessment of the magnitude of likely changes across the watershed.

7.2.1.1 Climate Scenario Development

The quantitative assessment employs a scenario-based approach to evaluate key vulnerabilities for water resources sectors. Future climate change scenarios were developed using 129 projections derived from 15 selected global climate models within the Coupled Model Intercomparison Project Phase 6 (CMIP6) dataset. These projections include variant members from each global climate model to capture model uncertainty. The scenarios are intended to encompass a wide range of potential climate conditions, from median projections to extreme cases, and are defined for two future periods: Mid-Century (2041 to 2070) and Late-Century (2071 to 2100).

Percentile-based thresholds were applied to represent a range of plausible futures while maintaining statistical robustness. A 50th-percentile (median) scenario was selected for Mid-Century conditions to reflect central tendency. For Late-Century conditions, Warm–Wet and Hot–Dry scenarios were defined using the 75th and 25th percentiles, respectively, to represent plausible extremes in precipitation and temperature. Figure 7-4 illustrates the range of conditions covered by these scenarios, which span median trends and high-impact futures relevant to long-term planning and risk management. The approach for the development of the climate change scenarios is detailed in Appendix D.

Figure 7-4. Projected Changes under the Selected Climate Change Scenarios



7.2.1.2 Sea Level Rise Scenarios

Each period includes different sea level rise (SLR) assumptions. The Existing Baseline assumes 0-centimeter (cm) SLR, while the Mid-Century (Central Tendency) assumes 30 cm SLR, and the Late-

Century (Hot-Dry [HD]) and Late-Century (Warm-Wet [WW]) assume 55 cm SLR. The elevated SLR in the future periods corresponds to greater challenges in meeting water quality standards in the Delta.

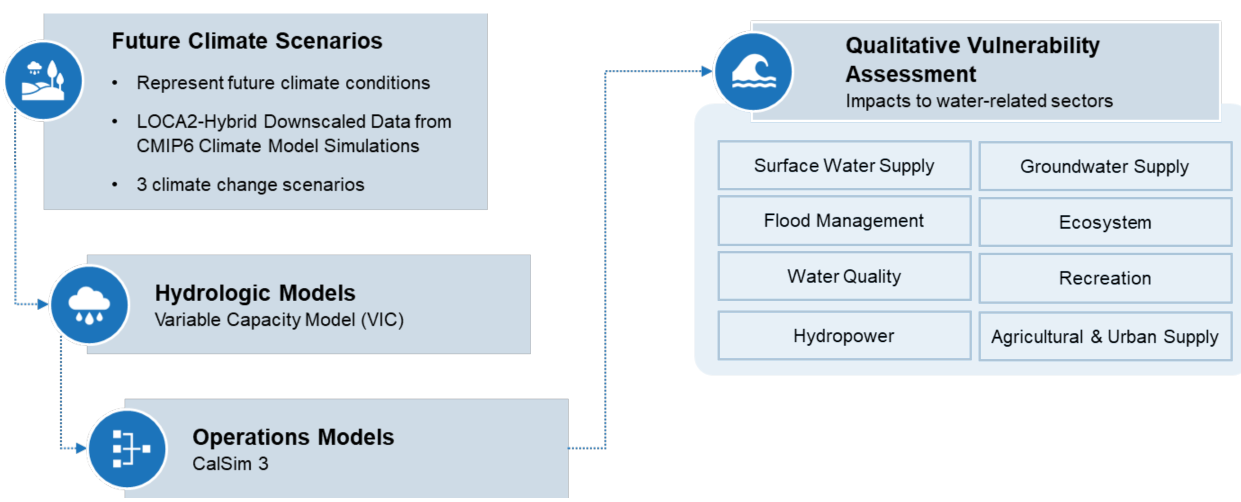
7.2.1.3 Modeling Tools

To evaluate climate vulnerability across water-resource sectors, the assessment applies a modeling framework that links future climate scenarios to hydrologic response, system operations, and sector-specific impacts (Figure 7-5). The three developed climate scenarios using CMIP6 projections provide the foundation for hydrologic and operations modeling, which in turn inform the quantitative vulnerability assessment across sectors. Hydrologic modeling using a VIC model translates changes in temperature and precipitation into watershed-scale runoff and inflow responses.

These hydrologic outputs, as well as SLR assumptions, are incorporated into CalSim 3, the primary operations model used to simulate reservoir storage, river flows, and surface water diversions and deliveries across the Sacramento and San Joaquin valleys. It provides a consistent, planning-level representation of system operations, facilities, demands, and regulatory constraints. To isolate climate-driven effects, the modeled scenarios vary only in hydrologic inputs and demand assumptions reflecting future climate and development, while all operational rules and infrastructure characteristics remain unchanged.

Outputs from CalSim 3 are then used to drive HEC-5Q for river and reservoir water temperature along the lower American River; and Long-Term Generation Model 3 to estimate hydropower generation at Folsom Reservoir. This approach confirms that temperature and energy impacts reflect the same operational and hydrologic conditions used in the water supply analysis. A detailed description of the modeling assumptions is included in Appendix D Attachment 2 – CalSim 3 Modeling.

Figure 7-5. Modeling Framework Linking Climate Scenarios to Sector-specific Vulnerability Assessment Indicators and Metrics



Model results from the tools outlined previously herein are synthesized to evaluate impacts across eight water-related sectors: surface water supply, groundwater supply, flood management, water quality, ecosystems, recreation, hydropower, and agricultural and urban water supply. A series of vulnerability indicators and metrics relevant to selected water sectors and land uses were developed and are provided in Appendix D. Indicators and metrics are the foundation for the quantitative vulnerability assessment documented in subsequent sections. Definitions for each of these terms are as follows:

- **Indicators** are the observable aspects of a given water resource sector that provide insight into existing conditions, projected conditions, and responses to adaptation. Indicators are intended to inform decision-making processes. Example indicators include Folsom Reservoir condition (surface water supply sector), flood stage (flood management sector), and aquatic ecosystem suitability (ecosystem sector).
- **Metric** is the quantitative measurement of a given indicator. Metrics must be relevant, spatially specific, time-sensitive, sensitive to climate, actionable, and comparable across scenarios. Example metrics include change in end-of-September Folsom Reservoir storage (surface water supply sector), change in 1% annual exceedance probability precipitation intensity (flood management sector), and deviation from suitable temperature targets at Watt Avenue Bridge (ecosystem sector).

7.2.2 Summary of Results

Results from the quantitative vulnerability assessment for each of the water-resource sectors are discussed in the following subsections. Detailed modeling results are presented in Appendix D.

7.2.2.1 Surface Water Supply

Future conditions are projected to correspond with reduced levels of annual unimpaired inflows entering the American River. Additionally, warmer temperatures and changing precipitation levels will cause a shift in the timing of upstream runoff, where a higher proportion of annual unimpaired inflow occurs in December through March and less occurs in May through August (Figure 7-6). Reduced levels of unimpaired inflow, especially later in the year, pose challenges in managing water supply to meet downstream demands and regulatory requirements, as demonstrated by the change in Folsom Reservoir storage on Figure 7-7.

Figure 7-6. Change in Timing and Distribution of Monthly Average Inflows to Folsom Reservoir

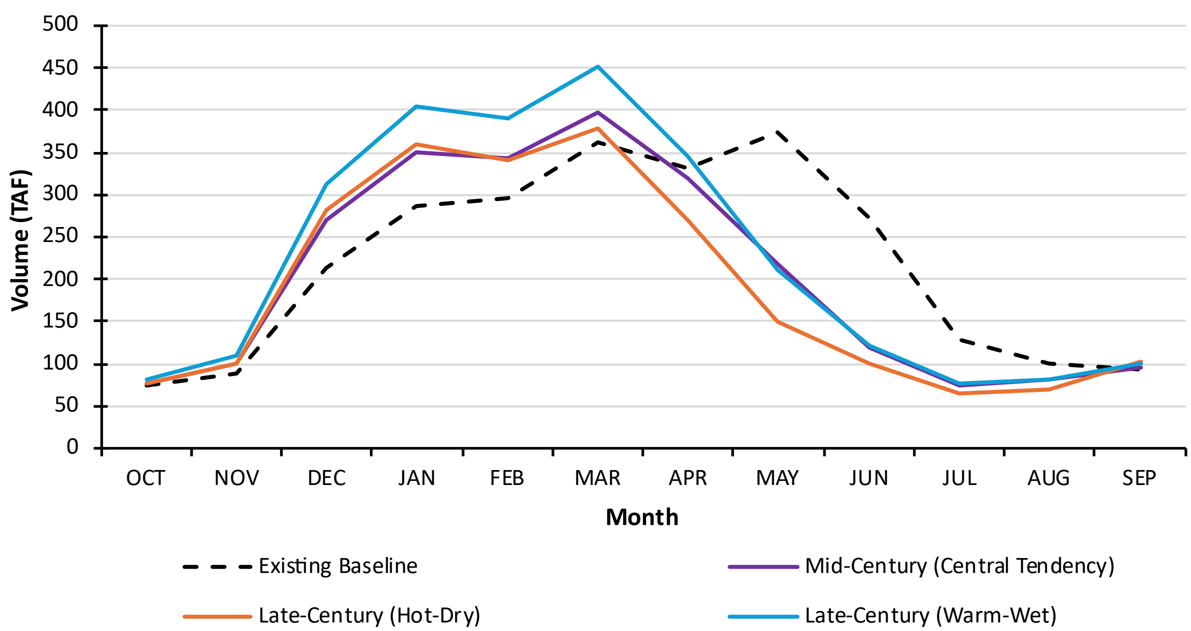
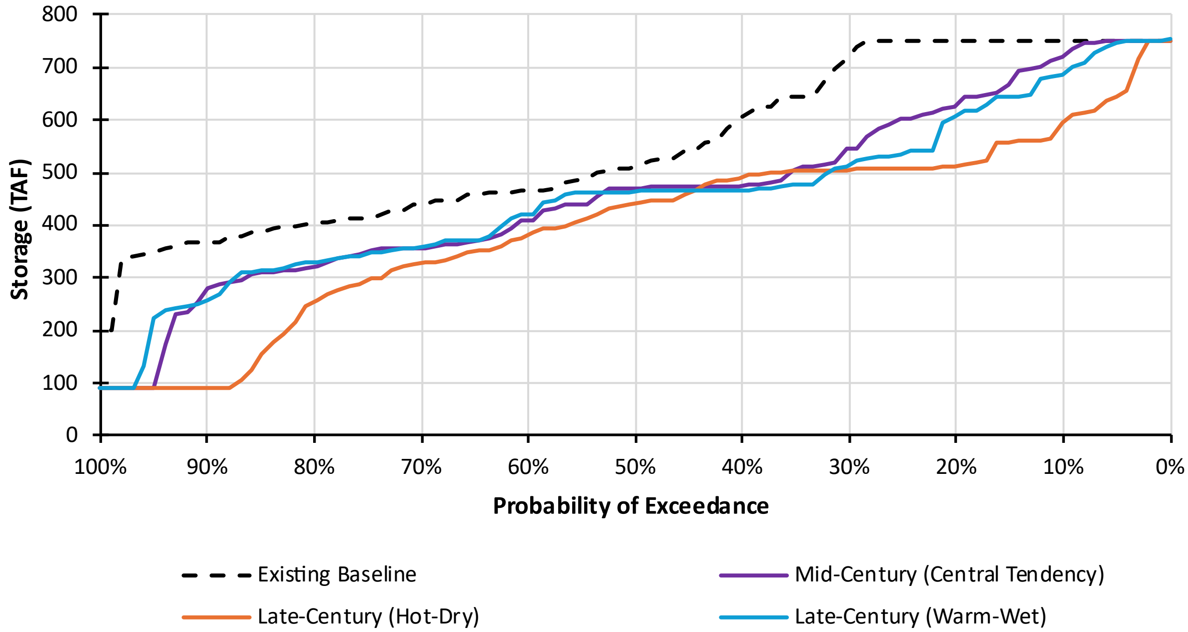


Figure 7-7. Change in End of September Folsom Reservoir Storage



Results from the surface water supply assessment reveal the following:

- By the Mid-Century, inflows to the American River may decrease by 22% relative to the Existing Baseline in December through August. Compliance with storage objectives at Folsom Reservoir and the upper watersheds will be impacted. Lower American River flows will reduce by 9% on an average annual basis, corresponding with water supply available to meet demands of service contractors and to comply with minimum instream flow requirements. Much of the reduced flow volume occurs in May through August. Water supply for hydroelectric projects in the Upper American River is impacted, and compliance with regulatory objectives decreases.
- In the Late-Century, the state of surface water supply was highly dependent on whether the climate trends warm and wet or hot and dry. If warm and wet, rim inflows and snowmelt will generally be higher in December through April than has been observed historically. Much of this water would be spilled from upstream reservoirs due to limited storage capacity and lost to Delta Outflow. Additionally, rim inflows would be less than historical levels in April through August. Overall, a warm and wet late century climate would include 16% less December through August inflows to the American River. Like the Mid-Century outlook, American River flows are significantly reduced relative to the Existing Baseline in May through September.
- If conditions in the Late-Century are hot and dry, inflow to the American River may reduce by 32% in December through August. A hot and dry late century climate would yield significantly reduced storage levels. Compliance with the Folsom Reservoir end-of-December storage standard of 230 TAF would be significantly impacted. Lower American River flows will reduce by 17% on an average annual basis, causing major challenges in meeting demands of service contractors while also complying with hydroelectric objectives and downstream minimum flow requirements.

7.2.2.2 Groundwater

Changes in groundwater storage are sensitive to climate and hydrologic conditions where increases in groundwater storage occur during wet periods, when recharge from precipitation and streamflow tends to be higher. Decreases in groundwater storage tend to occur during drier periods, when recharge from precipitation and streamflow tends to be lower and when groundwater pumping to meet agricultural demands is higher due to increased temperatures. In summary, groundwater inflows are generally larger during wet periods and smaller during drier periods, and this has a larger influence on the change in groundwater storage over time. Key results from the groundwater analysis include the following:

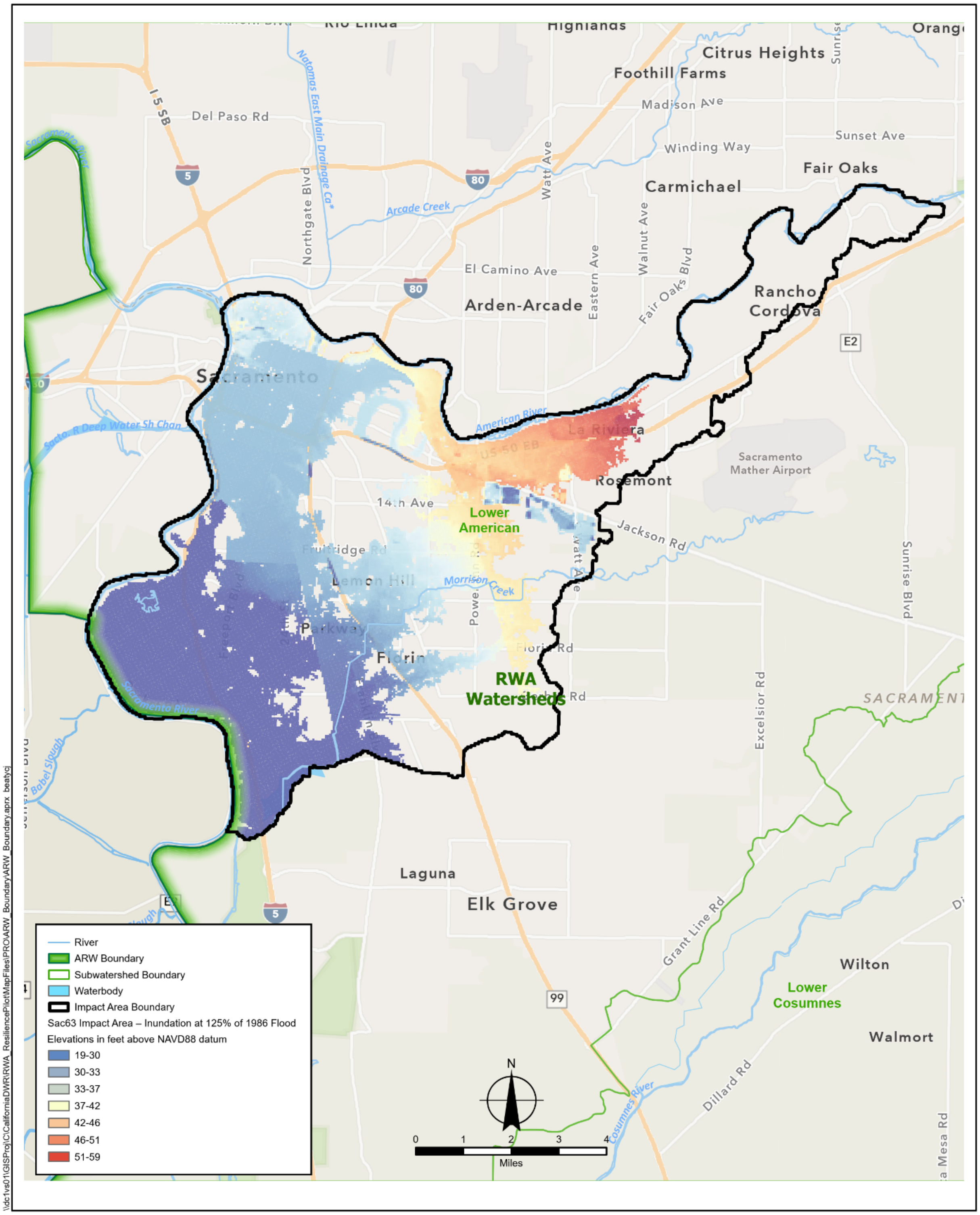
- Seasonal variability in the change in groundwater storage is observed across all climate scenarios, where increases in storage are driven by recharge from precipitation and streams during wet periods and larger decreases in groundwater storage are driven by evapotranspiration and groundwater pumping during drier periods. This dynamic indicates potential vulnerabilities in groundwater supply during the drier periods (where groundwater storage declines can result in lower water levels, which may result in some wells running dry).
- Increased temperature and decreased precipitation cause an increase in agricultural demand. This can lead to increased groundwater pumping, causing larger declines in groundwater storage during the drier periods.
- The North American, South American, and Cosumnes Subbasin Groundwater Sustainability Plans have indicated other factors that can have an influence on groundwater storage conditions. For example, increased urbanization can lead to more impervious areas; this reduces the amount of groundwater recharge that can occur, reducing the total inflow to the groundwater system and leading to larger declines in groundwater storage. In wet periods, when surface water supplies are abundant, opportunities for managed aquifer recharge can positively impact groundwater conditions by increasing groundwater storage for later use in the drier periods when surface water supplies are less abundant.

7.2.2.3 Flood Management

Increased river flows under future climate scenarios are expected to shift the flow frequency curve such that the current annual exceedance probability event (e.g., 100-year flood event) would happen more frequently in the future, increasing challenges for flood management practitioners. Additional considerations are as follows:

- As levee breaches are generally a function of river flow and stage, and since high flows will occur more frequently in the future, breaches and subsequent inundation of urban areas currently protected by levees will likely occur more frequently in the future.
- Flood modeling of inundation in urban areas protected by levees requires assumptions on the location, timing, size, and shape of the potential breach. Modeled flood inundation extents (such as those used by DWR in work supporting the Central Valley Flood Protection Plan, and in this analysis to quantify flood impacts [e.g., Figure 7-8]) must be interpreted with an understanding of the risk or probability of levee failure.
- Modeling flood inundation in areas not protected by levees is much more straightforward and does not require assumptions on levee breaches. In such areas, increased climate will extend inundation extents for a given return interval event, as flows and river stages at a given event will increase in the future. Flood maps will expand laterally, potentially inundating more structures, as warmer climates increase river flows.

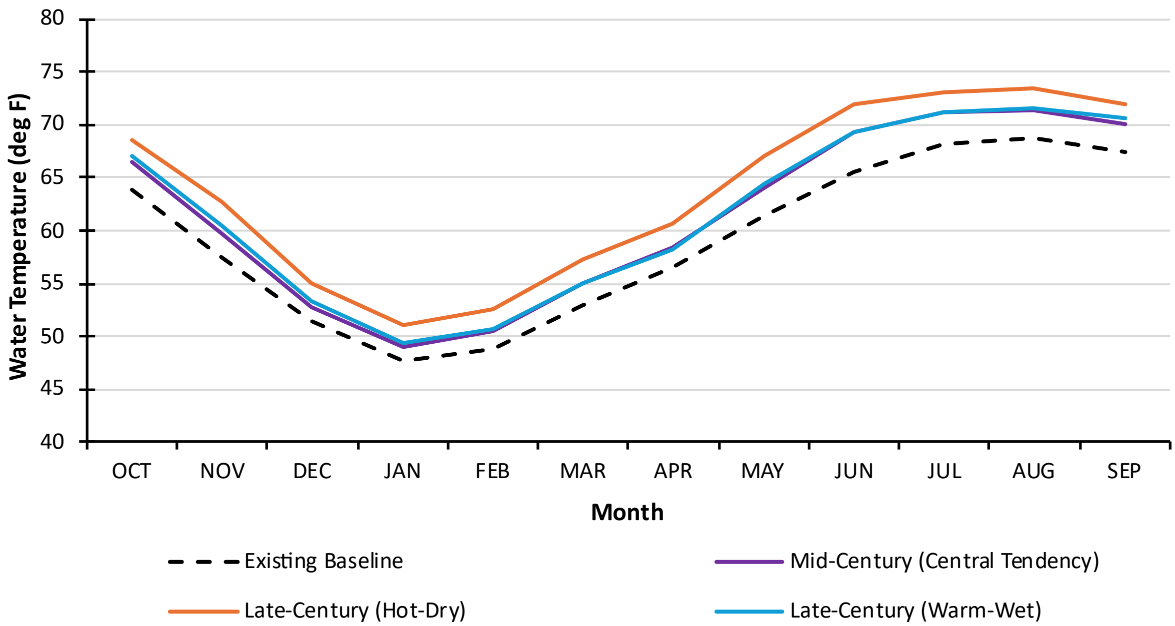
Figure 7-8. Projected Inundation under Approximately 125-year Flood Event Conditions with a Simulated Levee Breach along the American River



7.2.2.4 Water Quality

The water quality parameters evaluated include river temperature, dissolved oxygen levels, and the presence of algal blooms. In general, warmer air temperatures under future climate conditions result in increased water temperatures along the American River (Figure 7-7).

Figure 7-9. Change in Monthly Average American River Water Temperatures at Watt Avenue Bridge



Key results from the water quality assessment indicate the following:

- All future climate scenarios show increased American River water temperatures compared to the baseline scenario. The Late-Century HD scenario demonstrates the most significant temperature increases, and summer months exhibit higher water temperatures across all scenarios. Water temperatures generally increase as the river progresses downstream.
- While not directly modeled, water temperatures for the Cosumnes and Bear rivers are expected to experience similar temperature increase patterns based on air temperature projections. However, the impact might be less severe than in the American River due to more stable flow patterns.
- Dissolved oxygen levels are expected to decrease as water temperatures rise. For the American River at Watt Avenue, the Late-Century HD scenario predicts a potential 6% reduction in dissolved oxygen in June.
- The predicted water temperature increases in the American River are unlikely to substantially elevate the risk of cyanobacterial blooms, as water temperatures remain less than the optimal range for bloom formation.

7.2.2.5 Ecosystem

Increases in temperature are driving conditions where snowmelt occurs earlier in the year and more precipitation falls as rain rather than snow. In upper watersheds, this results in a reduction in late-spring and summer baseflow; warmer water temperatures; higher winter peak flows; and, in some cases, a reduction in total annual water supply. These changes, as they propagate downstream, are projected to result in additional exceedances for key minimum flow and water temperature thresholds, promoting conditions that are threatening for aquatic, riparian, and groundwater-dependent ecosystems (Figure 7-10). Warmer temperatures also result in seasonal shifts in total climatic water deficit, resulting in an overall decrease in forest health and ecosystem services in upper watershed areas. This is exacerbated by a heightened risk of more severe wildfires, resulting in a degradation of the condition of the landscape in these areas (Figure 7-11). Ultimately, outcomes of the vulnerability assessment indicate a heightened risk to ecosystems under future climate conditions. Existing infrastructure and operations are unable to fully mitigate many of the warmer and drier conditions that threaten ecological communities.

Figure 7-10. Change in Watt Avenue Bridge Daily Temperatures between May 15-September 30

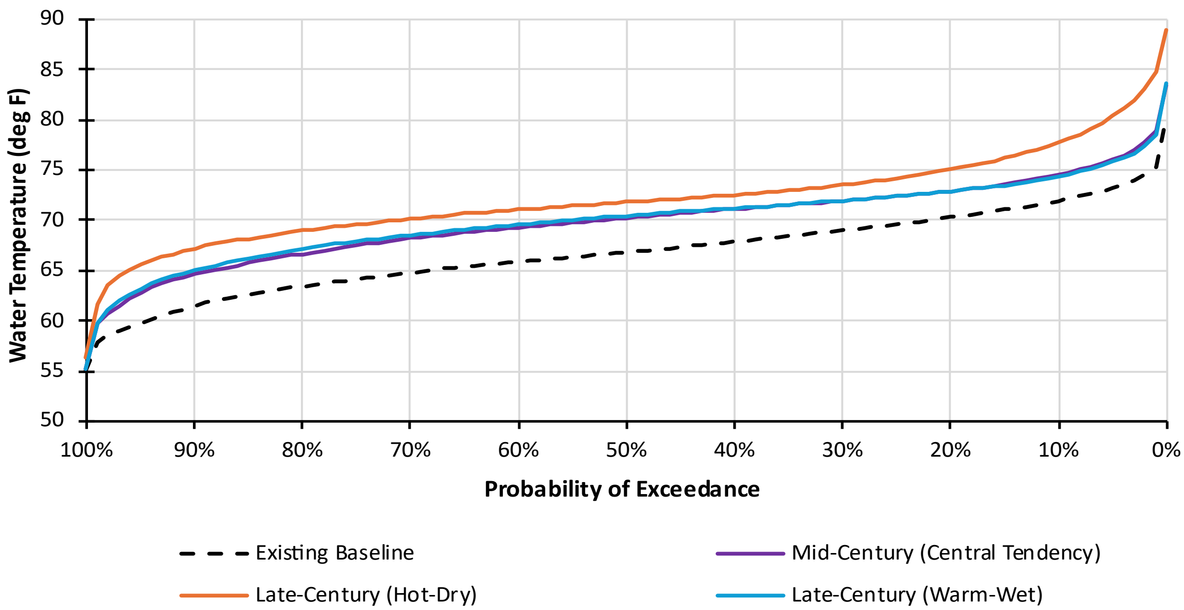
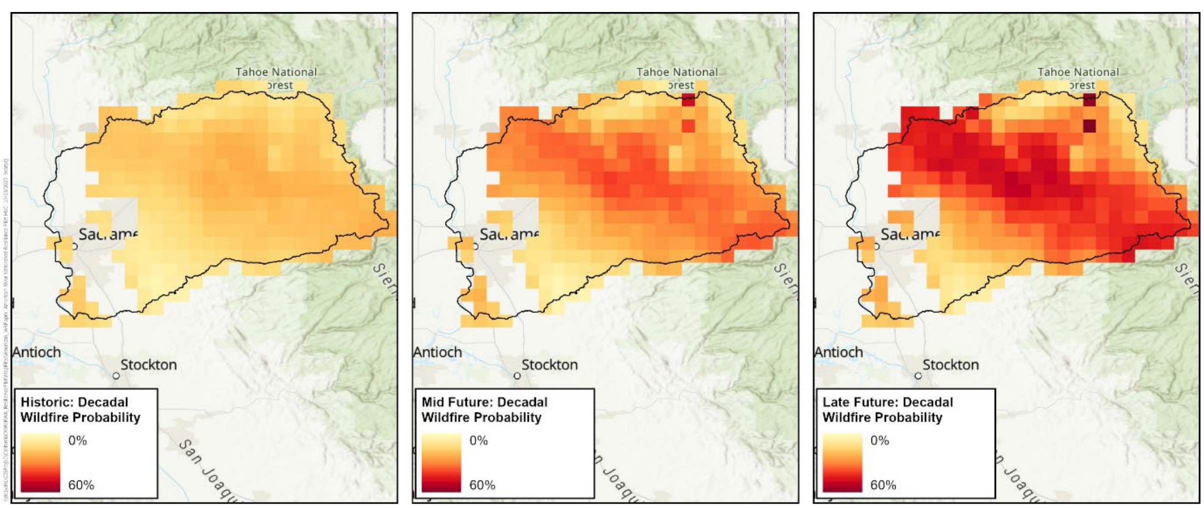


Figure 7-11. Decadal Wildfire Probability under Historical, Mid-Future, and Late-Future Conditions



Key results from the ecosystem assessment include the following:

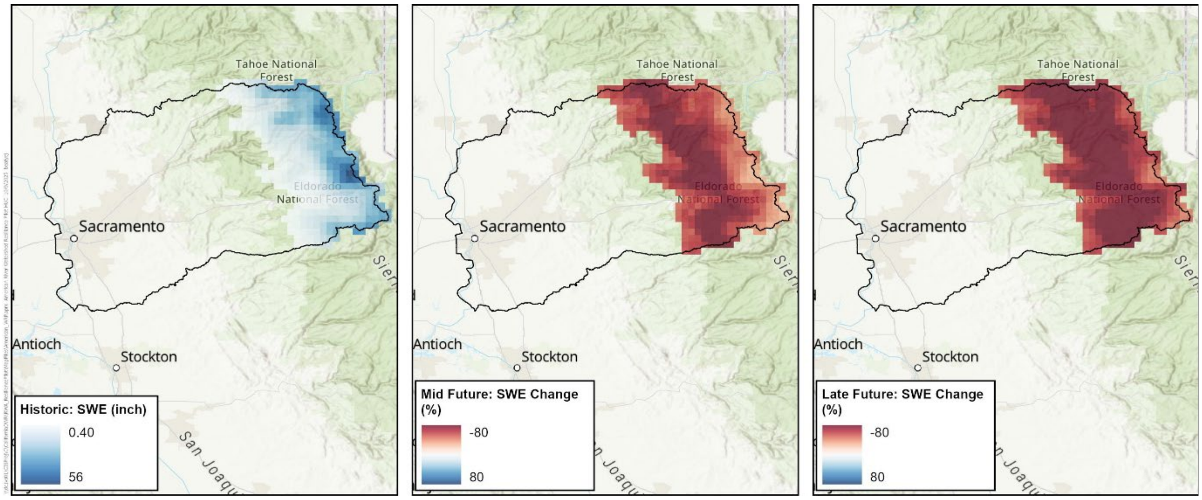
- Relative to the existing baseline, the frequency of monthly average flows exceeding 800 cubic feet per second decreases by between 2% and 10% below Lake Natoma. Conversely, shifts in minimum flow exceedances below Camp Far West Reservoir and Granlees Dam are largely unchanged under future conditions.
- Changes to upper watershed hydrographs along the North Fork, Middle Fork, and South Fork American rivers are far more pronounced than those along the Bear and Cosumnes rivers, demonstrating increased peak flows during the wet season and a reduction in flows during late spring and summer months.
- The frequency of daily water temperatures exceeding 65 °F between May 15 and September 30 increases by 20% to 28%, depending on scenario.
- Climatic water deficit decreases during the winter and spring in the upper watershed, suggesting earlier snowmelt and drier conditions during the fall and summer. Annually, this results in an increase in total climatic water deficit by up to 30% in some locations in these areas.
- By the late century, decadal wildfire probability increases by up to 60% in some locations. Similarly, projected changes in burn areas indicate up to a 100% increase in upper watershed areas.
- The frequency of 2-year peak flows is likely to increase. However, given the sharper peaks in hydrographs noted in upstream areas of the American River watershed, the duration of beneficial flows that promote floodplain inundation and spawning habitat may decrease.

7.2.2.6 Recreation

Recreational opportunities within the American River are largely dependent on total annual water supplies, reservoir operation, and shifts in temperatures. During drier water years, the prevalence and quality of recreation in lakes, rivers, and upper watersheds may decrease; and in wet years, conditions may preclude certain activities due to high flows and storage. Changes under climate change are highly location-specific due to differences in existing infrastructure, water management regimes, and other factors. Key results from the recreation assessment include the following:

- The frequency of conditions sufficient for boat access at Folsom Lake decreases by between 3% and 14%, depending on climate scenario. Similar trends at Camp Far West Reservoir are also present (2% to 9%). However, the frequency of recreational days at Rollins Lake increases by up to 31% due to rarer occurrences of reservoir elevations that preclude boat access.
- The quality of recreation along the South Fork American River below Chili Bar is projected to decrease under the mid-century and late-century (HD scenarios). However, assuming existing infrastructure can adequately manage increases in peak flows, the late-century (WW) scenario may result in a greater frequency of higher quality recreation in some years.
- Because the Cosumnes River is unregulated, changes under future conditions suggest an overall decrease in the number of days suitable for recreation along all runs of the Cosumnes River. Decreases range from roughly 10% to 15% for the upper and lower runs and from 4% to 9% for the Middle Fork run.
- Up to 80% reductions on April 1 snow water equivalent are noted for some locations in the upper watershed (Figure 7-12), suggesting a decrease in the total number of recreation days for snow-based recreation activities.

Figure 7-12. Projected Change in April 1 Snow Water Equivalent in Upper Watershed Areas



Note: SWE = snow water equivalent

- The frequency of flows greater than 10,000 cubic feet per second between October and April along the American River Parkway increase by roughly 2% to 4%. This is likely to result in more frequent closures of Parkway facilities during these months, reducing the availability of recreational activities between late fall and early spring.

7.2.2.7 Hydropower

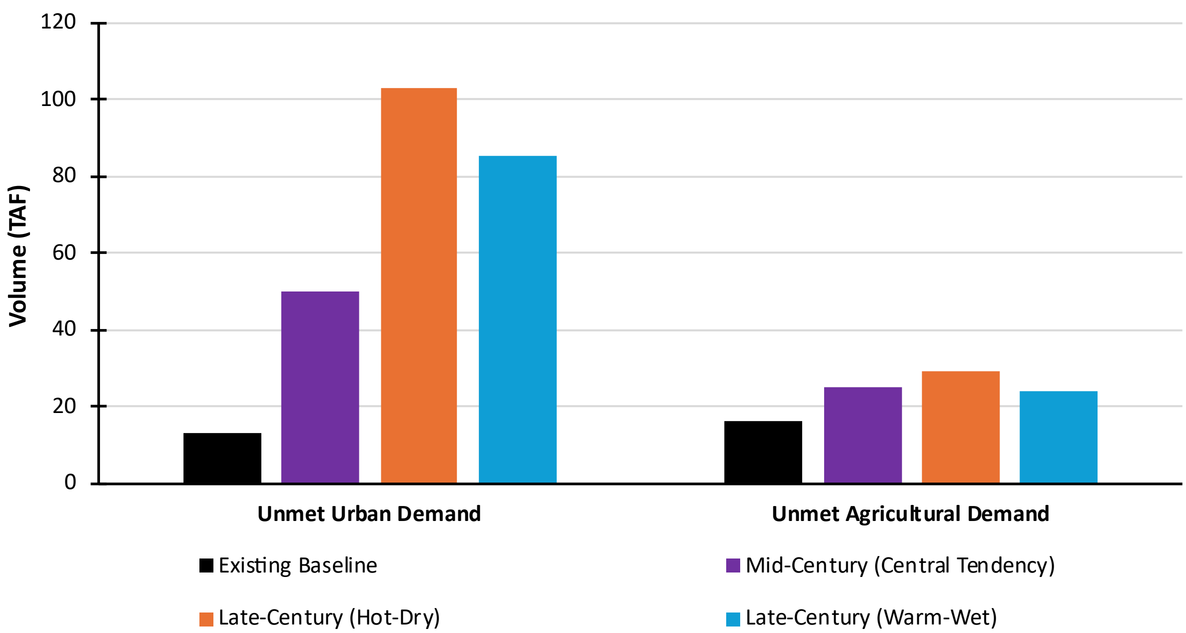
Changes in the magnitude and timing of American River inflows can have a significant effect on hydroelectric production. Generally, power production is higher during summer months when reservoir levels are higher, and water is released to satisfy delivery requirements. Reductions to storage levels in the late spring and summer, as projected by future climate modeling, will result in reduced energy capacity and generation. Over time, adjustments to hydropower operations will be needed to maintain balance in energy production with flood protection, downstream flow standards, and water supply demands. Under current operations, projected changes to climate will cause overall reductions to reservoirs in the American River watershed; thereby reducing the potential for hydropower production. Energy generation will be especially impacted in May through August. Key results include the following:

- Reduction in storage at Folsom Reservoir, the largest hydropower facility in the American River watershed, is projected to decrease average annual energy generation by about 13% to 29%.
- Most reservoirs in the American River watershed that are compatible with hydropower production are projected to include lower storage levels in the future, particularly in May through August. This results in less total energy generated through hydropower in the entire watershed.
- Storage conditions are sensitive to extreme changes in climate. Hydropower production is most impacted when the climate becomes hot and dry. If the late century is warm and wet, hydropower production will be relatively high in December through April, but relatively low in May through August, and low overall on an average annual basis relative to existing conditions.

7.2.2.8 Agriculture and Urban Water Supply

Agricultural and urban demands are expected to increase in the future and surface water supply availability is expected to decrease, causing greater reliance on groundwater and greater imbalances in supply and demand. Average annual temperature and potential evapotranspiration are projected to increase, while soil moisture conditions are projected to decrease. Consequently, agricultural applied water requirements will increase, requiring more water supply to meet demands. However, projected average annual surface water supply is projected to decrease, causing greater reliance on groundwater pumping and greater water shortages for agricultural and urban users (Figure 7-13).

Figure 7-13. Long-Term Average Annual Unmet Water Demand for Urban and Agriculture Uses



Key results for the agriculture and urban water supply assessment include the following:

- Average annual shortage for the urban sector grows from 13 TAF per year (Existing Baseline) to 132 TAF per year (Late-Century [HD]).
- Average annual shortage for the agricultural sector grows from 16 TAF per year (Existing Baseline) to 29 TAF per year (Late-Century [HD]).
- With limited access to groundwater, water users in the foothills will experience greater shortages than users in the valley floor.
- Drier years result in greater shortages and greater risk of overdraft conditions caused by elevated reliance on groundwater.
- Increased use of groundwater pumping, especially during droughts, will elevate the risk of overdraft conditions in the valley floor of the American River watershed.

7.2.3 Quantitative Assessment Findings

Key findings from the quantitative vulnerability assessment are summarized in the following bullet points. Coupled with those from the qualitative assessment, these findings provide foundation for the development of targeted climate adaptations.

- **Seasonal mismatch is the dominant system-wide challenge:** Across surface water supply, hydropower, ecosystems, recreation, and urban and agricultural uses, runoff is projected to shift earlier in the year, with higher winter flows and reduced spring and summer availability, when demands are highest.
- **Late-season water availability declines drive cascading vulnerabilities:** Reductions in May to September flows reduce reliability for water supply deliveries, instream flow compliance, hydropower generation, recreation quality, and ecological health, amplifying tradeoffs among competing objectives.
- **Groundwater becomes increasingly critical and stressed:** Higher temperatures and reduced surface water availability increase reliance on groundwater during dry months and droughts, heightening risks of declining water levels that result in the dewatering of shallower wells, and overdraft in the absence of expanded managed aquifer recharge and demand management.
- **Flood risk increases even as water supply reliability declines:** More intense storms and higher peak flows increase flood frequency and inundation extents, particularly in unprotected areas, while leveed areas become more sensitive to breach risk, highlighting a growing divergence between flood and supply conditions.
- **Water quality and ecosystem stress intensify under warming conditions:** Rising water temperatures and reduced baseflows lead to more frequent exceedances of thermal thresholds, declining dissolved oxygen, increased climatic water deficit, and reduced resilience of aquatic, riparian, forest, and groundwater-dependent ecosystems.
- **Upper watershed systems experience the most pronounced physical changes:** Snowpack loss, earlier snowmelt, increased wildfire probability, and sharper hydrograph peaks are most evident in upper watershed areas, with downstream propagation of impacts to flows, temperatures, sediment, and habitat conditions.
- **Recreation and hydropower outcomes become more variable and less reliable:** Climate-driven changes reduce the predictability of reservoir access, river recreation quality, snow-based recreation, and summer hydropower production, with benefits in wet winters often offset by losses during peak use seasons.
- **Agricultural and urban water users face growing supply-demand imbalances:** Increasing evapotranspiration and applied water requirements coincide with declining surface water availability, leading to substantially higher shortages under late-century HD conditions and greater vulnerability for foothill and groundwater-constrained users.
- **Late-century HD conditions represent the highest-risk future:** While WW future conditions introduce flood and spill-related challenges, HD scenarios consistently produce the most severe impacts across supply reliability, groundwater stress, ecosystem health, and shortage magnitude.
- **System-level adaptation is required:** The results indicate that incremental, asset-specific responses will be insufficient. Addressing vulnerability will require coordinated strategies that improve seasonal flexibility, storage utilization, groundwater recharge, operational integration, and cross-sector coordination at the watershed scale.

8. Climate Adaptations

This chapter outlines the development of adaptations, which are a structured, watershed-scale response to the identified climate vulnerabilities. They define how the region intends to reduce climate risk and improve resilience across all systems.

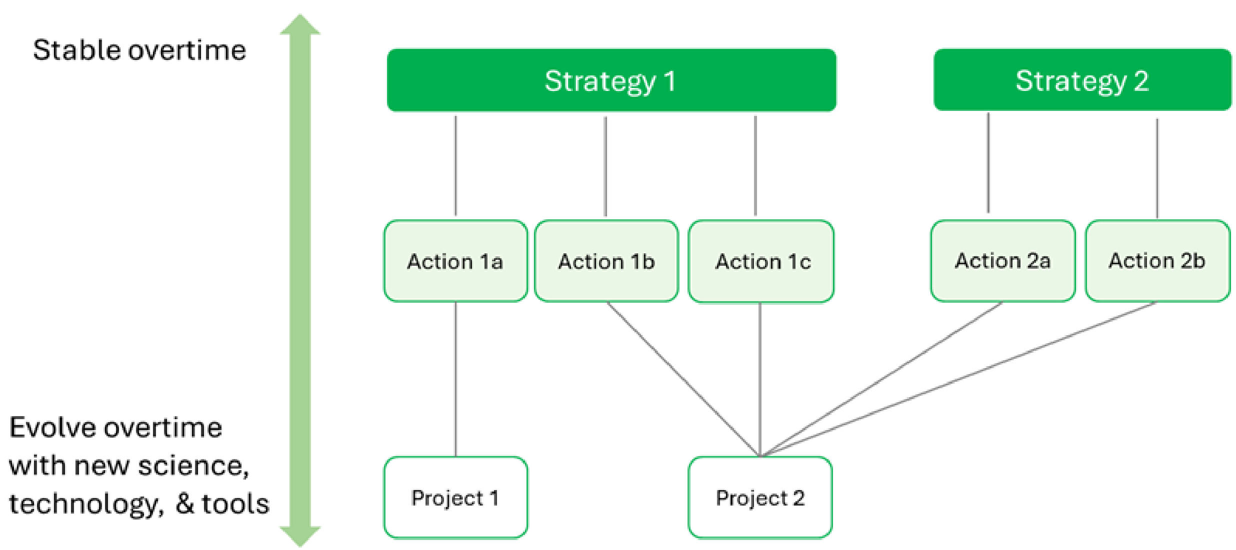
8.1 Adaptations Framework

Adaptations are organized using a three-tier framework designed to balance long-term durability with near-term flexibility. The framework separates enduring resilience objectives from project-level implementation decisions, allowing the plan to remain relevant under climate uncertainty. The three tiers include adaptation strategies, adaptation actions, and implementation projects, as follows:

1. **Adaptation Strategies** are high-level, outcome-focused statements that define the long-term direction for reducing climate risk and improving system resilience. These strategies are intentionally stable over time and serve as anchor points for future action.
2. **Adaptation Actions** are more specific descriptions of *what types of interventions are needed* to advance each strategy. Actions may include planning, infrastructure, operations, policy, coordination, or data and science efforts. Actions may evolve over time as new information becomes available.
3. **Implementation Projects** are discrete, site-specific efforts with defined scope, budget, schedule, and responsible leads. Projects implement one or more adaptation actions and may support multiple strategies simultaneously. Projects are expected to change most frequently over time.

Adaptation strategies and actions establish stable, outcome-focused direction to guide formulation and implementation of projects over time. This structure allows the region to get the strategies right first, while maintaining flexibility in how actions and projects are implemented. It also supports adaptive management; maintains continuity of intent; and enables transparent, project-level decision-making aligned with evolving funding opportunities and readiness. Figure 8-1 illustrates the relationship between strategies, actions, and projects.

Figure 8-1. Adaptation Frame: Relationship between Strategies, Actions, and Projects

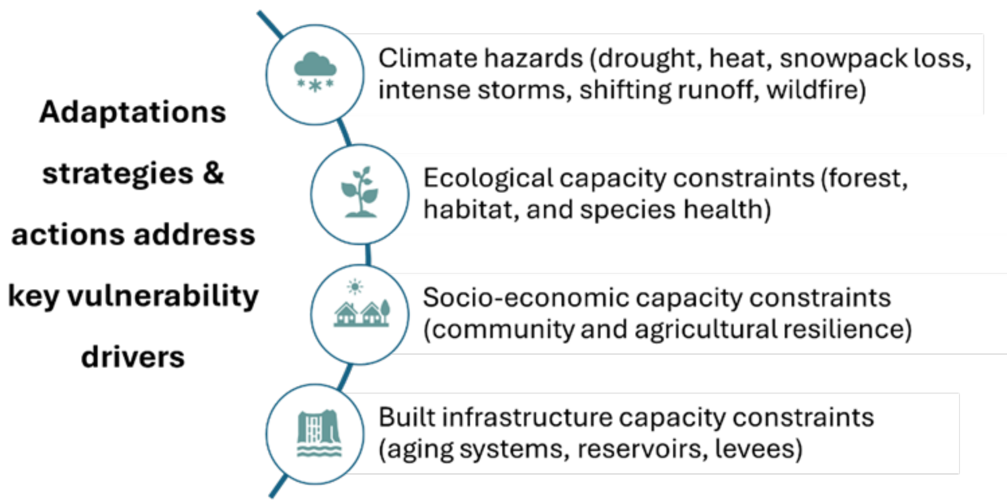


8.2 Adaptations Development

The adaptation strategies and actions were developed through an iterative, multi-source process grounded in the watershed vulnerability assessment, which identified key climate hazards, exposure, sensitivity, and adaptive capacity constraints across systems. Building on this foundation, the team leveraged existing plans and studies (including watershed, basin, flood management, and regional and local climate adaptation efforts) to verify technical rigor and consistency with established frameworks. The adaptation strategies and actions framework draws from the 2023 Programmatic Watershed Plan developed by the Headwaters Connect Watershed Group (formerly the Upper American River Watershed Group). To maintain consistency and alignment of planning efforts across the broader watershed, the numbering and wording of many adaptation actions under strategies 1 through13 were retained.

Substantial input from the Watershed Network and Advisory Committee directly informed the strategies and actions, with project-specific ideas generalized into broader actions where needed to confirm watershed-wide applicability. Throughout development, strategies and actions were repeatedly reviewed against climate, ecological, socioeconomic, and built infrastructure vulnerability drivers (Figure 8-2), with gaps identified and addressed through refinement and expansion of the action set.

Figure 8-2. Key Vulnerability Drivers Addressed by Adaptations Strategies and Actions



This process resulted in 19 adaptation strategies supported by 132 adaptation actions, reflecting both technical analysis and stakeholder priorities. Table 8-1 provides an overview of the developed adaptation strategies. Together, these adaptations strategies address water reliability, ecosystem health, risk reduction, equity, and governance consistent with watershed-scale climate resilience planning. A complete list of adaptation actions associated with each strategy is provided in Table 8-2.

Table 8-1. Summary of Climate Adaptation Strategies and Associated Actions

Adaptation Strategies	# Actions	Type of Action
1 - Secure Surface Water Supply Entitlements	5	
2 - Continue and Expand Demand Management	8	
3 - Implement Sustainable Groundwater Management	11	
4 - Increase Water Reuse	3	

Adaptation Strategies	# Actions	Type of Action
5 - Secure Drinking Water Infrastructure	8	■■■■■■■■
6 - Manage Stormwater as a Resource	5	■■■■■
7 - Improve Drought Preparedness and Response	4	■■■■
8 - Ensure All Residents Have Access to Clean and Affordable Water	3	■■■
9.1 - Develop Data and Tools for Improved Watershed Understanding, Knowledge Sharing, and Transparency	9	■■■■■■■■■
9.2 - Implement Sustainable Forest Management	6	■■■■■■
9.3 - Implement Multi-benefit Watershed Protection and Restoration Projects	9	■■■■■■■■■
9.4 - Enhance Environmental Flows and Aquatic Habitat Resilience	6	■■■■■■
10 - Prevent Contamination of Surface Water and Groundwater Resources	9	■■■■■■■■■
11 - Reduce the Risk of Flooding in Communities	13	■■■■■■■■■■■■■
12 - Promote Fire-Adapted Communities	11	■■■■■■■■■■■
13 - Increase Community Capacity for Sustainable Management and Resilience to Major Disasters	7	■■■□□□□
14 - Preserve and Enhance Access to Open Space and Support Sustainable Recreation	2	■■
15 - Preserve and Optimize Reservoir and River System Operations	7	■■■■■■■
16 - Enhance and Streamline Policies, Regulations, and Funding for Resilient Watershed Management	5	■■■■■

■ = Planning and Strategy ■ = Coordination and Collaboration
■ = Implementation and Operations ■ = Science and Data ■ = Policy and Institutional

Table 8-2. List of Adaptation Actions and Types

ID	Adaptation Actions	Type of Action
1 – Secure Surface Water Supply Entitlements		
1a	Secure water rights for projected needs and maintain existing water rights to confirm local and regional supply reliability.	Planning and Strategy
1b	Manage and leverage collaboration through cooperative water resource agreements.	Coordination and Collaboration
1c	Develop regional water master plan or equivalent to identify management and built infrastructure investments needed to demonstrate the beneficial uses of available water rights and contract entitlements in an integrated and efficient manner for projected needs and climate resilience.	Planning and Strategy

ID	Adaptation Actions	Type of Action
1d	Determine water purveyors for areas not currently served by a water purveyor.	Planning and Strategy
1e	Develop operational agreements as needed for flexible use of collective water rights and contract entitlements to promote regionwide benefits.	Coordination and Collaboration
2 – Continue and Expand Demand Management		
2a	Review and update water demand projection to include regulatory changes, anticipated implementation of best management practices, population and growth patterns, and climate change information.	Planning and Strategy
2b	Develop implementation strategy and plan to address the compliance with regulatory requirements of the "Making Conservation a California Way of Life" regulation, which includes urban water use standards, system water loss standards, variances, and commercial, industrial and institutional performance measures.	Planning and Strategy
2c	Engage in the continued development and implementation of Statewide long-term water conservation policies, regulations, and legislation to ensure applicability in both urban and foothill and forested/ mountain communities and preserve countywide interests.	Coordination and Collaboration
2d	Implement water conservation projects and programs consistent with Statewide conservation policies.	Implementation and Operations
2e	Transform urban landscapes to reduce outdoor water use through irrigation efficiencies, incorporation of low water, drought tolerant and native plants, reduction of high water use grasses with a focus on maintaining and expanding tree canopy.	Implementation and Operations
2f	Use rebates and incentives to accerlate and increase customer adoption of long-term water conservation and reuse practices with a goal of reducing overall and peak summer time water demand.	Implementation and Operations
2g	Expand programs to modify customer behavior and result in decreased demand for water.	
2h	Increase funding and scope of local and regional public outreach and school education programs that encourage water efficiency practices, with a primary focus on reducing outdoor water use.	Implementation and Operations
3 – Implement Sustainable Groundwater Management		
3a	Implement sustainable groundwater management in the Sustainable Groundwater Management Act-regulated groundwater basins consistent with approved plans and best practices.	Implementation and Operations
3b	Engage in the development of Statewide sustainable groundwater management policies, regulations, and legislation to protect the interests of headwaters and rural mountain counties.	Coordination and Collaboration

ID	Adaptation Actions	Type of Action
3c	Enhance alignment in groundwater management, drought resilience, and well permitting practices.	Coordination and Collaboration
3d	Improve understanding of groundwater conditions and long-term sustainability in fractured rock formation.	Science and Data
3e	Develop County-level policy for well permitting and management to address groundwater sustainability for fractured rock aquifers and basin areas that are not subject to management under a Groundwater Sustainability Agency.	Policy and Institutional
3f	Implement conjunctive use, in-lieu groundwater recharge, and aquifer storage and recovery projects where feasible to achieve regional sustainable groundwater management.	Implementation and Operations
3g	Identify key recharge areas (floodplains, paleo channels, and quarries) and protect via zoning.	Planning and Strategy
3h	Use cropland for stormwater recharge, and partner with farmers to flood fields and recover water later.	Implementation and Operations
3i	Conduct a well vulnerability assessment and mitigation program for small systems and domestic wells (including risk screening, prioritization, deepening/replacement, and emergency interties).	Implementation and Operations
3j	Institutionalize and scale flood diversion agreements for managed recharge.	Implementation and Operations
4 - Increase Water Reuse		
4a	Increase implementation of cost-effective and financially responsible water reuse to improve drought resilience and benefit compliance with efficient urban water use regulations where possible.	Implementation and Operations
4b	Explore the feasibility of nonportable reuse for instream flow augmentation or nonrestricted irrigation use with third parties.	Planning and Strategy
4c	Encourage greywater reuse and rainfall harvest practices on household and individual facility level.	Implementation and Operations
5 - Secure Drinking Water Infrastructure		
5a	Verify drinking water infrastructure integrity, operations, and maintenance through water agency-specific Capital Improvement Programs.	Implementation and Operations
5b	Develop means to replace lost snowpack and increase water supply reliability, (such as, but not limited to, increased recharge of groundwater in the lower watershed and actions to slow and capture runoff in the upper watershed).	Implementation and Operations
5c	Reduce vulnerability of drinking water infrastructure to large-scale wildfires.	Implementation and Operations

ID	Adaptation Actions	Type of Action
5d	Update drinking water infrastructure emergency response and communication plans regularly to keep current, including the threat of wildfire and potentially extended power shutoffs.	Planning and Strategy
5e	Assess the regional infrastructure needs to support the implementation of regional water and master plans or equivalent.	Planning and Strategy
5f	Establish a fire protection water system reliability program.	Implementation and Operations
5g	Establish a framework to support transitions of small or failing water systems through annexation, consolidation, or emergency support.	Policy and Institutional
5h	Expand regional interties and inter-system connectivity between agencies to increase reliability and redundancy.	Implementation and Operations
6 - Manage Stormwater as a Resource		
6a	Update Stormwater Resource Plans to address changed conditions and unique foothill characteristics and needs.	Planning and Strategy
6b	Develop implementation strategy to finance program implementation, align State policy implementation, and improve project readiness, as appropriate, for capitalizing on funding opportunities.	Planning and Strategy
6c	Implement water quality control measures and best management practices to address runoff from highways, streets, and other priority impervious areas.	Implementation and Operations
6d	Implement Stormwater Management Plan (now also as part of the Stormwater Resource Plan) and California Municipal Separate Storm Sewer Systems Permits.	Implementation and Operations
6e	Explore implementation of green infrastructure such as design of urban stormwater systems (e.g., cisterns, rain gardens, or bio-swales) to capture runoff and store it for non-potable uses, such as irrigating parks, irrigating street medians, or cooling street trees.	Implementation and Operations
7 - Improve Drought Preparedness and Response		
7a	Convene a long-standing County Drought and Water Shortage Task Force to facilitate drought and water shortage preparedness for small water suppliers. and rural communities, and provide consistency for countywide drought planning.	Coordination and Collaboration
7b	Implement and update the Regional Drought Contingency Plan and urban water supplier-specific Water Shortage Contingency Plans.	Implementation and Operations
7c	Update drought component in the County Local or Multi-Jurisdictional Hazard Mitigation Plans for emergency response coordination and potential future Federal Emergency Management Agency (FEMA) assistance.	Planning and Strategy
7d	Develop and implement Drought Resilience Plans for addressing water shortage vulnerability for small water suppliers and domestic well owners in rural communities.	Planning and Strategy

ID	Adaptation Actions	Type of Action
8 - Ensure All Residents have Access to Clean and Affordable Water		
8a	Assess countywide challenges in water accessibility and affordability (Human Right to Water, California Water Code Section 106.3).	Planning and Strategy
8b	Assess viability assessment for water system consolidation and implementation challenges to support advocacy and acquisition of State and Federal assistance.	Planning and Strategy
8c	Participate in Statewide efforts to develop policy, regulations, and legislation related to water affordability that is workable for specific communities.	Coordination and Collaboration
9.1 - Develop Data and Tools for Improved Watershed Understanding, Knowledge Sharing, and Transparency		
9.1a	Improve hydrological and meteorological data acquisition to support planning needs and improve forecasting.	Science and Data
9.1b	Develop and synthesize the potential economic values of ecosystem goods and services in the watershed to help properly characterize the value of the watershed.	Planning and Strategy
9.1c	Develop and maintain a common platform that is publicly accessible for sharing water resource-related data and analytical tools, to avoid duplicate investments in their development and promote transparency.	Coordination and Collaboration
9.1d	Assess the impacts of recent wildfires on ecosystem goods and services, including water supply, flood, water quality (including sedimentation), power generation, and outdoor recreation.	Science and Data
9.1e	Develop a cultural heritage management strategy in collaboration with Tribes, including protocols for collaboration and consultation.	Coordination and Collaboration
9.1f	Inventory upper watershed forests for vegetation types, wildlife, and other attributes to support wildfire mitigation efforts.	Science and Data
9.1g	Inventory upper watershed headwater meadows.	Science and Data
9.1h	Establish routine post-fire watershed condition assessments to guide sediment and water quality response.	Science and Data
9.1i	Engage Tribal Nations and representatives to integrate Traditional Ecological Knowledge into planning, management, and implementation, supported by dedicated funding for Tribal participation and services.	Science and Data
9.2 - Implement Sustainable Forest Management		
9.2a	Assess the health of upper watershed forests, under existing and planned levels of hazard reduction management.	Planning and Strategy
9.2b	Develop a regional post-fire forest restoration plan that promotes consistent management practices to support long-term forest health and public safety, and that cross-connects lands managed by Federal agencies, local agencies, and private entities.	Planning and Strategy

ID	Adaptation Actions	Type of Action
9.2c	Develop and implement a watershed-level forest management strategy, consistent with the National Cohesive Strategy, that promotes common management practices for long-term forest health maintenance and public safety and that cross-connect lands managed by Federal agencies, local agencies, and private entities.	Planning and Strategy
9.2d	Expand options for using and disposing of woody biomass.	Implementation and Operations
9.2e	Collaborate with resource management agencies, power utilities, water purveyors, and interested parties to promote sustainable forest management strategies that provide long-term benefits to water supply, infrastructure, biodiversity, and ecosystem functions.	Coordination and Collaboration
9.2f	Develop watershed health projects that restore or preserve the quality, quantity, and connectivity of floodplain, wetland, riparian, woodland, grassland, and other native habitat communities.	Implementation and Operations
9.3 - Implement Multi-benefit Watershed Protection and Restoration Projects		
9.3a	Improve vegetation management with livestock grazing.	Implementation and Operations
9.3b	Implement invasive species management.	Implementation and Operations
9.3c	Assess the health of upper watershed headwater meadows using the inventory from strategy 9.1g.	Science and Data
9.3d	Implement headwater meadow restoration to improve water retention for water supply and flood risk reduction, water quality, and other ecosystem functions, including outdoor recreation.	Implementation and Operations
9.3e	Develop an agricultural economy consistent with the County General Plans and working landscape principles to realize its potential for applicable ecosystem goods and services.	Implementation and Operations
9.3f	Implement water resource-related infrastructure development and modifications, incorporating considerations to promote co-benefits from compatible ecosystem goods and services and increased flexibility in public financing for implementation.	Implementation and Operations
9.3g	Establish conservation easements and preservation with willing landowners that promote co-benefits from compatible ecosystem goods and services.	Implementation and Operations
9.3h	Conduct research on alternatives and options for disposing short-lived climate pollutants (e.g., organic food waste) without redirecting impacts on environment or local economy.	Science and Data
9.3i	Restore headwater meadows and wetlands, including beaver translocation as appropriate, to retain water, slow runoff, enhance baseflows, and improve ecological resilience.	Implementation and Operations

ID	Adaptation Actions	Type of Action
9.4 - Enhance Environmental Flows and Aquatic Habitat Resilience		
9.4a	Optimize reservoir operations to protect environmental flows and cold-water habitat.	Implementation and Operations
9.4b	Implement a cold-water management program to retain conserved or reallocated water to support summer and fall ecological flows.	Implementation and Operations
9.4c	Adapt hatchery and fishery management to drought and warming conditions.	Implementation and Operations
9.4d	Protect and expand thermal refugia and spawning and rearing habitat through side-channel reconnection, riparian shading prioritization, and targeted habitat enhancement.	Implementation and Operations
9.4e	Implement a sediment and gravel management program (including gravel augmentation, sediment routing, and sediment bypass where feasible) to sustain spawning habitat downstream of reservoirs.	Implementation and Operations
9.4f	Assess and manage climate impacts on tributaries to the American River and associated groundwater-dependent ecosystems.	Science and Data
10 - Prevent Contamination of Surface Water and Groundwater Resources		
10a	Apply advanced technologies for water quality monitoring (surface water and groundwater), including remote sensing, for areas susceptible to water quality problems.	Science and Data
10b	Implement Sewage System Management Plans in coordination with system owners, including emergency response protocols and vulnerability assessments.	Implementation and Operations
10c	Implement the Nutrient Management Plan for agricultural practice to reduce the risk of long-term effects on the quality of surface water and groundwater resources.	Implementation and Operations
10d	Implement County Local Agency Management Plan for Onsite Wastewater Treatment Systems, including enforcement of guidelines for approval and repairs.	Implementation and Operations
10e	Conduct public outreach and education activities to encourage prevention of water supply contamination.	Coordination and Collaboration
10f	Implement the Local Agency Management Plan for Onsite Wastewater Treatment Systems (e.g., septic tanks) and comply with relevant Waste Discharge Requirement Orders.	Implementation and Operations
10g	Develop and implement a post-wildfire water quality response playbook (including turbidity and ash response, treatment adjustments, source switching, and watershed erosion controls).	Implementation and Operations
10h	Implement targeted nutrient and septic hot-spot reduction projects in priority subareas (such as buffers, treatment wetlands, septic upgrades, and agricultural BMP expansion).	Implementation and Operations

ID	Adaptation Actions	Type of Action
10i	Address wastewater discharge issues during periods of heavy storm water to prevent partially treated water from being discharged to the rivers.	Implementation and Operations
11 - Reduce the Risk of Flooding in Communities		
11a	Update potential risks of flooding and water infrastructure vulnerability.	Planning and Strategy
11b	Develop and implement flood risk reduction projects to reduce localized and neighborhood flooding with considerations of increase in frequency and intensity of flood-causing storms in facility planning (siting and design) for long-term sustainability.	Implementation and Operations
11c	Improve implementation of residual flood risk mitigation actions, including participation of the National Flood Insurance Program and voluntary use of flood-resistant materials and other California Building Code requirements, as appropriate.	Implementation and Operations
11d	Develop strategies and collaborate to combine nature-based solutions to reduce expenditure, facilitate additional flexibility of pooled funding use, and prolong the effectiveness of hard infrastructure investment and operational changes for regional flood risk reduction.	Implementation and Operations
11e	Complete critical flood infrastructure upgrades to achieve 500-year protection for deep floodplains along the Lower American River, including levee reinforcements and Folsom Dam outlet improvements.	Implementation and Operations
11f	Implement Forecast-Informed Reservoir Operations (FIRO) to release water in advance of major storms using forecast data, improving flood space management and water supply reliability.	Implementation and Operations
11g	Update flood risk maps and apply them to land use planning by revising hazard zones, adjusting building codes, and requiring retention basins in vulnerable areas.	Planning and Strategy
11h	Expand natural flood management features by restoring floodplains, wetlands, and open-space buffers to store and slow runoff while providing ecological co-benefits.	Implementation and Operations
11i	Require use of retention basin in developing areas, especially those upstream of vulnerable areas or those with low resilience.	Implementation and Operations
11j	Enhance levee and bank monitoring systems using side-scan sonar and remote sensing to detect erosion and structural vulnerabilities before failure occurs.	Implementation and Operations
11k	Implement levee encroachment and penetration remediation and maintenance access improvements.	Implementation and Operations
11l	Expand behind-the-levee risk communication and resident preparedness program.	Coordination and Collaboration
11m	Advance regional conveyance and floodway improvements that reduce peak stages (e.g., Yolo Bypass).	Implementation and Operations

ID	Adaptation Actions	Type of Action
12 - Promote Fire-Adapted Communities		
12a	Update the County Safety Elements and City General Plans to protect communities from unreasonable risks of hazards, including wildfire and associated considerations of safe egress route requirements and California Building Code amendments for home fire hardening.	Planning and Strategy
12b	Update and enforce vegetation management and defensible space ordinances, including coordinating with CAL FIRE to prioritize County Focus Area inspections.	Coordination and Collaboration
12c	Update the requirements for building permits to have owner(s) acknowledge being located in CAL FIRE high and very high Fire Hazard Severity Zones, and for deed recording to provide sufficient evidence for meeting fire disclosure requirements by real estate property seller(s) and homeowner associations for common areas, if applicable per AB 38 of 2019.	Policy and Institutional
12d	Develop, implement, and update a community wildfire protection plan, including the assessment of fire protection needs of communities within the Wildland Urban Interface in coordination with an associated implementation plan (including a financing plan and funding acquisition assistance).	Planning and Strategy
12e	Develop a public education campaign to improve wildfire preparedness; improve resident awareness of relevant laws, regulations, and best management practices; and facilitate community-specific wildfire emergency preparedness and response plans.	Coordination and Collaboration
12f	Implement strategic shaded fuel breaks using canal and utility corridors to protect communities and critical infrastructure while maintaining ecological function.	Implementation and Operations
12g	Establish and implement Tribal and interagency cultural burning partnerships (Memorandums of Understanding, training, burn windows, and programmatic compliance) to scale prescribed fire safely.	Coordination and Collaboration
12h	Implement distributed “micro-pond” and small water retention features in strategic upland or Wildland–Urban Interface locations.	Implementation and Operations
12i	Improve the implementation of existing requirements by local fire districts to have adequate water tank installed on site for structural protection against fire if not served by a community water system with adequate fire hydrants, and encourage additional volume considerations to accommodate short-term health and safety water supply needs in water shortage during drought or other emergencies (SB 552).	Implementation and Operations
12j	Complete and update Countywide and/or consistent area-specific Community Wildfire Protection Plans with consistent update of the County's Multi-hazard mitigation plan.	Planning and Strategy

ID	Adaptation Actions	Type of Action
12k	Review and update the community water system's fire flow capacities in light of changing climate and potential wildfire risks for potential rehabilitation and improvements.	Implementation and Operations
13 - Increase Community Capacity for Sustainable Management and Resilience to Major Disasters		
13a	Coordinate with counties, economic development interests, and the California Community College to develop workforce needs, curricula, and programs to foster local workforce growth to support long-term sustainable watershed management.	Coordination and Collaboration
13b	Perform a regional transportation needs assessment to support agricultural development consistent with County General Plans that incorporate working landscapes, improve outdoor recreation access, expand broadband availability in rural-agricultural areas, and promote safe egress of communities during wildfires and other emergencies.	Planning and Strategy
13c	Investigate the opportunities to create new, or expand existing, wood-utilization businesses within the watershed in collaboration with State and Federal agencies.	Planning and Strategy
13d	Explore potential alternative funding mechanisms based on the findings from the ecosystem good and service valuation (strategy 9.1b) to support long-term sustainable adaptation strategy implementation.	Planning and Strategy
13e	Improve emergency response planning for major disasters, including wildfires and floods and the shared understanding of the roles and responsibilities of involved agencies and entities; and expand and share tools for recovery planning.	Coordination and Collaboration
13f	Determine water suppliers for areas within County General Plans that are currently outside of service areas of any major water suppliers to confirm water resilience for planned development.	Coordination and Collaboration
13g	Address urban heat islands through nature-based solutions with emphasis on prioritizing vulnerable communities.	Implementation and Operations
14 - Preserve and Enhance Access to Open Space and Support Sustainable Recreation		
14a	Through collaboration with local agencies, nonprofits, and Tribes, develop the capacity to effectively plan for recreation needs while anticipating, avoiding, and mitigating impacts from high recreation use.	Coordination and Collaboration
14b	Identify opportunities to increase public access to outdoor recreation while also preserving critical areas and educating the public about the associated value.	Planning and Strategy
15 - Preserve and Optimize Reservoir and River System Operations		
15a	Optimize operations of hydropower projects for multi-purposes including water supply, ecosystems, recreation, flood management, and clean energy production.	Implementation and Operations
15b	Ensure reservoir and hydropower infrastructure integrity and reliability through agency-specific Capital Improvement Programs, with dedicated dam-safety and spillway assessment, upgrade, and maintenance actions.	Implementation and Operations

ID	Adaptation Actions	Type of Action
15c	Implement enhancements to physical facilities that better transport sediment, debris, flow, and similar for the environment and species.	Implementation and Operations
15d	Implement enhancements to recreational elements for greater public access and use (e.g., upgrades to boat launches, trails, and campgrounds for safety and broader access).	Implementation and Operations
15e	Implement forecast informed reservoir operations and forecast coordinated operations, and adaptive reservoir rule curves where applicable.	Implementation and Operations
15f	Implement reservoir sediment management and capacity recovery program.	Implementation and Operations
15g	Implement hydropower asset reliability upgrades for climate and grid resilience.	Implementation and Operations
16 - Enhance and Streamline Policies, Regulations, and Funding for Resilient Watershed Management		
16a	Clarify roles and responsibilities for local, regional, Tribal, State, and Federal agencies to efficiently manage natural resources collectively, such as formalized agreements or legislation.	Coordination and Collaboration
16b	Align and coordinate project planning by developing landscape-scale projects to better leverage available funding sources, reduce inter-agency competition for funding, and pool resources to improve administrative efficiency.	Coordination and Collaboration
16c	Identify new or revisit existing financing mechanisms to improve the ability to fund forest health and infrastructure projects and operation and maintenance needs over the long term.	Planning and Strategy
16d	Implement regional and programmatic permitting methods to decrease administration costs and delays for environmental and cultural compliance and mitigation to allow for more efficient project implementation.	Planning and Strategy
16e	Advocate for new or amended policies that reduce regulatory burdens to promote collective regional interests.	Policy and Institutional

8.3 Adaptations Evaluation

To confirm that the adaptation portfolio collectively addresses all major vulnerability drivers identified in the assessment and avoids over-reliance on single-purpose responses, each adaptation action is reviewed using a structured, qualitative framework. Actions are assessed by type (planning, coordination, implementation, science, or policy), the watershed systems they support (such as surface water, groundwater, flood management, ecosystems, communities, agriculture, or recreation), and their geographic applicability across the watershed or within specific sub-regions.

Each action is further evaluated for how it addresses underlying vulnerability drivers, including climate hazard sensitivity, ecological capacity, socioeconomic capacity, and built infrastructure capacity (Table 8-3). Together, this review documents how actions strengthen ecological, socioeconomic, and infrastructure capacity and provides a transparent foundation for future project-level decision-making.

Table 8-3. Adaptation Actions Potential Contribution to Addressing Vulnerability Drivers

Vulnerability Driver	Adaptations Response
Climatic Hazard Sensitivity Drivers	
Warming and Extreme Heat	Reduce exposure or sensitivity to increasing temperatures. Projects may reduce heat impacts directly or indirectly through cooling, shading, storage, or operational flexibility.
Snowpack Loss and Water Availability Decline	Mitigate reduced snowpack and declining seasonal water availability by improving storage, supply diversification, timing, or operational adaptability under changing hydrologic regimes.
Shift from Snow to Rain and Runoff Timing Shift	Address altered runoff timing and hydrograph shape caused by increased rainfall dominance, including earlier peak flows and reduced late-season supply reliability.
Increased Water Demand	Reduce demand growth or improve system capacity to reliably meet higher demands driven by heat, drought, population growth, or economic activity.
More Intense Storms and Flashier Hydrographs	Improve ability to manage increased peak flows, attenuate runoff, reduce erosion, and protect communities and infrastructure from extreme precipitation events.
More Frequent and Severe Droughts	Increase resilience to prolonged or repeated droughts through projects such as supply diversification, conjunctive use, storage, operational flexibility, or demand reduction.
Increased Wildfire Risk	Reduce wildfire likelihood or consequences, including impacts on water quality, sedimentation, infrastructure vulnerability, and ecosystem recovery.
Ecological Capacity Drivers	
Forest Health	Improve forest condition, reduce fuel loads, stabilize headwater hydrology, and support long-term watershed resilience to climatic shocks.
Degraded Habitat and Ecosystem Function	Restore or enhance ecological processes (e.g., floodplain connectivity, riparian function, aquatic habitat, and water quality and temperature) that provide natural buffering against climate impacts.
Socioeconomic Capacity Drivers	
Community and Economic Resilience	Strengthen the ability of communities and local economies to prepare for, respond to, and recover from climate impacts, particularly where adaptive capacity is limited.
Upper Watershed Agricultural Vulnerability	Support agricultural viability in climate-sensitive areas that lack access to reliable groundwater resources; for example, by improving water reliability, operational flexibility, and protection from drought, heat, and flood impacts.
Land Use and Development	Address or avoid land-use patterns that exacerbate climate risk, including development in flood- or fire-prone areas; address urban heat islands; and improve coordination between land use and water management.
Built Infrastructure Capacity Drivers	

Vulnerability Driver	Adaptations Response
Aging and Fragile Infrastructure	Reduce vulnerability associated with deteriorating or obsolete infrastructure increasingly stressed by climate extremes. Actions may replace or harden infrastructure or adapt nature-based solutions.
Folsom Reservoir Constraints	Address operational, physical, or regulatory constraints affecting Folsom Reservoir's ability to balance flood management, water supply, and environmental objectives under changing conditions.
Limited Reservoir Storage Capacity	The extent to which a project compensates for limited surface storage through operational efficiency, groundwater storage, expansion of storage space, or functional storage provided by nature-based solutions.
Reservoir Operational Tradeoffs	The extent to which a project improves reservoir operations by balancing flood management, water supply, environmental flows, and hydropower under climate variability, including through advanced forecasting, real-time data, decision-support tools, and FIRO.
Levee System Fragility	The degree to which a project reduces flood risk associated with aging, constrained, or vulnerable levee systems through structural improvements or complementary non-structural measures.

9. Implementation Plan

This chapter outlines how the recommended adaptation strategies move from concept to results, providing a practical framework for advancing watershed-scale climate resilience in the coming years.

9.1 Implementation Plan Framework

The implementation framework establishes a structured, regionally appropriate approach for advancing adaptation strategies through coordinated implementation activities, project development, and phased investment over time. It is not a fixed list of projects. Instead, it is designed to translate planning outcomes into implementable actions that reflect the watershed's hydrologic complexity, jurisdictional diversity, and exposure to multiple climate hazards. This approach recognizes that implementation in the watershed must remain flexible to accommodate changing hydrologic conditions; evolving regulatory and funding environments; and differing agency capacities across the upper and lower watershed.

The implementation framework builds directly on the vulnerability assessment and developed climate adaptations. The vulnerability assessment identifies priority risk areas in the watershed, as well as the key drivers for vulnerability. The adaptation strategies and actions define the scope of response needed to address these risks across the systems for each part of the watershed. The implementation framework defines how these strategies and actions are advanced through concrete projects, partnerships, and investments tailored to watershed conditions.

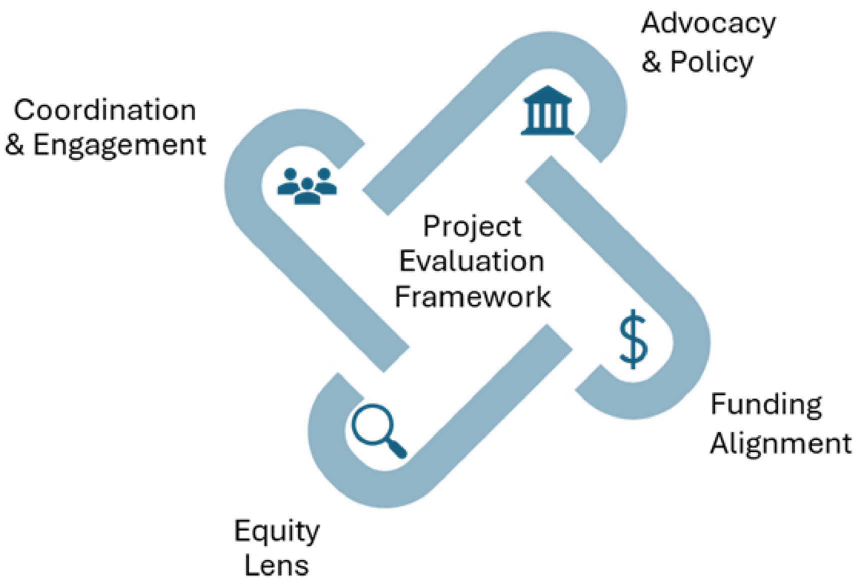
Adaptation strategies are not re-ranked during implementation. Instead, they establish the long-term direction for resilience in the watershed, while implementation decisions are made at the project level as opportunities, funding, and readiness align. The intentions of the implementation framework watershed are as follows:

- Translate adaptation strategies and actions into implementable projects appropriate to watershed conditions.
- Clarify roles and coordination needs among watershed agencies, land managers, utilities, and partners.
- Support phased implementation across the upper and lower watershed.
- Align projects with State and Federal climate resilience funding programs.
- Integrate equity considerations into implementation decisions affecting downstream and disadvantaged communities.
- Maintain flexibility through adaptive management under climate uncertainty.

9.2 Plan Elements

Implementation of the Watershed Climate Resilience Plan is structured around five interrelated elements that together guide how adaptation strategies are translated into coordinated, fundable, and actionable projects. These elements function as an integrated system rather than a sequence of discrete steps, confirming that implementation remains flexible, transparent, and responsive to changing conditions. Each of the elements shown on Figure 9-1 plays a distinct role while reinforcing others: project evaluation framework, equity focused lens, funding alignment, engagement and coordination, and advocacy and policy alignment.

Figure 9-1. Implementation Decisions Guided by a Project Evaluation Framework Project Evaluation Framework



The Project Evaluation Framework is the core mechanism of the implementation plan. It defines how implementation projects are assessed, refined, and advanced as they move from concept to execution. Rather than ranking projects competitively, the framework provides a shared structure for evaluating how proposed projects align with adaptation strategies, watershed needs, funding opportunities, and implementation readiness.

Evaluation occurs when specific projects are proposed and apply consistent, project-level criteria related to climate risk reduction, adaptive capacity, equity, feasibility, and coordination. The framework supports phased project advancement, allowing projects to move forward as readiness and opportunities align, while others continue to mature or are coordinated with complementary efforts. The framework is adaptive by design and is refined over time using new data, monitoring results, and lessons learned from implementation. All other elements of the implementation plan inform and strengthen the Project Evaluation Framework.

9.2.1 Equity as an Implementation Lens

Equity is integrated into the implementation plan as a lens that shapes how and where projects are delivered, rather than as a re-evaluation of climate vulnerability. Equity considerations are applied after the vulnerability assessment to inform project evaluation, phasing, and geographic focus. Within the Project Evaluation Framework, equity guides attention toward communities experiencing the greatest combined climate exposure and social vulnerability. Equity considerations strengthen alignment with State and Federal climate-equity funding priorities; they also inform engagement strategies, helping to confirm that implementation delivers meaningful and accessible resilience benefits.

9.2.2 Funding Alignment

Funding alignment determines when projects evaluated through the framework can realistically advance. The implementation plan recognizes that funding opportunities are episodic and program specific.

Therefore, projects are structured and evaluated in ways that align with evolving State and Federal priorities for climate resilience and equity. Funding considerations are integrated into the Project Evaluation Framework to support phased advancement across multiple funding cycles. This approach allows projects to move forward as opportunities emerge, rather than relying on a single funding pathway, while maintaining consistency with watershed-wide resilience objectives.

9.2.3 Engagement and Coordination

Engagement and coordination verify that projects evaluated through the framework are implementable within the watershed's multi-agency context. This element focuses on building shared understanding of adaptation strategies, implementation roles, sequencing, and constraints among watershed agencies, land managers, utilities, local governments, and community partners.

Through the Watershed Network and coordination facilitated by RWA, engagement activities support transparency, improve project readiness, and strengthen institutional capacity. Feedback from engagement and coordination efforts informs project refinement and evaluation, reinforcing the effectiveness of the Project Evaluation Framework.

9.2.4 Advocacy and Policy Alignment

Advocacy and policy alignment sustain momentum beyond individual projects and funding cycles. This element focuses on elevating watershed resilience priorities in broader State and Federal policy, planning, and funding discussions.

Advocacy supports the Project Evaluation Framework by helping shape future funding priorities; reinforcing consistent regional messaging; and building long-term institutional and political support for implementation. In doing so, advocacy strengthens funding alignment and confirms that the implementation plan remains relevant as external conditions evolve.

9.3 Project Evaluation Framework

To support transparent, consistent, and cooperative advancement of climate resilience projects, the RWA Watersheds Climate Resilience Plan uses a Project Screening and Prioritization Scoring Matrix as the core tool within the Project Evaluation Framework. The matrix provides a structured, evidence-based approach for evaluating how a proposed project contributes to watershed resilience, aligns with adopted adaptation actions, and demonstrates readiness for implementation and funding.

9.3.1 Evaluation Categories

The scoring matrix is organized into eight evaluation categories that reflect the key drivers of climate vulnerability, adaptive capacity, and implementation readiness in the American River watershed:

1. Alignment with Adaptation Actions: Verify that projects directly advance the adopted adaptation strategies in this plan. Metrics evaluate explicit linkage to adaptation actions, the strength of strategic fit, and the extent to which projects integrate multiple actions or cross-sector strategies.
2. Climate Hazard Sensitivity Drivers: Assess the extent to which a project addresses priority climate hazards affecting the watershed, including the following: warming and extreme heat; snowpack loss and declining water availability; shifts from snow to rain and altered runoff timing; increased water demand; more intense storms and flashier hydrographs; more frequent and severe droughts; and

increased wildfire risk. This category emphasizes direct risk reduction and system resilience across a range of climate stressors.

3. Ecological Capacity Drivers: Evaluate how projects strengthen forest health and restore or enhance habitat and ecosystem function. Metrics focus on improving ecological resilience, reducing fire severity, supporting watershed hydrology, and restoring connectivity, flow, temperature, or biodiversity.

4. Socioeconomic Capacity Drivers: Consider how projects support community and economic resilience within the watershed. This includes protecting essential services, livelihoods, and public health; addressing agricultural vulnerability in the upper watershed; and reducing climate exposure associated with land-use and development pressures.

5. Built Infrastructure Capacity Drivers: Assess the degree to which projects improve the resilience of critical infrastructure systems. Metrics address aging and fragile infrastructure; operational constraints at Folsom Reservoir; limited storage capacity; operational tradeoffs among flood control, water supply, and ecosystem needs; and the fragility of the levee system.

6. Implementation Readiness and Feasibility: Evaluate whether a project can realistically advance within near- or mid-term implementation windows. Criteria consider technical feasibility, permitting and regulatory readiness, institutional capacity and leadership, and schedule readiness.

7. Funding Alignment and Equity: Examine how well projects align with State and Federal climate resilience and equity funding priorities. Metrics assess benefits to vulnerable communities, delivery of multi-benefit outcomes, and cost-effectiveness and scalability, supporting strategic alignment with competitive funding programs.

8. Community and Institutional Support: Assess the readiness of projects for collaborative implementation. Metrics consider community support or benefit recognition, stakeholder engagement readiness, multi-agency coordination, partnership readiness, and the extent to which projects leverage existing programs, infrastructure, or investments.

9.3.2 Scoring Approach and Use

Each evaluation criterion is scored on a standardized 0 to 3 scale based on documented evidence:

0 – Does not address the criterion
1 – Indirect, minor, or uncertain contribution
2 – Clear, moderate contribution
3 – Strong, direct, and well-documented contribution

Scores from each category (1 through 8) are summarized to produce a total project score. By default, all categories are equally weighted, though weights may be adjusted to reflect specific funding program requirements, decision contexts, or implementation phase.

Based on total scores, projects are grouped into indicative priority tiers:

- High priority (greater than 80% of total score): Strong candidates for advancement when funding is available
- Medium priority (60 to 80% of total score): Promising projects that may require refinement or phasing

- Lower priority (40 to 60% of total score): Projects needing additional development or alignment
- Not competitive (less than 40% of total score): Projects not ready for advancement currently

These tiers are intended to guide discussion, to support comparative screening and prioritization, and to guide sequencing and investment planning rather than to serve as fixed or binding rankings. This flexibility allows the framework to remain adaptive while maintaining consistency across evaluation cycles.

9.3.3 Framework Use in Implementation Planning

The Project Screening and Prioritization Scoring Matrix serve as a practical implementation tool within the Project Evaluation Framework, supporting multiple complementary functions as follows, across the life cycle of climate resilience projects in the watershed:

1. Screen projects for funding opportunities.
2. Support project formulation and readiness.
3. Enable portfolio and multi-benefit project development.
4. Improve watershed-wide integration and coordination

The framework supports screening of proposed projects for specific funding opportunities. By aligning evaluation criteria with common State and Federal climate resilience and equity funding requirements, the matrix helps identify which projects are well positioned for near-term funding and which may require additional development to improve competitiveness. This use allows agencies and partners to efficiently match projects to appropriate funding programs as opportunities arise.

The framework supports project formulation and refinement. Scoring results highlight areas where a project is strong as well as where additional work may be needed to improve readiness, coordination, or alignment with adaptation actions. In this way, the matrix functions not only as an evaluation tool, but also as a diagnostic tool that informs project development, sequencing, and refinement over time.

The Project Evaluation Framework enables exploration of project portfolios and multi-benefit implementation opportunities. By evaluating projects across a consistent set of criteria, the framework helps identify opportunities to bundle or coordinate complementary projects across agencies, sectors, or geographic areas. This portfolio-based perspective supports development of multi-benefit projects that address multiple climate hazards or adaptation actions and leverage partnerships among different implementation entities.

The framework supports integration across the upper and lower watersheds and with existing programs and initiatives. By applying consistent evaluation criteria, the framework helps to confirm that projects developed in different parts of the watershed are aligned with shared resilience objectives and coordinated with ongoing operational, infrastructure, ecosystem, and land management programs. This integration strengthens regional coherence, reduces fragmentation, and promotes more effective watershed-scale implementation.

9.4 Equity as a Lens for Implementation

9.4.1 Social Vulnerability and Climate Resilience

Social vulnerability plays a critical role in shaping how communities experience climate impacts and their capacity to respond and recover. Differences in socioeconomic conditions, access to resources, and institutional capacity mean that similar climate hazards can produce very different outcomes across communities. For this reason, equity is incorporated into the implementation plan not as a separate analytical exercise, but as a lens for informing implementation decisions, including where, when, and how resilience actions are advanced.

9.4.2 Equity Analysis Approach

Mapping intersectional vulnerabilities is a critical step toward designing resilience strategies that center disinvested communities, honor Tribal knowledge and practices, and move beyond one-size-fits-all approaches in favor of collaborative, community-informed solutions. A GIS-based community sensitivity analysis was developed using the Vulnerable Communities Platform (VCP) to better understand how social vulnerability intersects with climate hazards within the American River watershed. The VCP, developed by the California Governor's Office of Land Use and Climate Innovation, identifies communities that may be more vulnerable to climate hazards due to socioeconomic and adaptive capacity factors and provides a data-driven foundation for incorporating equity considerations into watershed implementation planning.

Although the VCP provides a robust Statewide foundation for identifying vulnerable communities, its indicators and summary metrics are designed for broad screening across large geographies. Applied directly at finer spatial scales, Statewide percentile rankings may obscure important local variation and limit usefulness for watershed-level decision-making. To improve applicability at the watershed scale, two refinements were applied:

- **Recalculated Community Sensitivity Rankings:** Percentile-based community sensitivity rankings were recalculated using only data from within the watershed. This allows community conditions to be interpreted relative to local patterns rather than statewide benchmarks, improving sensitivity to intra-watershed differences and supporting more meaningful comparisons among communities experiencing similar climate conditions.
- **Integration of Hazard-Specific Exposure Data:** Localized hazard data for flooding, extreme heat, wildfire, and drought—developed as part of this study's climate and hydrologic analyses—were integrated with VCP indicators. This ensures that social vulnerability is assessed in direct relation to the climate hazards most relevant to the American River watershed.
- **More Precise Population Representation Using FEMA High-Resolution Population Counts.** The analysis integrates FEMA/ORNL LandScan population estimates to map social characteristics at a finer spatial scale than census block groups. This provides a clearer picture of exactly who is exposed to hazard conditions by pairing localized population locations with VCP social indicators, improving the validity and equity relevance of exposure mapping.

By combining recalculated community sensitivity rankings with watershed-specific hazard exposure data, the equity analysis establishes a transparent, scalable, and context-sensitive framework for implementation planning. Detailed methodology, indicator definitions, and analytical steps are documented in the Equity Analysis Technical Appendix. This framework is designed as follows:

- To inform project phasing, geographic focus, and funding alignment by identifying locations where early or targeted actions may deliver disproportionate resilience benefits and strengthen competitiveness for state and federal climate-equity funding programs.
- To support integrated, multi-hazard resilience strategies by enabling coordinated project development that reflects both physical climate risk and differences in community capacity across the watershed.
- To enable adaptive, equity-informed implementation over time by allowing the framework to be updated with new data, monitoring results, and evolving funding priorities, confirming that it remains a living tool for equitable climate resilience.

9.4.3 Key Findings

The Equity Analysis Technical Appendix provides additional detail on these refinements and presents hazard-specific population sensitivity distributions. The appendix demonstrates how social vulnerability aligns with the physical hazard environment across the watershed, highlighting several major findings:

- **Flooding**. Flooding impacts are most severe downstream, where rising flows increasingly stress Sacramento's levee system; a modeled levee-breach scenario affects 12.5% of the watershed population, and 59% of those affected fall into the highest flood-sensitivity category.
- **Wildfire**. Wildfire exposure grows sharply under mid-century climate conditions, with the population exposed to high burn probability increasing from 14% today to 34% in the future, and the number of people in the highest sensitivity category increasing five-fold.
- **Extreme Heat**. Extreme heat is the most widespread hazard, with more than 99% of residents projected to experience 30 or more additional days above 95°F, and one-third of the population falling into the highest heat-sensitivity category.
- **Drought**. Drought vulnerability intensifies in the upper watershed, where cumulative annual flow deficits are projected to increase by up to 25%, contributing to downstream water-supply and affordability pressures that disproportionately affect low-income households.

10. Performance Tracking

10.1 Purpose of Performance Tracking

Performance tracking is a core component of the RWA Watersheds Climate Resilience Plan and is intended to support implementation, learning, and adaptive decision-making over time. Rather than serving as a compliance or audit function, performance tracking is designed to provide timely, actionable information that helps RWA, its members, DWR, and the Watershed Network, understand progress, identify gaps, and adjust implementation strategies as climate conditions, funding opportunities, and watershed priorities evolve. Strengthening climate resilience within the RWA Watersheds also directly advances statewide objectives. Because the planning area supports critical water supply, ecological, and economic functions for not just the regional community, but California as a whole, local improvements in resilience translate to statewide benefits. Successful implementation strengthens not only local watershed conditions but also the State's broader climate resilience initiatives by reducing regional risks, advancing integrated water management objectives, and supporting California's long-term water security.

Consistent with principles outlined in the DWR Climate Action Plan, performance tracking emphasizes the following:

- Adaptive management rather than fixed benchmarks
- Practical, scalable indicators rather than exhaustive monitoring
- Integration of equity considerations into implementation decisions
- Use of performance information to inform sequencing, coordination, and investment

This approach recognizes that many climate resilience benefits accrue over long time horizons and that uncertainty is an inherent feature of climate adaptation planning.

10.2 Performance Tracking Framework

The performance tracking framework is designed to operate in parallel with the Project Evaluation Framework and broader implementation plan. Together, these components support a continuous cycle of planning, implementation, tracking, learning, and refinement.

Figure 10-1. Performance Tracking Framework

Performance tracking focuses on three complementary questions:

1. Are adaptation actions and projects being implemented as intended?
2. Are implementation efforts improving watershed resilience over time?
3. Are investments being delivered in an equitable, coordinated, and regionally integrated manner?

To answer these questions, the framework uses a combination of Statewide indicators, watershed-specific indicators, and programmatic tracking, drawing on existing data sources wherever possible.

Performance tracking under this plan is intended to achieve the following objectives:

- Track progress in implementing adopted adaptation strategies and actions

- Monitor advancement, phasing, and coordination of projects across the watershed
- Assess delivery of resilience benefits at the system and community level
- Support equity-informed implementation and funding alignment
- Provide feedback to inform adaptive management and future decision-making

These objectives align with RWA's role as a regional coordinating entity rather than a project implementer, emphasizing synthesis, transparency, and learning.

10.3 Performance Indicators

Performance indicators are organized into four indicator types that track different dimensions of implementation progress and outcomes:

- **Implementation and Delivery Indicators:** track whether adaptation actions and projects are moving forward. These indicators focus on activity and progress, rather than long-term outcomes, and are particularly useful in the near term.
- **Outcome and Resilience Indicators:** focus on whether implementation efforts are contributing to improved resilience capacity over time. These indicators may be quantitative or qualitative and may reflect system-level changes rather than site-specific performance. Given the long timeframes associated with many climate adaptation benefits, these indicators are used to assess directional progress, not to attribute outcomes to individual projects.
- **Equity and Community Outcome Indicators:** Equity and community outcome indicators track where and how resilience benefits are delivered, verifying that implementation aligns with equity objectives identified in the plan.
- **Portfolio and Programmatic Indicators:** Portfolio and programmatic indicators assess how well implementation efforts function as a coordinated watershed-scale program, rather than a collection of isolated projects.

Performance indicators are listed on Table 11-1. These performance indicators are developed to support watershed-scale implementation and decision-making, but some of these indicators may also serve as Statewide indicators. Watershed-specific indicators provide actionable insight into implementation progress and resilience outcomes within the watershed, while Statewide indicators support alignment and comparability across California.

Figure 10-2. Performance Indicators for Tracking Climate Resilience Implementation & Outcomes

Indicator Type	Indicators	Watershed Specific	Statewide
Implementation & Delivery	Number and type of projects initiated, advanced, or completed	■	■
	Progress against planned implementation phases	■	-
	Coordination milestones achieved among watershed partners	■	-
	Advancement of projects aligned with specific adaptation actions	■	■

Indicator Type	Indicators	Watershed Specific	Statewide
Outcome & Resilience	Increased operational flexibility or redundancy in water management systems	■	-
	Improved preparedness for drought, flood, wildfire, or extreme heat	■	■
	Enhanced ecological condition or function in targeted areas	■	■
	Reduced exposure or vulnerability of critical systems	■	-
Equity & Community Outcome	Distribution of implemented projects relative to areas of higher social vulnerability	■	■
	Access to resilience benefits for communities with limited adaptive capacity	■	■
	Integration of equity considerations into project phasing and sequencing	■	-
Portfolio & Programmatic	Balance of projects across hazards, sectors, and watershed geographies	■	-
	Degree of integration with existing programs, operations, and investments	■	-
	Development of multi-benefit or bundled project portfolios	■	■
	Alignment with regional and Statewide resilience priorities	■	■

10.4 Indicator Development

Performance tracking relies primarily on existing data sources and reporting mechanisms, consistent with guidance from DWR to minimize new reporting burdens on implementing partners. This approach emphasizes practicality, scalability, and efficient use of information already generated through project delivery and funding programs.

Data sources used for performance tracking may include the following:

- Project status and grant reporting
- Documentation of planning and implementation activities
- Monitoring and operational data, where available
- Publicly available datasets and mapping tools

Rather than requiring continuous monitoring, performance tracking is conducted through periodic synthesis and review. Indicators are reviewed at defined intervals to assess implementation progress, identify emerging trends, and support adaptive management discussions. As implementation advances and new information becomes available, data sources and tracking methods may be refined to improve relevance, efficiency, and decision-making.

RWA's role in performance tracking is focused on coordination, synthesis, and communication, rather than direct data collection, monitoring, or enforcement. Implementing agencies and partners remain responsible for project-level reporting and monitoring in accordance with their mandates and funding requirements. RWA supports the performance tracking process by:

- Compiling and synthesizing information across projects and programs
- Facilitating regional discussions on progress and challenges

Communicating performance information to partners, decision-makers, and stakeholders.

This shared-responsibility approach reflects the collaborative nature of watershed resilience implementation and confirms that performance tracking supports learning, transparency, and coordinated action without imposing unnecessary administrative burdens.

10.5 Application and Use of Indicators

Performance indicators are used to support adaptive management and informed implementation, rather than to enforce fixed targets or prescriptive outcomes. Periodic review of performance information provides a structured opportunity to apply indicator results to ongoing decision-making across the watershed. Specifically, performance indicators are used to complete the following:

- Adjust project sequencing and investment strategies in response to observed progress, readiness, and emerging conditions
- Refine evaluation criteria and implementation approaches based on lessons learned from project delivery
- Identify emerging risks, opportunities, or coordination needs that may not have been apparent during initial planning

Information generated through performance tracking is fed back into the Project Evaluation Framework and the broader implementation plan, reinforcing a continuous improvement cycle that supports phased, coordinated implementation over time.

Performance indicators must be applied and interpreted in the appropriate context. Their primary value lies in supporting adaptive management, improving coordination, and guiding future implementation decisions, rather than in providing definitive or immediate measures of success. Some of indicators key limitations are the following:

- Some resilience outcomes may not be observable for many years, particularly where benefits accrue gradually or under future climate conditions.
- Attributing observed outcomes to individual projects may be challenging given the cumulative and interacting nature of watershed-scale actions.
- Data availability, quality, and consistency may also vary across implementing partners and programs.

11. Recommendations and Next Steps

Building on plan's watershed-scale vision, vulnerability insights, and adaptation framework, this chapter outlines how the region will move from planning to action. It focuses on sustaining the Watershed Network and inclusive engagement, applying the project evaluation framework to prioritize and advance implementation-ready projects, aligning with near-term funding opportunities through coordinated advocacy, and using performance tracking to refine priorities and conditions evolve. Recommendations are divided into locally driven actions and State actions to be implemented by RWA WRP and DWR working in concert over the next 12 months. Together, these recommendations provide a practical bridge from strategies to implementation, positioning the watershed network and partners to deliver measurable, multi-benefit resilience strategies across the American, Bear, and Cosumnes watersheds.

11.1 Recommendations for Local Action

The following local recommendations are sustaining action for how the RWA WRP can continue to develop, work collaboratively and advance climate resilience projects within the American, Bear, and Cosumnes watersheds.

11.1.1 Sustaining the Watershed Network and Regional Partnerships

This Plan establishes a strong foundation for regional collaboration. Continued engagement with the Watershed Network, including Tribal Nations, community organizations, and regional agencies, is essential to maintain momentum, share knowledge, and support coordinated implementation. Regular coordination, information sharing, and convening of the Watershed Network is recommended to continue and RWA members should consider dedicating fiscal resources to sustaining this regular interaction.

11.1.2 Bridging from Planning to Implementation

The RWA WRP is intended to serve as a bridge between watershed-scale planning and on-the-ground action. Next steps include advancing project concepts that address priority vulnerabilities and using the project evaluation framework to screen and refine projects as implementation opportunities emerge. The outcome of the screening and refinement process will be a Master Plan or Portfolio of projects and regional priorities that would be supported by the collective Watershed Network.

Assuming funding is available, an immediate next step in the next 3 months would be an evaluation of the following projects as an initial test of the project evaluation framework:

- Upper Watershed Forest Health initiatives
- Upper American River Woodland-Urban Interface Resilience Projects
- American River Water Instrumentation Network
- Pilot Creek Watershed Restoration
- Sacramento Regional Groundwater Bank
- RiverArc Project
- Water Forum American River Climate Adaption Program and Two-Year Workplan
- Folsom Temperature Control Device
- Forecast Informed River Operations (FIRO)

11.1.3 Establishing Clear Regional Policy Direction

To support long-term resilience, the region should articulate a shared policy direction that affirms vulnerability- and resilience-centered planning as the basis for future watershed efforts. Clear regional priorities will help guide coordination, advocacy, and investment decisions.

One recommendation would be the establishment of a small working committee (in the next 3 months) that identifies and articulates the policy and regulatory impediments to successful project and regional priority implementation is recommended to be formed. The committee should provide recommendations to the RWA Board members for consideration in the next 12 months. An example for the committee to work through could be a case study on FIRO and the development of an action plan that identifies policy, regulatory, and government alignment impediments. This would create a common platform for regional entities to advocate from.

11.1.4 Preparing for and Pursuing Funding Opportunities

Positioning the region for upcoming State and Federal funding, including near-term Proposition 4 funds, will require continued coordination, project readiness, and alignment with State objectives. Short-term bridge funding may be needed to sustain progress between planning and implementation phases. The RWA WRP will develop costs, phasing, and funds needs of the Portfolio to inform collective local, state, and federal investments over the near and longer term.

RWA WRP will prepare for the near-term $152 million Proposition 4 grant solicitations with the timing and investment needs of the Portfolio in mind. There are many opportunities in American, Bear, and Cosumnes watersheds to advance on-the-ground projects in the next 12 months depending on what type of project are eligible for the grant solicitations and how DWR's Watershed Resilience Program is ultimately constructed.

11.1.5 Advancing the Plan as a Living Framework

The RWA WRP is designed to evolve over time. Ongoing performance tracking, stakeholder engagement, and incorporation of new data and initiatives will allow the Plan to adapt to changing conditions and remain relevant as implementation advances.

11.2 Recommendations for DWR Actions

Implementing complex climate resilience and multi-benefit projects that include infrastructure (natural and built) has become cost prohibitive in recent years due to many factors ranging from higher labor costs for preparation of engineering and environmental studies to procuring construction materials and equipment. Further, conflicting policy direction from critical state and federal agencies has left local project proponents with uncertainty of regulatory environments. This uncertainty and cost escalation has stifled the ability of many organizations (particularly local) to implement projects that reduce climate risks and therefore exposure to extreme heat, drought, wildfire, and flooding has continued to rise. No regrets type projects are simply not getting put in the ground because project implementation has become too complex, expensive, and onerous for any one smaller entity to carry out. State, and particularly DWR, leadership is critical when it comes to addressing these issues and providing continuity between changing political and regulatory conditions.

The following recommendations are what the RWA WRP Advisory Committee sees as opportunities for DWR to provide greater clarity in their leadership role at the State level and contribute to on-the-ground future success that advance climate resilience.

- **Establish a long-term DWR Watershed Resilience Program that provides funding for the planning and implementation of meaningful projects and strategies that reduce climate vulnerabilities and promote climate resilience, equity, collaborative planning and provide watershed scale benefits.** The Watershed Resilience Program should be established in a way that allows current and future Proposition or State General Fund funds to be administered through a competitive or directed funding solicitation guided by DWR prepared funding guidelines. It is important to signal to local jurisdictions and entities with project implementation responsibilities that DWR is committed to cost-sharing in projects that support the goals of the locally driven Watershed Resilience Plans. Further, signally that a long-term program with staff resources is in place to deliver projects gives local jurisdictions and other entities more security in taking risks with future funding advocacy for watershed resilience.

- **Incentivize larger projects to advance to on-the-ground implementation with strong cost share from DWR's Watershed Resilience Program.** DWR's watershed Resilience program must be a major source of matching funds for local jurisdictions and other entities to be able to execute projects. This will mean that DWR will need to fund fewer overall projects across the state but invest significantly in advancing the most impactful, qualified, and effective projects to full execution. A small amount of DWR implementation funding scattered across the state will not be enough to complete projects and does not incentivize the larger climate projects that will move the needle on climate change risk reduction. It is better to fund fewer more impactful projects than "spreading the wealth" so everyone gets a small token amount.

- **Leverage the work conducted under the 2024 Watershed Resilience Pilot Program to test the *implement and monitor* phase of the Watershed Resilience Planning Framework (as presented in the 2023 California Water Plan Update).** The five Watershed Resilience Pilots are well suited to continuing piloting DWR's Watershed Resilience Program by further advancing the implementation and performance tracking elements of the Watershed Resilience Planning Framework to better guide how DWR could roll out a Statewide program that is effective for project implementation. Available funds from Proposition 4 should be directed to assist in continuing piloting the Watershed Resilience Program with the five Pilots for the next phase and demonstrate the value of effective climate adaption planning and implementation to the CA legislature. There are many opportunities in American, Bear, and Cosumnes watersheds to advance on-the-ground project implementation in the next 12 months depending on what type of project are eligible for the grant solicitations and how DWR's Watershed Resilience Program is ultimately constructed.

- **Incentivize Projects, Actions and Strategies identified in other DWR required plans.** Senate Bill 552 requires all counties to improve drought and water shortage preparedness for state small water systems and domestic wells within a county's jurisdiction by developing a County Drought Resilience Plan (County DRP). DWR has provided guidance, funding, and technical tools to counties to support the development of the County DRPs. DWR should incentive implementation of locally identified projects, actions, and strategies that are integrated between County DRP and Watershed Resilience Plans because their objectives overlap with mitigating drought vulnerabilities and risks.

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