PUBLIC POLICY INSTITUTE OF CALIFORNIA

Storing Water for the Environment

Technical Appendix C: Proposition 1 Water Storage Investment Program

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Introduction

In 2014, the California voters approved Proposition 1—the Water Quality, Supply, and Infrastructure Improvement Act—to boost public investment in California's water infrastructure. While the $7.5-billion bond measure included various funding elements—such as water recycling, cleaning up groundwater contamination, watershed protection, and improving drinking water quality—the statute assigned a significant portion of the bond funds to water storage projects (CNRA 2015). Proposition 1's Water Storage Investment Program (WSIP) dedicated $2.7 billion to such projects. WSIP aimed to create a novel funding mechanism that paid for only the public benefit portion of water projects. Proposition 1 defined five categories of public benefits eligible for funding: ecosystem improvements, water quality improvements, flood control benefits, emergency response, and recreation (See Box C1).

As described in the main report (Null et al. 2022), re-operation of existing storage along with investments in new storage—both above and below ground—will be needed to build resilience of California's ecosystems against increasingly severe and prolonged droughts. WSIP creates a unique approach to diversifying the storage portfolio available to the environment.

This technical appendix examines WSIP as a potential model for funding increased storage for the environment. We examine how the California Water Commission (CWC), the principal administrator of the program, solicited and funded the public-benefit portion of projects. This includes a description of how CWC estimated and assigned monetary ecosystem benefit values for specific projects, a timeline of WSIP administration, and summaries of current WSIP-funded projects and their estimated ecosystem benefits. We also provide an overall analysis of the funding program itself and the reliability of environmental water supply.

Proposition 1's requirements for WSIP

The purpose of Proposition 1 is to encourage development of water infrastructure, but the statute limits WSIP funding to the costs of the public benefit portion of any project. WSIP also requires that: (1) for each project, benefits to ecosystems must constitute at least 50 percent of all public benefits funded under the program (Cal. Code Regs. Tit. 23 § 6006); (2) the public benefit cost share of the funded project shall not exceed 50 percent of the total cost of the project. (Water Code section 79756); and (3) a funded project must provide measurable improvements to the Sacramento–San Joaquin Delta ecosystem or to the tributaries to the Delta (Water Code section 79752). The Act does not specify how these benefits are measured or monetized. It also delegates the task of benefits quantification and determination to CWC, acting in consultation with the State Water Resources Control Board (SWRCB), the California Department of Water Resources (DWR), and the California Department of Fish and Wildlife (CDFW) (Water Code section 79754).

CWC prepared and approved regulations (Cal. Code Regs. Tit. 23, Div. 7, Chap. 1) implementing WSIP. The regulations defined the quantification of benefits and incorporated a detailed Technical Reference (CWC 2016) prepared by CWC staff and consultants that describe methods for quantifying and monetizing public benefits. The regulations defined the application process, eligibility criteria, the evaluation and selection process, and the funding process. They also clarified the program's timeline and the roles of CDFW, SWRCB, and DWR (Figure C1).

Box C1: What is a public benefit in Proposition 1?

The concept of "public benefits" can be defined broadly or narrowly, depending on the purpose. Broad definitions can encompass societal goals such as providing safe, clean drinking water, maintaining vibrant communities, or managing groundwater in a sustainable manner (see for example Water Code section 79701). Under such broad definitions, public funding could be justified for almost any water-related benefit. In contrast, WSIP in Proposition 1 defined, and voters approved, a narrow definition that identified five specific public benefits as eligible for funding. These are (Water Code section 79753):

- Ecosystem improvements, including changing the timing of water diversions, improvement in flow conditions, temperature, or other benefits that contribute to restoration of aquatic ecosystems and native fish and wildlife, including those ecosystems and fish and wildlife in the Delta.
- Water quality improvements in the Delta, or in other river systems, that provide significant public trust resources, or that clean up and restore groundwater resources.
- Flood control benefits, including, but not limited to, increases in flood reservation space in existing reservoirs by exchange for existing or increased water storage capacity in response to the effects of changing hydrology and decreasing snow pack on California's water and flood management system.
- Emergency response, including, but not limited to, securing emergency water supplies and flows for dilution and salinity repulsion following a natural disaster or act of terrorism.
- Recreational purposes, including, but not limited to, those recreational pursuits generally associated with the outdoors.

WSIP project evaluation criteria

The methods and criteria used to evaluate potential projects are complex. WSIP requires that an application's benefits and impacts be evaluated based on component scores (Cal. Code Regs. Tit. 23 § 6009). This score has four categories: (1) resiliency, (2) implementation risk, (3) Relative Environmental Value (REV), and (4) Public Benefit Ratio (PBR) and non-monetized public benefits. Among these four categories that contribute to the score, the first three assess the projects qualitatively (although quantitative analysis was used in many cases to inform the component score) while the fourth (PBR) quantifies the magnitude of benefits by utilizing various scientific and economic tools (Table C1).

TABLE C1

WSIP evaluated the projects in four categories that account for the statutory requirements

Project Score Category	Description	Score breakdown	Percentage of the total score
Resiliency	Integration and flexibility of a project and its ability to respond to an uncertain future	10% - Integration and flexibility based on the evaluation of claims made and the quality of the analysis	25%

		15% - Response to an uncertain future based on quality of analysis and effects on public benefits	
Implementation risk	Risks that the project could face regarding technical, financial, economic, and environmental issues during the construction or operation phases	3.75% - Technical risk 3.75% - Financial risk 3.75% - Economic risk 3.75% - Environmental risk	15%
Relative Environmental Value	A score system that evaluates the merits of physical benefits claimed by the applicants based on 16 CDFW priorities (Table C2) and 10 REV criteria (Table C3)	27% - Environmental benefits OR 19% - Environmental benefits 8% - Water quality benefits	27%
Public Benefit Ratio and non-monetized public benefits	An assessment of the monetary value of public benefits compared to the requested funding to determine whether the public investment in the project will pay off	Public Benefit Ratio – 33% Non-monetized public benefits – up to 4%	33%

SOURCE: Cal. Code Regs. Tit. 23 § 6009.

NOTES: For projects with water quality benefits, water quality makes up 30 percent of the Relative Environmental Value score. If a project provides non-monetized benefits, 4 percentage points can be added to the Public Benefit Ratio score, as to not exceed 33 percent in total. If the project does not have a water quality benefit, the Relative Environmental Value is calculated solely based on environmental benefits.

CDFW and SWRCB developed methodologies for assessing relative environmental values that were incorporated into the CWC regulations. Tables C2 and C3 summarize the methodology developed and used by CDFW to assess relative environmental value for each project applying for WSIP funding.

TABLE C2

The Relative Environmental Value (REV) process takes 16 CDFW priorities into account

Priority Number	Priority Definition
Priority 1	Provide cold water at times and locations to increase the survival of salmonid eggs
Priority 2	Provide flows to improve habitat conditions for in-river rearing and downstream migration of juvenile salmonids
Priority 3	Maintain flows and appropriate ramping rates at times and locations that will minimize dewatering of salmonid redds and prevent stranding of juvenile salmonids in side-channel habitat
Priority 4	Improve ecosystem water quality
Priority 5	Provide flows that increase dissolved oxygen and lower water temperatures to support anadromous fish passage
Priority 6	Increase attraction flows during upstream migration to reduce straying of anadromous species into non-natal tributaries
Priority 7	Increase Delta outflow to provide low salinity habitat for Delta smelt, longfin smelt, and other estuarine fishes in the Delta, Suisun Bay, and Suisun Marsh
Priority 8	Maintain or restore groundwater and surface water interconnection to support instream benefits and groundwater dependent ecosystems
Priority 9	Enhance flow regimes or groundwater conditions to improve the quantity and quality of riparian and floodplain habitats for aquatic and terrestrial species
Priority 10	Enhance the frequency, magnitude, and duration of floodplain inundation to enhance primary and secondary productivity and the growth and survival of fish
Priority 11	Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species
Priority 12	Enhance access to fish spawning, rearing, and holding habitat by eliminating barriers to migration
Priority 13	Remediate unscreened or poorly screened diversions to reduce entrainment of fish
Priority 14	Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on State and Federal wildlife refuges and on other public and private lands

Priority 15	Develop and implement invasive species management plans utilizing techniques that are supported by best available science to enhance habitat and increase the survival of native species
Priority 16	Enhance habitat for native species that have commercial, recreational, scientific, or educational uses

SOURCE: Cal. Code Regs. Tit. 23, § 6007.

TABLE C3

The REV category consists of 10 criteria

REV Category	REV Definition
REV 1	Number of different ecosystem priorities claimed. For each priority claimed, CDFW adds 0.375% to the project's final REV score.
REV 2	Magnitude of ecosystem improvements
REV 3	Spatial and temporal scale of ecosystem improvements
REV 4	Inclusion of an adaptive management and monitoring program that includes measurable objectives, performance measures, thresholds, and triggers to achieve the ecosystem benefits
REV 5	Immediacy of ecosystem improvement actions and realization of benefits
REV 6	Duration of ecosystem improvements
REV 7	Consistency with species recovery plans and strategies, initiatives, and conservation plans
REV 8	Location of ecosystem improvements and connectivity to areas already being protected or managed for conservation values
REV 9	Efficient use of water to achieve multiple ecosystem benefits
REV 10	Resilience of ecosystem improvements to the effects of changing environmental conditions, including hydrologic variability and climate change

SOURCE: Cal. Code Regs. Tit. 23, § 6007.

NOTES: The maximum score for each REV is 6 points, except for REV 1. REV 1 score adds 0.375 percent to the final percentage score for each CDFW priority claimed by the applicants (Table C2). The REV score is calculated separately for each priority claimed by a WSIP applicant, then summed up and divided by the maximum possible score to calculate a percentage. REV 1 score is then added to this percentage.

Component scores were used to rank the projects based on their merits and prioritize funding for the projects with the highest benefits and return on public investment. For example, Rank 1 projects would need a project component score of 85 or above, would have the highest priority in funding, and would be awarded their full requested amount as their Maximum Conditional Eligibility Determination (MCED, described below). Rank 2 projects would have a score of 70–84 and be considered if there were remaining funds after Rank 1 projects were awarded their MCEDs. Rank 3 projects, with a score of less than 70, would be considered for an MCED only if there was still funding available (Cal. Code Regs. Tit. 23 § 6011).

Regulations allow some flexibility in the calculation of component scores and benefit values. CWC may adjust the project component score by plus or minus 25 percent without exceeding the component's maximum score (Cal. Code Regs. Tit. 23 § 6011). For example, the commission can adjust a project's PBR score of 27 to 33 (the maximum possible score). The regulations also direct CWC staff to "adjust the scores to reflect the Commission's decisions" (Cal. Code Regs. Tit. 23 § 6011), granting the commissioners additional discretion over the scoring process.

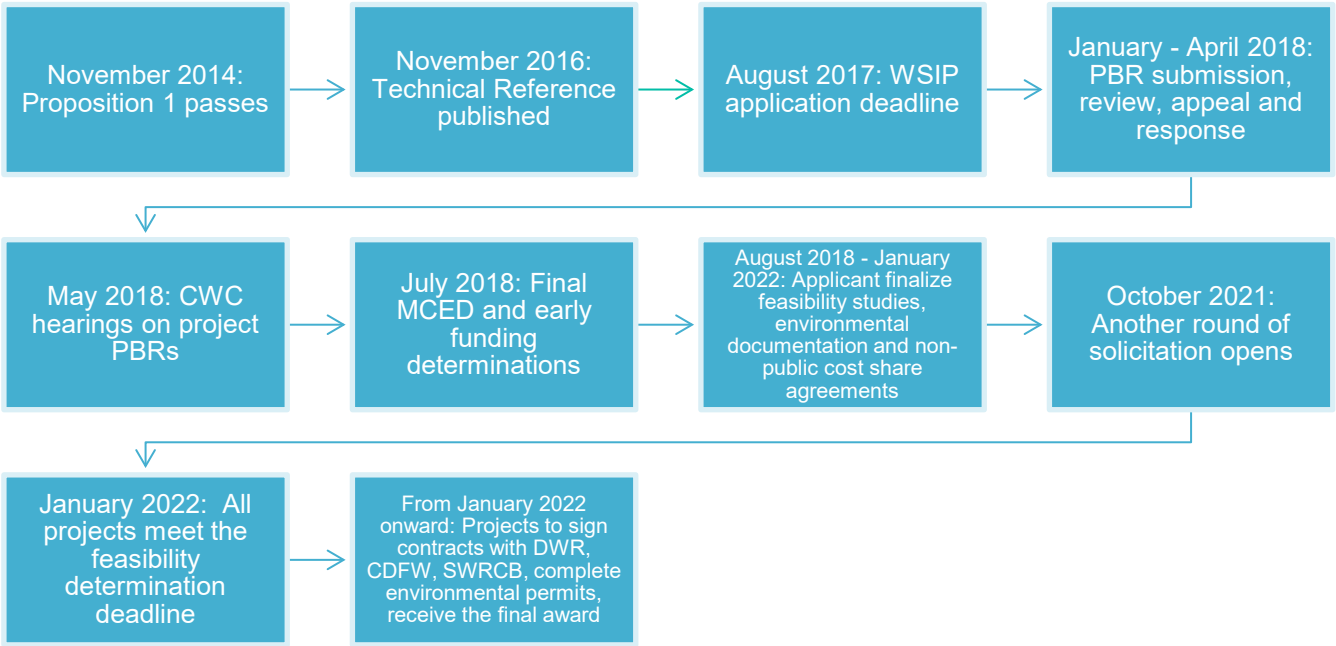
Public Benefit Ratio and non-monetized public benefits

The Public Benefit Ratio (PBR) is key to the success of any project since it determines whether a project is eligible for funding and ultimately the amount of that funding (the Maximum Conditional Eligibility Determination, or MCED). An example of the complex calculations involved in defining PBR and MCED are described in Box C2.

The PBR is calculated by assigning monetary value to public benefits, including the environment, and comparing that value to the amount requested by the applicant. For the monetary value of a benefit to be accepted, the ecosystem benefits are first evaluated by CDFW. These benefits are defined as measurable improvements in physical conditions as a result of the project operations. If CDFW concludes that, based on the documents and justification provided by the applicants, the physical benefits would be present, the benefits are monetized based on methods provided by CWC in the Technical Reference document. If the physical benefits cannot be proven, CDFW can recommend the removal of the benefit. In that case, the monetary value to the claimed physical benefit is assigned as zero. The total monetary value of all public benefits divided by the funding request makes up a project's PBR.

The PBR component of a project stands out from other factors that make up a project's component score, because it also helps determine the MCED that a project can be awarded. For this reason, PBR and the monetization of ecosystem benefits were subject to lengthy discussion between project applicants and reviewers. PBR calculations also enable WSIP to fulfill Proposition 1's directives that (1) public funds only pay for the public benefits of a project, and (2) ecosystem benefits make up at least 50 percent of the public benefits.

FIGURE C1
Timeline of Prop 1 WSIP implementation



Box C2: Calculating the Public Benefit Ratio

A project's WSIP funding is determined by its PBR, which has to be at least 1.00, indicating that the monetary value of public benefits must be at least equal to the amount of funds requested.

For example, if a project that otherwise meets all requirements in the regulations proves that it would provide $100 million worth of public benefits and requests $75 million, its PBR would be 1.33 and the project would be potentially eligible (depending on its ranking based on the project component score) to receive the full requested amount.

$$PBR = \frac{Total\ value\ of\ all\ public\ benefits}{Funding\ request} = \frac{100{,}000{,}000}{75{,}000{,}000} = 1.33$$

In cases where the PBR is less than 1.00, the WSIP funds available to the project are adjusted so that PBR would be 1.00. For example, if a project's public benefits are valued at $100 million overall but the applicants request $200 million, that would equate to a PBR of 0.50. As a result, the applicants would only be qualified for a maximum eligible funding of $100 million.

$$PBR = \frac{Total\ value\ of\ all\ public\ benefits}{Funding\ request} = \frac{100{,}000{,}000}{200{,}000{,}000} = 0.50$$

$$PBR\ has\ to\ be\ at\ least\ 1.00, meaning\ that\ the\ maximum\ funding\ cannot\ exceed\ the\ public\ benefit\ value:$$

$$Maximum\ eligible\ funding = \frac{Total\ value\ of\ all\ public\ benefits}{PBR} = \frac{100{,}000{,}000}{1.00} = \$100{,}000{,}000$$

Per Proposition 1 requirements, the maximum eligible funding is limited to twice the eligible ecosystem benefit value. For example, if a project calculates $40 million in ecosystem benefits and $60 million in other public benefits (water quality, emergency response etc.), it would only be eligible for a maximum funding of $80 million even though the public benefits total $100 million.

$$If\ value\ of\ ecosystem\ benefits \geq\ value\ of\ other\ public\ benefits,$$
$$Total\ value\ of\ all\ public\ benefits\ eligible\ for\ funding = Ecosystem\ benefits + other\ public\ benefits$$

$$If\ value\ of\ ecosystem\ benefits < value\ of\ other\ public\ benefits,$$
$$Total\ value\ of\ all\ public\ benefits\ eligible\ for\ funding = 2 * ecosystem\ benefits$$

$$In\ which\ case, maximum\ eligible\ funding = 2 * 40{,}000{,}000 = \$\mathbf{80{,}000{,}000}$$

The Technical Reference document provides three methods for monetizing the claimed environmental benefits and including them in the PBR calculations: (1) willingness-to-pay, (2) alternative cost, and (3) avoided cost.

- **Willingness-to-Pay.** The willingness-to-pay (WTP) approach is based on the assumption that ecosystem improvements bring value to nature and people's lives. As a calculation method, it aims to measure how much people value these improvements in monetary terms, and how much people are willing to pay to preserve, enhance, or access certain ecosystem services (Technical Reference 2016). The WTP values can be especially high for rare ecosystem services, or rare and endangered species.

- **Alternative cost.** With the alternative cost approach, benefits are calculated based on the least-cost, comparing the project to a feasible alternative that would deliver the same benefits. For example, for instream pulse flows, project applicants can calculate the cost of purchasing water from existing uses. If enough water cannot be acquired, applicants would have to include the next lowest cost option—such as land fallowing or land acquisition—in their alternative cost calculations. Some of the relevant cost data and data sources for alternative cost calculations are provided by the Technical Reference (2016).
- **Avoided cost.** This approach consists of an ecosystem improvement that would reduce costs of other improvements, replace a more expensive improvement method, or render other potential projects unnecessary. The net reduction in the total money spent as a result of the project is defined as the avoided cost (Technical Reference 2016). For example, if a wildlife refuge purchases 1,000 acre-feet (af) of water each year from a regional supplier at $200 per af, and the project would meet this supply need with no additional cost, the avoided cost of the project with regards to the refuge water deliveries would be calculated as $200,000 per year.

The Technical Reference (2016) guidelines suggest that both the willingness-to-pay and the alternative cost methods should be provided when possible, since the values calculated by either approach can vary widely depending on the project's nature. For example, a project might be releasing small amounts of water, but it provides critical support for endangered fish species in a remote location with no other water supply alternatives. The market value of this water may not be high in a less remote region, but in this specific context the project could support a large population of the fish and prove critical to a vulnerable ecosystem. Throughout the application process, the applicants and the reviewers engaged in multiple discussions to determine which method would make the most sense in the case of each ecosystem benefit.

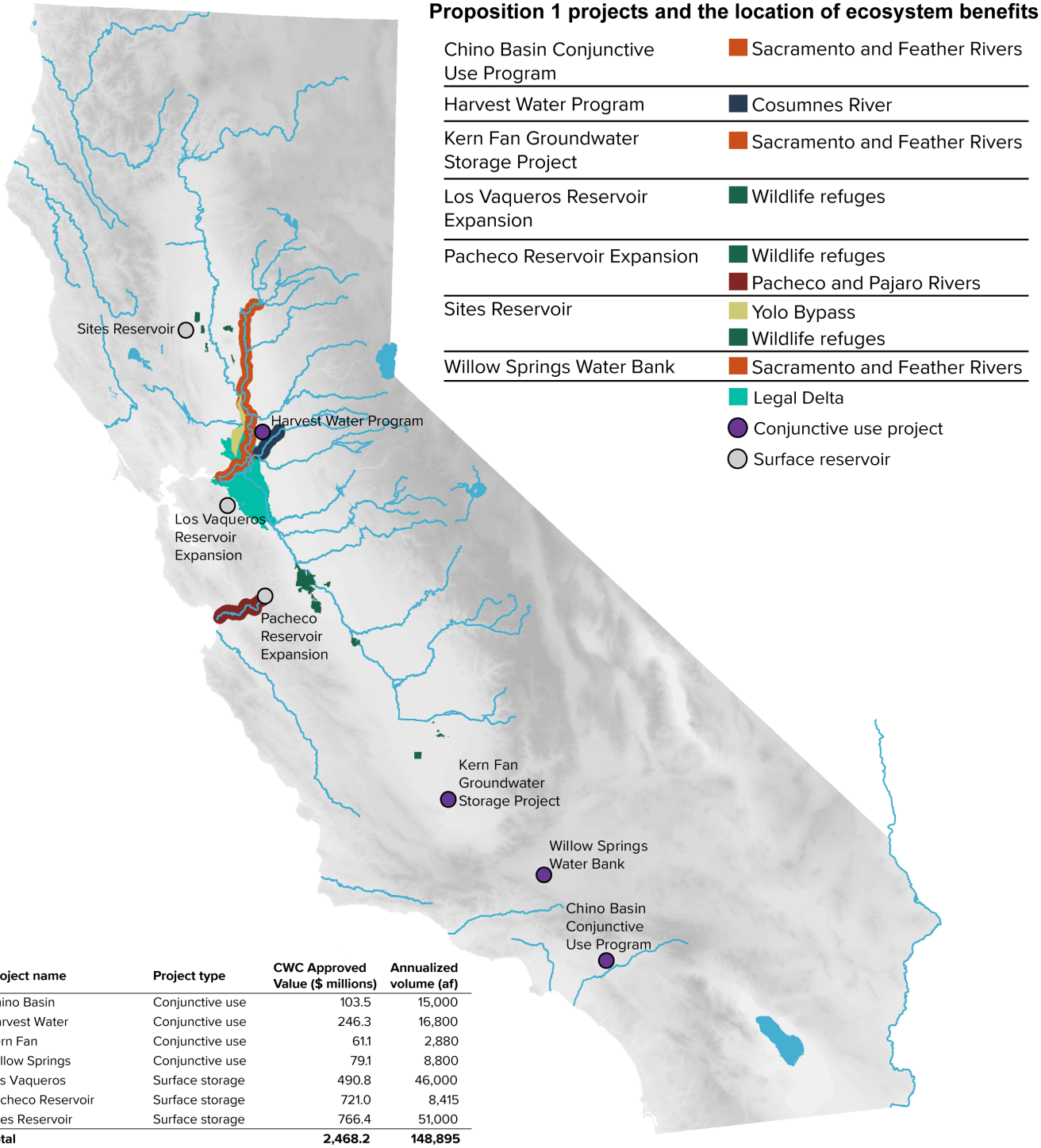
An overview of WSIP projects' monetized environmental benefits

In this section, we review the projects that successfully received an MCED from WSIP, were deemed eligible for funding by January 2022, and are in the process of acquiring the required permits and finalizing their contracts. Each review includes an overview of the project, a summary of the claimed physical ecosystem benefits, the conclusion reached by CDFW and CWC on the merits of the claimed physical ecosystem benefits at the end of the review process, and key uncertainties around the project. Final MCEDs of projects are not always directly aligned with the ecosystem values due to inclusion of other public benefits, different project rankings, and availability of funds. The MCED values only indicate the maximum funding that CWC determined the project is eligible for. These funds are not guaranteed and may be adjusted downwards by the time that the permits and public benefit contracts are finalized.

The projects that qualified for MCEDs fall into two categories: (1) conjunctive use projects involving groundwater storage that makes surface water available for ecosystems at key times (Chino, Harvest, Kern Fan, Willow Springs) and (2) surface storage (Los Vaqueros, Pacheco, and Sites). The project locations can be found in Figure C2 along with the locations of their monetized environmental benefits.

FIGURE C2

Locations of WSIP eligible projects and the monetized environmental benefits provided by them



Project name	Project type	CWC Approved Value ($ millions)	Annualized volume (af)
Chino Basin	Conjunctive use	103.5	15,000
Harvest Water	Conjunctive use	246.3	16,800
Kern Fan	Conjunctive use	61.1	2,880
Willow Springs	Conjunctive use	79.1	8,800
Los Vaqueros	Surface storage	490.8	46,000
Pacheco Reservoir	Surface storage	721.0	8,415
Sites Reservoir	Surface storage	766.4	51,000
Total		**2,468.2**	**148,895**

SOURCE: Data compiled in this report.

NOTES: Figure depicts the location of each WSIP project along with the approximate area of benefit. CWC Approved value indicates the monetized ecosystem benefits and excludes the other public benefits. See Tables C5 and C6 for more information.

Chino Basin Conjunctive Use Environmental Water Storage/Exchange Program

Project Description

The Chino Basin Conjunctive Use Program is a groundwater storage project that expands the existing Chino Basin Water Bank by adding an advanced water treatment facility and distribution facilities, and operates by conducting in-lieu exchanges with the State Water Project (SWP) and its contractors, who store water in Lake Oroville. This would expand the storage by 15,000 af for treated wastewater at the Chino Basin Water Bank. The project was proposed by the Inland Empire Utilities Agency. The project's goal is to improve water quality and emergency response, and allow pulse flows to be released from Lake Oroville in dry and critically dry years to increase the survival of salmon. The project would provide this environmental benefit for the first 25 years. Thereafter, this water would go to other uses. The total project cost is $385 million (CWC n.d.d).

Environmental Benefits

The project application claimed two ecosystem benefits: (1) the increased emigration of juvenile Chinook salmon and (2) reduction in stray rate of returning adults. The project would achieve these benefits by providing up to 50,000 af per year in April of dry and critically dry years as pulse flows in the Feather River—up to three consecutive such years—for the first 25 years of the project operation. With the applicants' calculation that they would provide 7.5 pulse flows in 25 years, the pulse flow volume would be equivalent to 15,000 af per year. This would save 15 adult spring-run Chinook from straying per pulse flow year and increase the juvenile Chinook survival rate by 3.1 percentage points (from 2.8% to 5.9%) (IEUA 2017). The applicants valued these benefits at $356.8 million in total.

CDFW and CWC Conclusions

After review, CDFW accepted the physical benefits to salmon, but removed the stray rate reduction benefits and adjusted benefit values downward. CWC calculated the monetary benefits to salmon at $103.5 million. The CWC staff calculated this value by using the cost of voluntary water transfers in dry and critically dry years, whereas the applicants had used the willingness-to-pay method to calculate the value. The staff also raised questions about the reliability of SWP Table A allocations for exchange, and the lack of any current exchange partners among the SWP contractors (CWC 2018b).[1] After the applicants expressed that they had some potential partners such as the San Bernardino Valley Municipal Water District (SBVMWD) and the Metropolitan Water District of Southern California (MWD), the staff accepted that with the potential partnership of MWD and SBVMWD, pulse releases could be made available. However, the ability of SBVMWD to participate in the exchange is contingent on the Table A allocations, as the pulse flow volume of 50,000 af constitutes 49 percent of its SWP Table A allocation.

In July 2018, the commission decided to set the project's MCED to $206.9 million as a Rank 2 project (CWC 2018c), which includes other benefits that the project provides in groundwater quality improvement and protection, and emergency response. As additional funds became available, the project's MCED was adjusted to $215 million (CWC 2022). As of July 2021, the applicants were in communication with the state agencies as well as MWD, which indicated its intent to collaborate with IEUA (IEUA 2021).

[1] SWP Table A allocations represent the portion of the water the districts are entitled to receive from the SWP per their contracts. The portions are determined every year based on the total water available and hydrologic conditions.

Harvest Water Program

Project Description

The Harvest Water Program project—formerly known as the South County Ag Program—is proposed by the Sacramento Regional County Sanitation District. It is a conjunctive use project that aims to deliver and store up to 50,000 af of recycled water annually to support irrigation and regional water supply for 16,000 acres, and to improve the stream flows and groundwater-dependent riparian habitats by raising the water table (CWC n.d.a). The project consists of a pump station, recycled water transmission pipelines, distribution lines, a recharge area and the existing raw water infrastructure (Sacramento Regional County Sanitation District 2017). Costing a total of $373 million, water from the project would be used for groundwater recharge. This is estimated to provide up to 15,500 af per year of base flow improvement to the Cosumnes River and various habitat benefits to wildlife. The project is designed to be operational through 2100.

Environmental Benefits

The project application claimed five monetized ecosystem benefits: (1) increased flows for fall-run Chinook, (2) wetland habitat enhancement, (3) riparian habitat enhancement, (4) greater Sandhill Crane habitat improvement, and (5) vernal pool habitat improvements. The applicants examined these benefits for 2030 and 2070 conditions based on projected climate change. They estimated that based on the widened migration window for salmon due to improved flows to the Cosumnes River, 143 adult fall-run Chinook will benefit from increased flows of 15,500 af per year under the 2030 conditions, and 95 adults from approximately 12,000 af per year under the 2070 conditions, valued at $49 million. For wetland habitat enhancement, the project calculated the wetland enhancement benefits for 3,187 acres in total, worth $91.6 million. For wetland and riparian habitat restoration, the applicants plan to restore a total of 500 acres along a 10-mile stretch, valued at $25.2 million. In addition, 3,500 acres of Sandhill Crane habitat would be managed, with potential benefits to 700 Sandhill Cranes (valued $146.1 million), and 500 acres of vernal pool would be restored or re-established, valued at $8.5 million (CWC 2018d).

In total, the project claimed to have a present value of $320.4 million for monetized ecosystem benefits. The program would achieve these benefits by mitigating the cone of depression due to groundwater depletion near the Cosumnes River that causes flow losses through channel seepage. The project would also improve habitat connectivity in the regional ecosystems, such as the Cosumnes Preserve and Stone Lake National Wildlife Refuge.

CDFW and CWC Conclusions

The CDFW review accepted all five physical ecosystem benefits, but CWC readjusted the total value to $246.3 million, reflecting both downward and upward adjustments of the individual benefit categories. Benefits to salmon were raised from $49 to $79.3 million based on the cost of voluntary water transfers. Wetland habitat benefit was lowered from $91.6 to $73.6 million, and riparian habitat benefit from $25.2 to $21.7 million, based on the cost of voluntary water transfers as well as potential wetland classification and habitat functionality assumptions. The reviewers valued the Greater Sandhill Crane habitat significantly less—down from $146.1 to $61.2 million, and they adjusted the value of vernal pool habitat upward slightly, from $8.5 to $10.5 million, based on the cost of water. In July 2018, the MCED for the Harvest Water Program was set as $280.5 million as a Rank 2 project (CWC 2018c), which was adjusted for inflation to $291.8 million when additional funds became available (CWC 2022). Of this amount, the applicants were approved to receive $14.4 million in early funding.

Kern Fan Groundwater Storage Project

Project Description

This groundwater storage project, located in Kern County near Bakersfield, aims to develop a water bank that would store unallocated water from the State Water Project under Article 21 (generally only available in high-flow years), and provide both public and non-public benefits. The project can recharge and store up to 100,000 af of water. The project's sponsors are Irvine Ranch Water District and Rosedale–Rio Bravo Water Storage District, which would divert the unallocated supplies to the project, to be operated by Rosedale (CWC n.d.g). These two partners are entitled to 75 percent of the stored water, with the remaining 25 percent dedicated to the environment to provide short-term pulse flows from Lake Oroville (CWC n.d.g). In October 2021, the two partners formed the Groundwater Banking Joint Powers Authority to build and operate the project.

Environmental Benefits

The applicants quantified two ecosystem benefits from the project: (1) spring-run and winter-run Chinook salmon survival and (2) incidental wetland habitat. For salmon, benefits would be achieved by releasing an 18,000 af pulse flow from Lake Oroville in the month of April over four days in dry and critically dry years. According to the applicants' calculations, the project could provide eight April flow pulses in a 50-year period. When annualized, this would equate to 2,880 af per year of pulse flows. Incidental wetlands would form as a result of groundwater basin recharge over the 1,200-acre recharge area. The pulse flows would provide a net benefit of 586 adult spring-run and 41 adult winter-run Chinook salmon over the life of the project (IRWD 2017). The project put the value of the benefit to salmon at $21 million and incidental wetlands benefits at $39.8 million, making the total ecosystem benefits worth $60.8 million. The original application requested $85.7 million in funding based on a total public benefit valuation of $125.8 million, which included emergency response benefits like levee failure and drought emergencies.

CDFW and CWC Conclusions

The CDFW reviewers accepted the applicants' ecosystem benefit claims for salmon and incidental wetland habitat. The CWC staff recommended valuing the benefits at values very close to those proposed by the applicants (salmon at $21.3 million and incidental wetlands at $39.8 million, bringing the total ecosystem benefit value to $61.1 million). In July 2018, the project's MCED was determined as $67.5 million by the commissioners based on its score as a Rank 3 project. As additional funds became available, this amount was increased to $89.1 million (CWC 2022).

The project proponents estimate the completion date of all required approvals and agreements as August 2024, with operations beginning in mid-2028 (RRBWSD and IRWD 2021).

Los Vaqueros Reservoir Expansion

Project Description

The Los Vaqueros Reservoir Expansion (LVE) Project is intended to increase the capacity of the Los Vaqueros Reservoir from 160,000 to 275,000 af via conveyance upgrade and reoperation. Proposed by the Contra Costa Water District (CCWD), the 115,000 af increase in storage would allow for more Central Valley Project (CVP) water to be stored in the reservoir (CWC n.d.h). The project's aim is to improve environmental water reliability and boost the Bay Area's water supply. The project would receive the water from the Sacramento River and the Sacramento–San Joaquin Delta. The source of water would be either Delta Surplus Water under CCWD's CVP water contract, or the project partners' CVP or SWP water contracts. (CCWD 2017a).

Environmental Benefits

The project application claimed two ecosystem benefits: (1) reduced salmonid entrainment and (2) Level 4 refuge water supply to Central Valley wildlife refuges. The two benefits were valued at $1.033 billion. Reducing salmonid entrainment would involve upgrades to the Rock Slough Fish Screen Facility, which includes an expansion of the aquatic weed management program to control the growth of water hyacinth and other invasive weeds (CWC 2018e). This would benefit spring- and fall-run Chinook salmon, and steelhead in the Delta. Specifically, up to 33 fall-run Chinook, 2 spring-run Chinook and 6 steelhead may benefit from the improvements to the fish screen, reducing the number of fish entrapped in the screens to one to two per year (CCWD 2016). This benefit was valued at $29.05 million based on the values of $3,500 per fall-run Chinook and $100,000 per spring-run Chinook or steelhead.

The benefits to the refuges would be achieved by supplying water to the Refuge Water Supply Program. The application identified the benefit to refuges at two main locations, Grasslands Ecological Area and south San Joaquin Valley (Mendota Wildlife Area, Kern and Pixley National Wildlife Refuges). The benefit to the refuges was valued at a little over $1 billion through the year 2121 and was calculated using alternative cost estimates of purchasing transfer water to the San Joaquin Valley refuges across all water year types (CCWD 2017b). The applicants explained that the refuge benefits would be the greatest under a wetter climate change scenario, with annual water deliveries reaching 52,000 af per year compared to 43,000 af per year in a drier future climate. The applicants stated that this water could be provided at different times of the year depending on conditions and other refuge water deliveries (CCWD 2017c).

CDFW and CWC Conclusions

CDFW accepted the physical benefits both to salmon and the wildlife refuges. The CWC staff reduced the monetary value of the refuge water supply benefit by more than half, to $489.9 million. This adjustment reflected the applicants' failure to test their model on the 2014–16 drought, calculations that included unjustified assumptions, and the conclusion that near-term benefits of the refuge water supply were overvalued. The staff also substantially decreased the monetary value of salmon benefits (from $29 million to $900,000) based on insufficient evidence that salmon would be saved with the fish screen.

During the public hearing, the total public benefit was revised slightly, to $490.8 million. In the July 2018 hearing, the MCED for the project was determined to be $459 million as a Rank 2 project. As additional funds became available, this value was adjusted to $477.6 million, including $23 million available in early funding (CWC 2022). In October 2021, the Los Vaqueros Reservoir Expansion was approved by CWC as feasible.

Pacheco Reservoir Expansion Project

Project Description

Pacheco Reservoir Expansion project, proposed by Valley Water (formerly Santa Clara Valley Water District) is an effort to increase the capacity of Pacheco Lake from 6,000 af to 141,600 af, in addition to new conveyance infrastructure to increase the water delivery network and deliver water to south-of-Delta wildlife refuges. The water to fill the reservoir would come from Pacheco Creek, and Valley Water and San Benito County Water District's CVP contract water (CWC n.d.f). The project would provide 2,000 af of water to the refuges in below normal years and improve conditions for steelhead in Pacheco Creek—a tributary to the Pajaro River—with supplemental flows.

Environmental Benefits

The project application claimed two ecosystem benefits: (1) steelhead habitat improvement through enhanced flows in Pacheco Creek and (2) water supply to south-of-Delta wildlife refuges. The applicants claimed that the project would target flows at 10–20 cubic feet per second (cfs) to Pacheco Creek, based on steelhead life-stage requirements, which would translate to approximately 8,000 af per year. The improved flow and temperature conditions in the creek is estimated to increase steelhead populations from 30–60 to 80–160. The project would stop these releases if reservoir storage fell below 55,000 af (38% of reservoir capacity). The applicants also claimed that they could deliver 2,000 af of Incremental Level 4 water to the wildlife refuges (see main report for a description of wildlife refuge water provided by the CVP), which would irrigate 1,000 af of wetlands in below-normal years. The applicants assumed that 17 out of 82 years would meet this condition under a 2030 climate scenario, bringing the annualized volume to 415 af per year. The applicants valued steelhead habitat improvement at $716 million and refuge water supply at $6.4 million, bringing the total to $722.4 million (SCVWD 2017).

CDFW and CWC Conclusions

CDFW accepted ecosystem benefits to both steelhead habitat and to wildlife refuges from the project. CWC accepted the valuation of steelhead habitat at $716 million and adjusted the monetary value of the wildlife refuge benefits downward slightly (from $6.4 million to $5 million) based on the cost of voluntary water transfers. The reviewers noted that there was no discussion of water transfers by crop idling, conservation, or land retirement as a least-cost alternative. They also expressed concern that additional costs may be incurred to reach the steelhead population goals. The project was approved for an MCED of $484.6 million including early funding of $13.7 million in July 2018 as a Rank 2 project (CWC n.d.e). The MCED was increased for inflation to $504.1 million when additional funds became available (CWC 2022) and the early funding increased to $24.2 million in 2021.

Recent Developments

The Pacheco Expansion project has come under scrutiny recently. Following increases in estimated costs of construction from $1.3 billion to $2.5 billion, San Jose Mayor Sam Liccardo voiced opposition and cast doubts on the ability of the project to secure partners. Valley Water board member Nai Hsueh also acknowledged that the project cost would probably increase again (Rogers 2021). The mayor also pointed out that the project does not provide additional water supplies, and he encouraged Valley Water's board to look at other water supply alternatives (Kadah 2021b). Expansion of the reservoir might also inundate riparian habitat and oak woodland, although the project proponents argued that the project would create more riparian habitat (Kadah 2021a). As of October 2021, the project proponents continue to pursue partnerships to share the cost.

Sites Reservoir Project

Project Description

The Sites Reservoir Project aims to build an off-stream surface storage reservoir in the Sacramento Valley and related facilities including pumping plants, a regulating reservoir and a new discharge pipeline. The reservoir would impound the Funks and Stone Coral Creeks. With its cost currently estimated at $3.9 billion, the reservoir would have a capacity of 1.5 million af and operate in conjunction with the CVP and the SWP facilities (CWC n.d.b). Up to about 40 percent of reservoir capacity (600,000 af) could be reserved for ecosystem benefits. The reservoir would be able to supply an average of 283,000 af of water per year for various purposes—including ecosystem improvements—and an average of 381,000 af per year in dry and critical years.

Environmental Benefits

The project application claimed four ecosystem benefits: (1) anadromous fish, (2) Incremental Level 4 refuge water supply, (3) Lake Oroville cold-water pool, and (4) Yolo Bypass flows. In addition to supporting water temperature and flows in the lower Feather River, the project would provide up to 50,000 af to north- and south-of-Delta wildlife refuges and provide two pulse flows of at least 400 cfs for two to three weeks to the Yolo Bypass. The annualized amounts of water dedicated to the environment would be 94,000 af to support anadromous fish and help maintain cold-water pools in Shasta and Oroville, 32,000 af for the refuges, and 39,000 af for the Yolo Bypass, bringing the total average environmental flows to 165,000 af per year. The applicants claimed total ecosystem benefits worth $3.17 billion: $1.6 billion from benefits to anadromous fish, $682 million from refuge water supply, $601 million from cold-water pool, and $261 million from Yolo Bypass flows. They calculated the benefits to anadromous fish by using the expansion of Shasta Lake as the least-cost alternative, and they valued the refuge water supply at a higher rate ($781/af) than the values provided in the WSIP Technical Reference document because they added energy costs to the calculation.

CDFW and CWC Conclusions

After several review cycles, the CDFW staff decided to not accept the benefits to anadromous fish and the Oroville cold-water pool on the grounds that the benefits were not significant enough to improve the conditions (in the case of the cold-water pool) or not substantiated (in the case of the anadromous fish). Additionally, at the applicants' request the value of the Yolo Bypass flows was ultimately assessed based on the benefits of the flows to Delta smelt only, and not salmonids. The CDFW staff had raised concerns about the operations potentially reducing the overall Yolo Bypass flows and causing harm to the salmonids. They emphasized the need for looking at both the positive and negative impact of the project. The applicants explained that the project would be operated with an adaptive management plan.

As a result of these adjustments to the physical ecosystem benefits and CWC staff assessments of their value, the project's total ecosystem benefits were substantially lower than the $3.17 billion originally proposed: $766.4 million, including refuge benefits valued at $432.9 million and the Yolo Bypass flows at $333.5 million.

In July 2018, the Sites Reservoir project was approved for an MCED of $816.4 million (CWC n.d.e) as a Rank 3 project. When additional funds became available, its MCED was adjusted to $875.4 million, including $40.8 million in early funding. In consideration of comments received during the CEQA process, the Sites Project Authority revised the project's diversion criteria to include 10,700 cfs as the minimum flows required to avoid harm to salmonids in the Sacramento River. If flows in the river fall below this value (as measured at Wilkins Slough) between October and June in any water year—either due to project operations or water conditions—the project would have to stop diverting water (Sites Authority 2022).

Willow Springs Water Bank

Project Description

This conjunctive use project, located on the boundary between Los Angeles and Kern counties, would integrate 500,000 af of groundwater storage into the SWP system (CWC n.d.c). The purposes of the project are to enable the Willow Springs Water Bank (WSWB) to improve water management flexibility, to increase south-of-Delta storage capacity, and to allow more water to be stored in Lake Oroville during high-flow events.

Environmental Benefits

According to the application, the WSWB project would enable more water to be made available from Oroville for pulse flow to support juvenile salmon migration in the Feather River by capturing excess Delta flows (RRVWSD and IRWD 2019). Over a 50-year period, it would allocate up to 28,650 af annually to be released in April and May of dry years and 19,000 af in critically dry years. The proponents expect to provide this water in 18 out of these 50 years, which corresponds to an annualized volume of up to 8,800 af per year.[2] The project would not be able to provide any pulse flows following three consecutive dry or critically dry years.

The initial application focused on two ecosystem priorities: (1) providing flows to improve habitat conditions for the migration of juvenile Chinook salmon, and (2) increasing attraction flows during upstream migration to reduce straying of species into non-natal tributaries (CWC 2018f). The total monetized ecosystem benefits were estimated at $765.8 million, including $755.1 million from the emigration of juvenile Chinook and $10.8 million from spring-run adult attraction.

CDFW and CWC Conclusions

After the reviews of CDFW and CWC, the stray rate reduction was removed from the monetized benefits due to insufficient evidence. The staff accepted the benefits to juvenile salmon in the Feather River. Following hearings in May and July 2018, the value of benefits to juvenile Chinook was calculated as $79.1 million—roughly one-tenth of the original estimate. As of 2022, as a Rank 3 project, Willow Springs' maximum conditional eligibility is $128.3 million, including $44.2 million for emergency response (CWC n.d.e; CWC 2022). The project is on track to become operational in 2028.

[2] Personal communication with Willow Springs Water Bank.

Summary of the Projects

In this section, we summarize the component scores, ecosystem benefit scores and values, and final Maximum Conditional Eligibility Determinations. In addition, we examine the total amount of water made available for the environment over time and explore several key uncertainties regarding the reliability of that water.

Table C4 shows the project component scores in the four score categories used by CWC. The commission allocated the funding to projects based on their ranking. No project was eligible as Rank 1 (the highest priority, above 85 points). Four projects (Chino, Harvest, Los Vaqueros, and Pacheco) were categorized as Rank 2 (above 70 points) and received their full requested amount. After these projects were funded, the remaining funds were split between the three Rank 3 projects (Kern Fan, Sites, and Willow Springs).

TABLE C4

Project component score breakdown (%)

	Resiliency	Implementation Risk	Relative Environmental Value	Public Benefit Ratio	Total
Maximum Possible Score	*25*	*15*	*27*	*33*	*100*
Chino Basin Project	13	10	24	23	70
Harvest Water Program	22	15	27	13	77
Kern Fan Project	12	15	13	14	54
Los Vaqueros Reservoir	22	14	17	23	76
Pacheco Reservoir	23	11	21	27	82
Sites Reservoir	21	12	15	13	61
Willow Springs Water Bank	14	10	17	12	53

SOURCES: Chino Basin, Harvest Water Program, Kern Fan, Los Vaqueros, Pacheco, Sites and Willow Springs technical reviews by CWC, WSIP Project Review Portal.

NOTES: Some of the scores presented here were adjusted by the commission before the MCED determinations and may not match the preliminary scores.

Table C5 provides a breakdown of the environmental benefit values of the funded projects, and how these values changed in different stages of the program. As described above, some environmental benefits were valued at $0 following the CWC review if CDFW determined that the claimed benefit would not result in improvements to specified environmental conditions. In later stages, some of the projects were able to provide additional scientific backing to their claim that the improvements would be realized.

TABLE C5

Ecosystem benefits claimed by the projects and their monetized values (in $1,000)

Funded project Ecosystem benefit	Original applicant-proposed values	CWC review	Applicant appeal to the review	CWC response to the appeal	Final CWC-approved values
Chino Basin Conjunctive Use Project	**356,900**	**0**	**215,800**	**76,900**	**103,500**
Flow benefits to salmon	356,900	0	215,800	76,900	103,500
Stray rate reduction*		-	-	-	-
Harvest Water Program	**320,400**	**182,040**	**233,050**	**196,700**	**246,300**

Benefits to salmon	48,900	63,850	63,850	42,200	79,300
Wetland habitat	91,600	49,030	78,400	65,300	73,600
Riparian habitat	25,300	1,660	23,300	21,700	21,700
Greater Sandhill crane habitat	146,100	57,000	57,000	57,000	61,200
Vernal pool habitat	8,500	10,500	10,500	10,500	10,500
Kern Fan Groundwater Storage Project	**60,800**	**34,600**	**129,000**	**54,100**	**61,100**
Flow benefits to salmon	21,000	-	30,800	14,300	21,300
Wetland habitat	39,800	34,600	98,200	39,800	39,800
Los Vaqueros Reservoir Expansion	**1,033,050**	**-**	**607,900**	**490,800**	**490,800**
Fish screen benefits to salmon	29,050	-	900	900	900
Wildlife refuges	1,004,000	-	607,000	489,900	489,900
Pacheco Reservoir Expansion	**722,400**	**10,000**	**720,000**	**721,000**	**721,000**
Benefits to steelhead	716,000	10,000	716,000	716,000	716,000
Wildlife refuges	6,400	-	4,000	5,000	5,000
Sites Reservoir	**3,176,300**	**420,800**	**2,921,100**	**691,500**	**766,400**
Flow benefits to anadromous fish	1,637,100	-	1,616,400	-	-
Wildlife refuges	675,400	420,800	448,100	432,300	432,900
Coldwater pool	595,300	-	597,400	-	-
Yolo Bypass	268,500	-	259,200	259,200	333,500
Willow Springs Water Bank	**765,900**	**-**	**371,800**	**61,100**	**79,100**
Flow benefits to salmon	755,100	-	371,800	61,100	79,100
Stray rate reduction	10,800	-	-	-	-

SOURCES: CWC response to the appeals of Chino Basin, Harvest Water Program, Kern Fan, Los Vaqueros, Pacheco, Sites and Willow Springs; economic analyses obtained via personal communication with CWC staff.

NOTES: Stray rate reduction benefits for the Chino Basin project are included in the salmon flow benefits. In cases where WSIP documents and economic analyses by the CWC reviewers showed discrepancies, CWC reviewers' most recent calculations were used. All values are in thousands of 2018 dollars.

Table C6 provides a general summary of the WSIP-funded projects and compiles the statistics from Tables C4 and C5. The benefit values reported in the table are for ecosystem benefits. The MCED values shown also take into account values of other eligible public benefits that the projects might provide. In late 2020, the Temperance Flat Reservoir Project withdrew from the program, freeing up funding for existing or new projects. Commissioners considered a second solicitation for new projects, but ultimately chose to backfill MCED for three projects that had not received full funding, and to increase funds for all projects to partially account for inflation. The table shows current MCED values after those adjustments (1.5%, following an adjustment of 2.5% in 2021).

TABLE C6

Summary of projects as evaluated by CWC (in $1,000)

Project name	Project duration (years)	Project component score	Original applicant-proposed ecosystem benefit value	Final CWC-approved ecosystem benefit value	2022 MCED
Chino Basin Project	25	70	$356,900	$103,500	$215,265
Harvest Water Program	73	77	$320,400	$246,300	$291,841
Kern Fan Project	50	54	$60,800	$61,100	$89,123
Los Vaqueros Reservoir	91	76	$1,033,050	$490,800	$477,558
Pacheco Reservoir	81	82	$722,400	$721,000	$504,141
Sites Reservoir	78	61	$3,176,300	$766,400	$875,396
Willow Springs Water Bank	50	53	$765,900	$79,100	$128,275
Total			$6,435,750	$2,468,200	$2,581,601

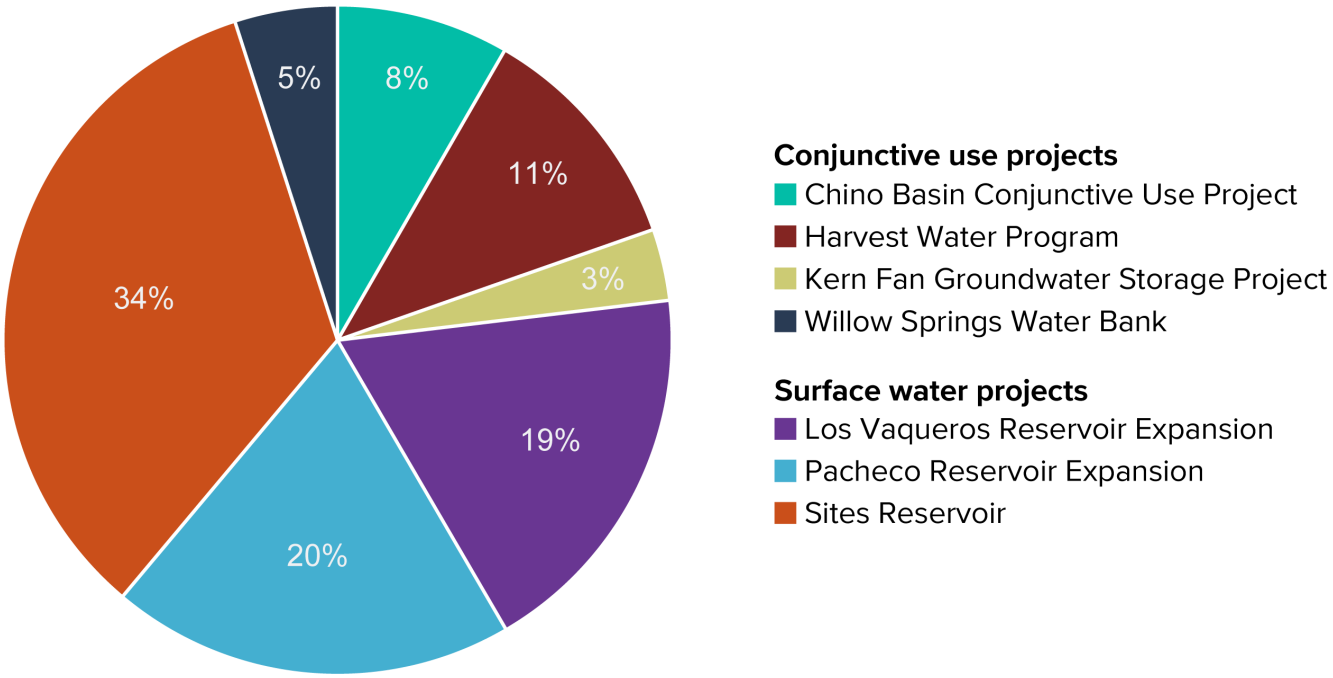
SOURCES: Proposition 1 Water Storage Investment Program, project technical reviews.

NOTES: Project duration indicates the number of years the project will contribute to the goals of Proposition 1. It may be shorter than the lifespan of the project. The benefit values included here only consist of ecosystem benefits. The 2022 MCED is adjusted for inflation based on the 2018 and 2021 MCEDs (2.5% and 1.5% respectively). The Sites Reservoir project's MCED was increased in 2022 by an additional $25 million due to fund availability. A project's MCED value may be higher than double the final CWC-approved ecosystem value due to MCED inflation adjustments. Ecosystem benefits of the Pacheco project exceed MCED because the MCED was limited to 50 percent of project costs. The total statewide bond cost share of the program was estimated at $54 million, and the program delivery cost was estimated at $64.4 million. With these expenses, the bond funding total sums up to $2.7 billion.

The amount of bond funds allocated to WSIP and administered by CWC was $2.7 billion, including $118 million for program administration (bond and program delivery costs). In the end, WSIP funded seven projects, three of which are surface storage reservoirs. The cost allocations (Figure C3) highlight the fact that surface storage projects are expensive in comparison with the conjunctive use projects. If all projects receive their full MCED, the three surface storage projects will have received 73 percent of the total WSIP funding, totaling $1.86 billion. These projects account for a slightly higher share—80 percent—of the final, CWC-approved ecosystem benefit values.

FIGURE C3

Surface water projects received nearly three-quarters of the WSIP funding



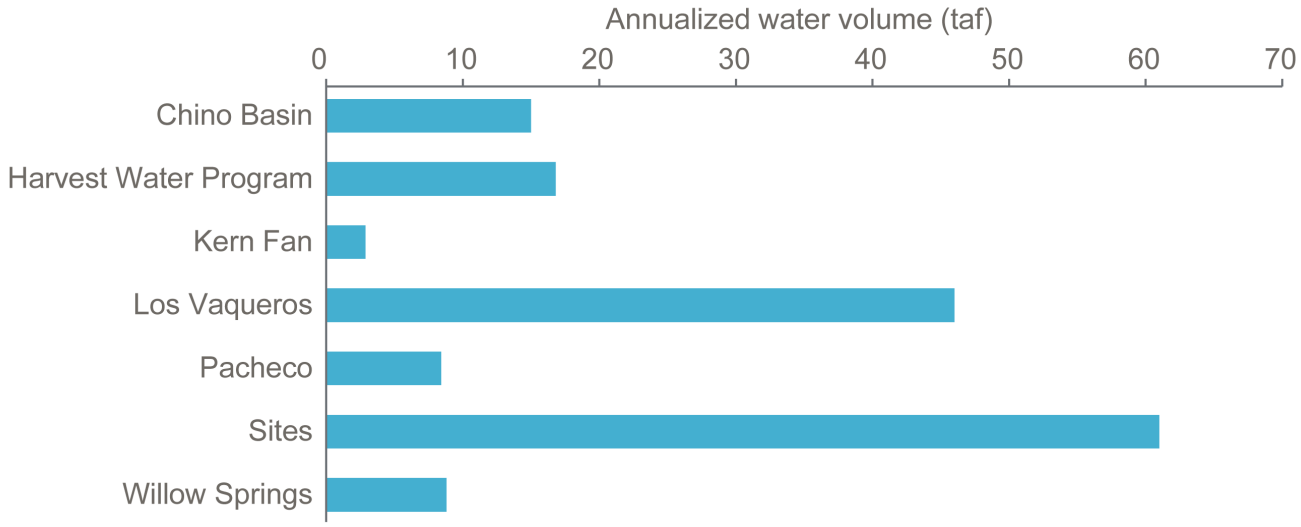
SOURCES: Proposition 1 Water Storage Investment Program.

NOTE: Includes the inflation-adjusted MCEDs from 2022.

Environmental water from WSIP projects

Proposition 1 requires that at least half of the public benefit funding go to ecosystem improvements. To meet that requirement, project applicants described the water that would be used for ecosystem improvement (Figure C4). The schedules for providing water—along with the specific purposes—vary greatly across projects. We have used available documentation to estimate the amount of water that would be made available by these projects once complete and fully operational. In Figure C4 we have taken the amount of water to be released over the life of each project and annualized it for comparison. For the three conjunctive use projects in the southern part of the state, the emphasis is on dry-year supplies; they would not provide supplies for the ecosystem in wetter years. All the other projects would supply water in all years, although for some projects the volume would vary with hydrologic conditions (Figures C5 and C6).

FIGURE C4
Annualized environmental water volumes by project



SOURCES: Author calculations based on WSIP applications and personal communication with the projects.

NOTE: When annualized water volumes were not available, they were calculated by dividing the total volume of water provided over the project lifespan by the project lifespan.

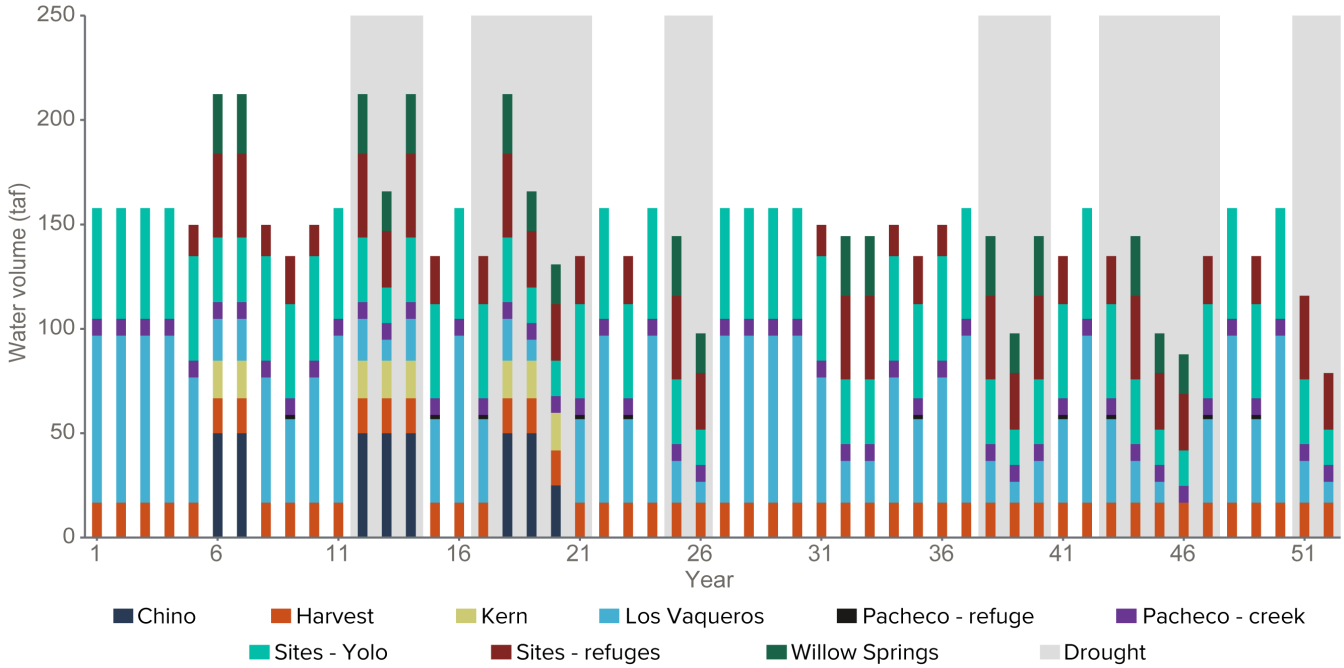
At the time of this writing, the final contracts for water between the project operators and CDFW and DWR are not completed. Although the deals are not final, projects usually promise to deliver water in most dry and critically dry years. However, the volumes released by the projects are subject to change based on project water release rules and other hydrological conditions. For example, some projects may only release water in below-normal water year conditions based on the Sacramento River Index published by DWR, whereas another project may provide pulse flows in dry or critically dry years.

In Figures C5 and C6, we allocated the environmental water provided by the projects across 52 years based on individual project release rules and water year types. Figure C5 shows the distribution of environmental water releases by the project. Figure C6 categorizes the same releases by ecosystem purpose/location. All projects were assumed to be built and operational on the first year of the time series, and water is included only for the duration of the project (Table C6). The water year types are based on the 1996–2021 water years, run twice. The three south-of-Delta conjunctive use projects do not plan environmental water releases after three dry/critically dry years even if the fourth year met the release criteria. The release assumptions used to estimate the water volume for each project are as follows:

- Chino Basin Project: Total of 7.5 50,000-af pulse flows in dry and critically dry years for the first 25 years.
- Harvest Water Program: 16,800 af every year.
- Kern Fan Project: Total of eight 18,000-af pulse flows during dry and critically dry years for 50 years.
- Los Vaqueros Reservoir Expansion: Distributed water volumes across years that add up to an annualized average of 46,000 af.
- Pacheco Reservoir Expansion: 8,000 af for Pacheco Creek every year, 2,000 af for refuges in below normal years only.
- Sites Reservoir: Based on the release schedule of Sites provided by project proponents.
- Willow Springs Water Bank: 28,000 af in dry years and 19,000 af in critically dry years for 50 years

FIGURE C5

An approximation of the combined flows based on project release rules and water year conditions

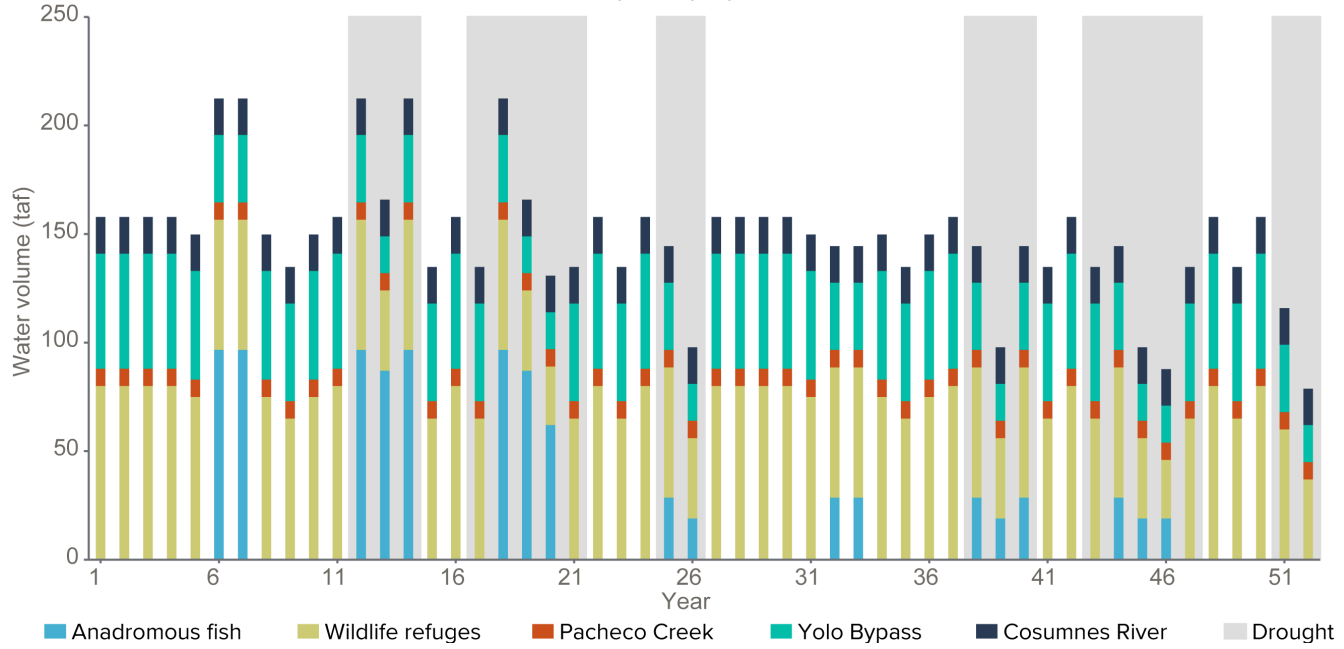


SOURCES: Author calculations based on the WSIP applications and personal communication with project applicants.

NOTES: Hydrologic conditions and drought classifications are based on the Sacramento River Water Year Index between 1996 and 2021, applied twice. This analysis assumes that Chino, Kern Fan, and Willow Springs projects will deliver ecosystem flows in up to three sequential dry and critically dry years. Los Vaqueros' annual water flows were distributed across water year types based on the long-term average, the maximum delivery and the minimum delivery volumes. As of this writing, the rules are still under negotiation. The Chino Basin Project only lasts for 25 years and provides 7.5 pulse flows with the last pulse flow delivered in year 20, Kern Fan Project lasts 50 years and provides 8 pulse flows with the last pulse flow delivered in year 20 also, and Willow Springs lasts for 50 years.

FIGURE C6

Combined environmental water flows based on the ecosystem purpose and/or location



SOURCE: WSIP applications and personal communication with the projects.

NOTE: Anadromous fish category includes Feather River pulse flows provided by Chino Basin, Kern Fan, and Willow Springs projects. Wildlife refuges include the water provided for refuges by Los Vaqueros, Pacheco, and Sites reservoirs. Pacheco Creek includes the flows from the Pacheco Reservoir. Yolo Bypass flows come from the Sites Reservoir. Cosumnes River flows come from the Harvest Water Program. For additional notes on methods and assumptions see Figure C5.

Uncertainties around supply reliability

In modeling the WSIP projects' environmental water releases, we identified several limitations that could undermine the reliability of environmental water supply by the projects during droughts, and particularly extended droughts. Some of these limitations are project-specific, whereas others apply to multiple projects. These include:

- **Dependence on SWP allocations for conjunctive use projects.** The three south-of-Delta conjunctive use projects (Chino, Kern Fan, Willow Springs) mainly rely on Table A exchanges with SWP contractors that receive water from Lake Oroville, with the goal of leaving water in Oroville for pulse flow use. Collectively, if they needed to exchange water at Oroville at the same time, there is a limited number of SWP contractors that could accommodate the exchange of large volumes, with the Metropolitan Water District (MWD) the most likely. The projects could technically conduct exchanges with other Table A contractors, but their reliance on the MWD's Table A allocation is evident from the documentation submitted to CWC. Based on the total maximum pulse flow volume of approximately 97,000 af, the exchanges might become challenging if—as in most dry years—Table A allocations fall under 10 percent. These exchanges would likely be impossible if SWP allocations fall to or below 5 percent. Based on these rules, exchanges that leave water in Oroville would have been challenging in 2020, and impossible in 2014, 2021, and 2022 (SWP 2022; DWR 2022). Given future uncertainty due to climate change, it is unclear how the projects would perform the exchanges even in the first three years of droughts if Table A allocations are low. Cooperation and joint operation with other projects (both WSIP and others) might be worth exploring to minimize the risk of inadequate pulse flows when they are needed the most.
- **Persistent droughts and depletion of surface storage reservoirs.** The CWC and CDFW did not assess the overall performance of the WSIP projects during extended droughts, and there was limited information on how the surface reservoir projects would be operated in such periods. Of greatest concern is the heavy reliance on wet periods to fill off-channel surface reservoirs, along with the high demand for releases for water supply and environmental water during the early stages of a drought. This issue applies to Sites Reservoir, which can only divert and add to storage when flows are relatively high, as well as Los Vaqueros and Pacheco, which rely on exports from the Delta that are greatly reduced during drought (Gartrell et al. 2022). During the 2012–16 drought, reservoir depletion by the third year left little capacity to meet environmental water needs (Mount et al. 2017). This same challenge appeared even earlier in the latest drought—when emergency measures were needed in year 2 (Null et al. 2021; Gartrell et al. 2022), and it is likely to be a significant issue for surface storage projects going forward.[3] Although these projects might be able to mitigate the earlier years of droughts, they may be limited in their capacity to meet environmental flows during extended ones.
- **Initial conditions.** The ability of a project to meet environmental release schedules depend greatly on hydrologic conditions shortly after completion of the project. All of the surface projects—particularly Sites Reservoir—are likely to take years to completely fill. In addition, the three south-of-Delta conjunctive use projects rely on readily available Table A water during their start up. If conditions are dry, these projects are likely to underperform. The only exception is the Harvest Water conjunctive use project, which is supplied by treated wastewater, a more reliable source during dry times.[4]

Based on these three key uncertainties, the estimates of water available for the environment shown in Figures C5 and C6 should be viewed as maximum values. Drought—particularly extended drought—is likely to reduce the volume of water available for the environment.

[3] For example, the Pacheco project applicants state that they would not be able to release water into Pacheco Creek if the reservoir storage drops to less than 39 percent of total capacity in a drought, arguably when fish need the flows the most.

[4] As Chappelle et al. (2019) describe, even this source has some impacts during dry years—when indoor water conservation tends to further increase, reducing wastewater volumes. But recycled wastewater is considerably more reliable than supplies depending directly on precipitation.

Assessment of WSIP projects

WSIP aims to support the construction of new surface and groundwater storage by paying for the public benefit portion of these projects. Its over-arching goal is to improve the drought resilience of California's freshwater ecosystems, especially the Sacramento–San Joaquin Delta.

Although WSIP is still in the early stages of implementation, it is worthwhile to evaluate the program's novel approach to incentivizing and funding environmental water supply—especially if this approach is to be used in the future to augment storage available for the environment (see main report). Here we identify five issues to consider in the future.

- **Projects were encouraged to be adaptive and multi-benefit, but benefits were defined narrowly.** Our review of documentation showed a disconnect between the desire to support multi-benefit projects and the methods used to calculate public benefit values that ultimately dictated the amount of money to be allocated to these projects. WSIP's component score system was structured to incentivize multi-benefit projects. The REV scoring system granted bonus scores to the projects based on how many CDFW priorities (Table C2) the projects could address. The scoring system also accounted for adaptive management needs, flexibility, habitat connectivity and climate change adaptation. Yet there was an inherent tension between this broad approach to considering benefits and the need to monetize them for purposes of awarding funds. To assign dollar values, eligible public benefits had to be narrowly defined, and environmental improvements had to be measurable and specific. Similarly, the contracts currently under negotiation between CDFW and project operators are highly prescriptive on certain key operational criteria such as defining the precise location and timing of releases—factors that could reduce the projects' ability to respond to changing conditions and species needs. A funding and management approach that allows for more operational flexibility—including the ability to coordinate operations with other projects—would likely be better at meeting ecosystem goals.
- **The bottom-up approach may not be best for the environment.** Although CDFW developed an expansive list of ecosystem priorities for projects to be used in CWC's evaluation process, there was no organized effort to address specific or geographically-focused ecosystem objectives, beyond the goal of creating benefit for the Delta and its watershed. Instead, the water supply projects currently in the pipeline all worked to carve out water for the environment in order to cover a portion of their costs. None—with the possible exception of Sites Reservoir—were designed with the environment as a priority. If the goal of a future bond effort like this is to have significant ecosystem benefits, and make the environment a true priority—rather than an ancillary benefit—there should be a greater emphasis on projects that, working together, achieve a specific set of environmental objectives. It might also be worthwhile to seek projects that create a higher overall environmental return on investment when developed and operated jointly.
- **Quantification of ecosystem benefits is inherently difficult.** The WSIP rules aimed to ensure that the eligible projects would be compensated to the extent of the public benefits that they could deliver, in keeping with the requirements of the bond itself. In order to comply with these rules, the projects were required to quantify their physical ecosystem benefits and then assign monetary value to those benefits. The process of quantifying ecosystem benefits proved highly contentious, principally because different approaches can lead to vastly different results, making the process seem highly subjective. One way around this in the future is to target specific ecosystem processes in specific geographic areas deemed to be a priority. This could include clear methods to quantify those benefits for monetization purposes. This pivot would encourage the development of projects that meet environmental goals, rather than treating the environment as an ancillary benefit.
- **Monetizing benefits is also challenging.** The bond act sets narrow requirements on the portion of the project that could be funded by the bond, and it requires that public benefits (including ecosystem benefits) be monetized to ensure that these requirements are met. While CWC specified the allowable analytical approaches to calculate ecosystem benefits, it did not always specify the numbers and assumptions to be used. This approach may reflect both the inherent challenge of data unavailability and the desire to be

flexible. But it resulted in large discrepancies between the monetary analyses of applicants and reviewers, and often fueled controversy and confusion. A more systematic approach—perhaps administered by a third party—might have made the monetization process clearer and less controversial. And an entirely different approach—"reverse auctions"—could satisfy the objective of spending public dollars wisely without a need for explicit monetization of benefits. In this approach CDFW would determine the amount of water needed to improve the conditions in critical watersheds and would conduct a "reverse auction" to acquire the water, taking the less expensive bids first. Project proponents in these watersheds would propose the amount of no-strings-attached water they could provide, at what cost, and the projects offering well-founded, cost-effective bids would qualify for funding.[5]

- **WSIP does not cover the O&M costs of providing environmental water.** Proposition 1 funding provides some adjustments for inflation during the construction phase or projects, but it does not cover their operations and maintenance (O&M) costs once the projects become operational. This is because general obligation bonds cannot be spent on O&M expenses. Since all seven projects have major non-public water use components, the lack of public funding to support O&M for their ecosystem water components may not be a major issue. However, if future bonds support projects more focused on delivering environmental water, it may be necessary to explore other ways to cover the associated O&M costs. One possibility would be to include in bond language the requirement that O&M costs of bond-funded environmental investments be supported by the General Fund (Pottinger 2018).

Conclusion

WSIP is a novel experiment in investing in infrastructure projects that could deliver benefits for the public with public dollars. The process of awarding funding to qualified projects was slow and deliberative by design, because the statute put strict limits on the funding based on the environmental improvement projects would provide (Alvarado 2022). This required a standardized approach and precise quantification of benefits based on a narrow range of operations. The program also sought to promote projects that aimed to be adaptive and multi-benefit. The challenge was to reconcile these two sometimes conflicting objectives. And while all WSIP projects had to provide ecosystem improvements within the greater Sacramento–San Joaquin Delta watershed, the bottom-up, project-by-project approach used may ultimately result in environmental benefits that are marginal, uncoordinated, and scattered.

It is important to recognize that WSIP had to balance two priorities at once: ensuring that public dollars are used to strictly fund public benefits, and that the funds are distributed efficiently and in a timely manner to strengthen California's drought resilience. Despite the challenges faced in the administration of the program, this new approach to public investment creates new possibilities in funding infrastructure. Future attempts could benefit from the groundwork laid by the WSIP process and build on the experience acquired.

[5] This approach has been used effectively to acquire water for surrogate wetland habitat in Sacramento Valley rice fields as part of the "Bird Returns" program launched during the 2012–16 drought (California Ricelands Waterbird Foundation n.d.; The Nature Conservancy n.d.). The Bird Returns reverse auctions are for single-year deliveries of water, so inherently less complex than multi-year commitments needed to fund large storage projects. For storage projects, this approach would require substantial staff evaluation to validate the projects' future capacity to deliver.

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