Funding the Flow: Federal Water Conservation Investments in the Colorado River Basin

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Federal funding has been crucial in addressing the rising water supply and demand imbalance in the Colorado River Basin (CRB). We examine the U.S. Bureau of Reclamation (USBR) funding allocation trends for 469 projects in the CRB over the last 20 years. Out of the total $1.1 billion (in 2023 dollars) allocated, 40% went to supply expansion, 29% to agriculture, 21% to infrastructure, 8% to municipal, and just 2% to environmental projects. CRB-related projects in California received 49% of these funds. We analyze the cost per acre-foot of water saved across these projects.

The Colorado River supplies water to about 40 million people in seven U.S. states and Mexico and irrigates nearly 4 million acres of farmland. Southern California relies on the river for roughly one-third of its urban water and much of its agricultural needs, especially in Imperial and Riverside counties. However, the CRB faces a significant water supply and demand imbalance driven by prolonged droughts, complex historical water agreements, and the growing impacts of climate change. Various policy interventions try to address this challenge, with federal government funding for supply and demand management being a key component.

The USBR, a federal agency that manages water resources in the CRB, has provided grant funding for water conservation across basin states for decades. While numerous studies have examined water scarcity and policy interventions in the CRB, there has not been a comprehensive analysis of USBR funding trends across the basin, the allocation of funds across various sectors, or the cost per acre-foot of water generated through these projects. This article sheds light on these gaps, with a focus on California.

To do so, we compiled a dataset analyzing USBR grant programs for the basin states over the past 20 years (2004–2024) for programs that fund water conservation projects. Water conservation in these programs is defined as reducing CRB water use and allowing water from the Colorado River to be available for other uses. The dataset includes total funding allocation, projects funded, and estimated annual water savings from each project.

We categorized each project into the following categories: agricultural, environmental, infrastructure, municipal, and supply expansion projects. Agricultural projects involved land fallowing or modification of irrigation methods to reduce water consumption. Environmental projects focused on habitat protection or restoration to improve water quality and ecosystem health. Infrastructure projects aimed to conserve CRB water through infrastructure improvements, such as reducing leakages by repairing or replacing existing malfunctioning systems. Municipal projects targeted residential and city-owned property within urban areas to improve efficiency. Supply expansion projects, such as recharge or storage projects, included those designed to increase future water availability by capturing additional water or generating water savings through reduced consumptive use.

Total Allocation of Funding

We analyzed 469 projects across 10 programs between 2004–2024. These projects were implemented in over 250 irrigation districts and municipalities across all seven CRB states. The total funding across these programs was about $1.1 billion in constant 2023 dollars. This amount was distributed among the five project categories: agriculture ($313 million), environmental ($16.6 million), infrastructure ($227.4 million), municipal ($91 million), and supply expansion ($437 million). The USBR allocated 5.8% of the funding to projects in locations within the Upper Basin, 75.6% to those in the Lower Basin, and 18.6% was designated for Tribal areas, some of which span both the Upper Basin and Lower Basin. California received 49% of the total CRB funding we analyzed over the past 20 years, which amounted to $527 million (in constant 2023 dollars), distributed across 177 projects.

California's agricultural sector was a major recipient of USBR funding, receiving 44% of all California funds. Agricultural conservation efforts focus on irrigation efficiency, farmland fallowing, and deficit irrigation, with high water-saving potential but varying cost-effectiveness. Infrastructure projects—such as funding for desalination projects, water recycling facilities, automation of canals, and well construction—received 29% of California's funding. Infrastructure projects are costly but result in long-term efficiency improvements for water conservation. Municipal projects—such as residential metering upgrades and turf removal programs—are often politically favored but have higher costs per acre-foot saved compared to other sectors; they received 12% of California's funding. Fourteen percent of funding went toward projects that would increase water supply, such as paying irrigation

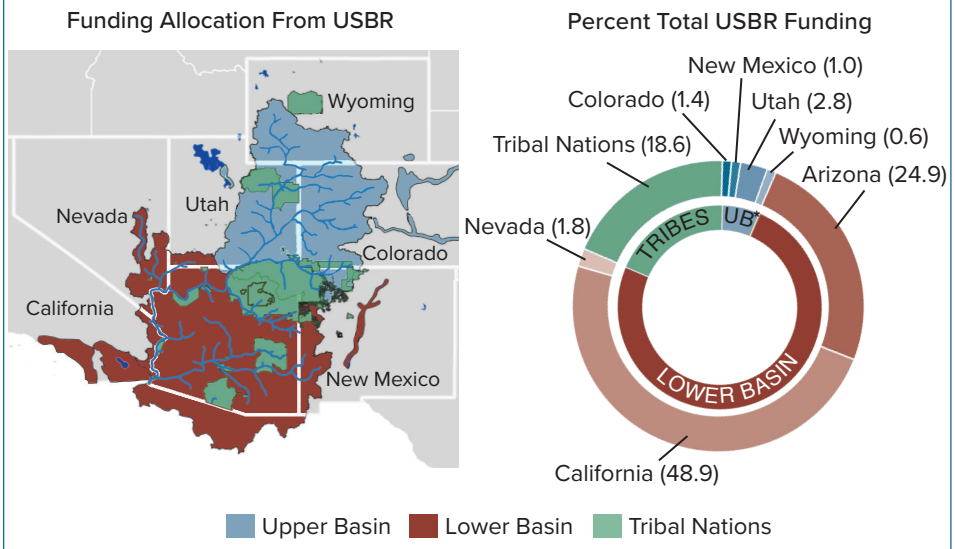
districts to reduce their water use and increasing storage capacity; these projects have expensive upfront costs but contribute to long-term water supply security. The remaining 1% went to environmentally focused wetlands restoration projects. Figure 1 provides the distribution of the USBR funding allocations within the basin by state.

Estimated Cost of Water by Project

U.S. Bureau of Reclamation programs require participating entities to propose the project costs and water savings estimates for water conservation projects. Ex-ante water savings estimates refer to projected or anticipated water savings before a conservation project is implemented. Grant programs often require these estimates in order to forecast the achievements of programmatic conservation goals. These estimates typically include annual water savings or conserved consumptive use (CCU)—the amount of water expected to be saved through efficiency improvements, infrastructure upgrades, or conservation measures.

Since they are based on modeling or engineering estimates, they may differ from realized savings after project implementation because of economic factors and behavioral responses.

Figure 1. U.S. Bureau of Reclamation Funding Allocation by State



Source: Authors' calculations.

Note: Total Funding = $1,100,233,727. *UB = Upper Basin.

Table 1. Estimated Cost Per Acre-Foot of Conserved Water

Sector	Number of Projects	Cost Per Acre-Foot of Water Saved ($/AF)		
		Minimum	Average	Maximum
Agriculture	6	257	405	777
Environmental	3	668	2,478	5,552
Infrastructure	69	1.01	2,987	52,066
Municipal	95	0.33	6,309	52,442
Supply Expansion	4	400	4,697	9,701

Source: Authors' calculations.

Note: This table presents the cost per acre-foot of water saved by sector in California. A project that costs $200,000 per acre-foot in the municipal category was excluded from the analysis. The minimum and maximum values were determined by calculating the average of the minimum and maximum values across projects, grouped by their type.

Although lacking a common approach, these estimates establish clear guidelines for funding allocation and offer valuable insights for future planning. The accuracy of ex-ante estimates depends on factors such as data availability, regional hydrology, and methodologies used, which can vary widely across programs and locations.

The cycle of water management typically involves three key steps: planning, implementation, and evaluation. As previously mentioned, the ex-ante estimates used in this paper are primarily intended for planning purposes. While the USBR also uses these estimates for evaluation, they often lack consideration of behavioral responses. Such ex-ante estimates tend to overestimate actual outcomes. This cyclical process reflects a learning framework, where evaluation results offer valuable insights that can improve planning in subsequent cycles.

As shown in Table 1, the cost per acre-foot of water saved in California varied significantly by project type. On average, agricultural projects were the most cost-effective, with costs ranging from $257 to $777 per acre-foot of water saved. Environmental projects followed, with a cost of between $668 and $5,552 per acre-foot saved. Infrastructure projects showed a wider range, from $1 to $52,066 per acre-foot saved, while municipal projects ranged from $0.33 to $54,200 per acre-foot saved. Supply expansion projects fell within a range of $400 to $4,400 saved per acre-foot.

Within the municipal sector, the most common project types were adoption of advanced metering infrastructure (AMI) and turf removal. These two categories alone represented about 71% of all municipal projects. Advanced metering infrastructure projects in the municipal sector had an average cost of $5,419 per acre-foot of water saved, though this figure was

heavily influenced by outliers, with some projects costing up to ten times the average.

In the infrastructure sector, recycling facilities and well construction were the most frequent, together making up 48% of the sector's projects. Recycling facilities in the infrastructure sector had an average cost of $2,474 per acre-foot of water saved. Turf removal—the third most frequent project type—had the highest average cost among the three, at $10,892 per acre-foot of water saved.

From our analysis of the agricultural sector, the most efficient project type was switching irrigation methods, while the least efficient type was combining fallowing and split-season deficit irrigation on farmland. In the environmental sector, the most efficient projects increased storage for environmental projects, while the least efficient projects restored wetlands. For infrastructure and municipal sectors, the most efficient projects were adopting supervisory control and data acquisition (SCADA) systems that automate operations, while the least efficient projects were hydroelectric projects and water recycling facilities, respectively. For supply expansion, the most efficient project was storage expansion (i.e., for capacity increases), while the least efficient was paying water districts to reduce their use.

The time span of a project and its objectives are crucial aspects for assessing its adequacy. Long-term projects often involve technological advancements and investments aimed at enhancing water supply, with the primary objective of improving the reliability of the water system. These types of projects require time to be implemented, and their effects are not immediate. On the other hand, short-term projects, such as fallowing, are typically designed to address supply crises when water demand needs to be reduced.

Conclusions

Alternative water conservation projects are being implemented throughout the CRB, presenting a valuable opportunity to address growing imbalances between supply and demand. We estimated the cost per acre-foot of water saved for various conservation projects funded by the USBR. Our analysis revealed significant cost variation across project types. Agricultural sector projects were the most cost-effective, with an average cost of $405 per acre-foot saved. In contrast, municipal sector projects were the most expensive, averaging $6,309 per acre-foot saved.

These findings carry important policy implications. As climate change and rising demand intensify water scarcity, it is critical for policymakers to prioritize federal investments based on cost-effectiveness. While no single solution can address the CRB's challenges, a diverse and strategic portfolio is essential. Focusing first on the most efficient options—particularly agricultural conservation—offers the best return on investment and impact.

In addition, while promoting conserved consumptive use is an important step toward improving water efficiency, its effectiveness as a water management policy depends on how the conserved water is managed. Without clear restrictions or targets, such as limits on expanded irrigated acreage or mechanisms to ensure that conserved water remains in-stream, there is a risk that efficiency gains could lead to increased total water use. Additionally, refining the methodologies for analyzing ex-post water savings (estimated based on actual water savings rather than anticipated savings) can enhance accountability and optimize funding allocation to maximize CRB conservation benefits.

Finally, we note that between 2004 and 2014, an average of seven projects were funded annually, which increased to an average of 38 funded annually between 2015 and 2024. The most abundant year for projects was 2023, with 52 projects funded, likely attributable to the 2022 Inflation Reduction Act (IRA) allocations. The current administration's recent funding freezes will likely constrain future allocations and hinder California's progress in meeting conservation goals. The future availability of IRA funds will influence the scale of investments and the capacity of federal agencies to implement long-term projects.

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For additional information, the authors recommend:

Dinar, Ariel and David Zilberman. 1991. "The Economics of Resource-Conservation, Pollution-Reduction Technology Selection: The Case of Irrigation Water." *Resources and Energy* 13(4): 323–348. Available at: https://tinyurl.com/5dwm5vc5.