acre-feet. However, this assumes that 100 percent of deep percolation is recovered and recycled. A recent federal-state study indicates that a substantial portion of deep percolation may not be recycled, either, because quality is poor or perched water tables are formed and the resulting drainage water is evaporated or exported from the basin.

Dudek and Horner used a mathematical programming model based on 400 soil-specific locations in the Valley. The model was linked to a mass balance hydrology model of the unconfined aquifer for the same soil-specific locations. Data on cropping patterns, water applications, groundwater pumping, deep percolation, and unconfined aquifer depths were used to estimate the amount of unconfined pumping needed to maintain historical aquifer depths. This procedure yielded an estimated 2.32 million acre-feet as unrecovered recoverable return flows, which include estimates of both unused surface return flows and unused deep percolation. This amount is equivalent to 13 percent of the water applied in the San Joaquin Valley and to 17 percent of the developed water supply. Admittedly, this is a crude estimate that could be refined by measuring the incidental evapotranspiration and unused return flows that occur in the San Joaquin Valley.

In conclusion, data from the *California Water Atlas* and a corroborating mass balance study leave little doubt that conserving irrigation water has the potential for supplying a substantial amount of water that could be used in agriculture. To assume that improving first-use irrigation efficiency has no impact on the net supply of water in the San Joaquin Valley ignores the existing data for the region. The Water Atlas indicates that 1.6 million acre-feet of surface return flows are available for reuse, and Dudek and Horner estimate that 1.71 million acre-feet are available from unused surface return flows and another 0.61 million acre-feet are available from unused deep percolation. The total 2.32 million acre-feet are available for reuse in agriculture at various costs ranging from almost nothing to relatively high amounts. The optimal amount of reuse should be determined by estimating the financial rewards for reducing on-farm water use. In comparison, the combined safe yield of enlarged Shasta, Auburn, Cottonwood, and Los Vaqueros reservoirs is 2.26 million acre-feet with costs ranging up to $300 per acre-foot. As an alternative method of meeting the projected deficit, voluntary on-farm conservation has significant potential.

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What is conservation?

Charles V. Moore

Conservation is often perceived simply as "using less," but most water conservation activities affect the state of the system in three other ways: First, these activities change the time in which the resource is used: for example, a storage dam changes water flows from the time of surplus in the spring to the summer, when water is scarce and has a higher use value. Second, reducing use through more efficient irrigation makes it possible to move the water saved to another location where its value in use is higher. Third, conservation is related to quality, the concentration of existing salts in irrigation water and addition of salts from the soil. Since concentrated salts cause taste problems and shorten equipment life, users of recycled irrigation water and urban wastewater operate at a cost disadvantage in comparison with those in other areas without these problems.

Conservation is often defined as "wise use." This raises the questions of wise use for whom, when, where, and at what cost? Section 102 of the California Water Code states, in essence, that the limited water supply belongs to the people of the state. To maximize statewide benefits (gross state income is one measure), water must be allocated and used efficiently at every level with respect to timing, location, and quality. The ultimate goal of conservation is to use the resource so efficiently that no further change could be made that would increase the net benefits to the state.

Conservation is a concept. Maximum benefits are the goal. What is implemented are practices and investments including additional storage, transfer, water use technology, and water quality factors.

The major institutional impediment to reaching this goal is the failure of laws and institutions to send a clear signal to all water users indicating the true scarcity value of water. Resource economists are in general agreement that a quasi-market for water would be the most efficient method of providing such a signal.

Final users now analyze their investments in conservation based on the nominal charges for water and not on its scarcity value to the state. Increased economic efficiency by the user, whether agricultural or urban, requires that water be treated as any other input in a production process: water should be applied until the cost of the last unit applied is just equal to its unit value in use. Investment in water-conserving activities is optimized in the same way. Economic concepts such as marginal cost pricing are as necessary as engineering technologies if conservation is to be implemented.

Agricultural water use and return flows in California and the San Joaquin Valley

	California	San Joaquin Valley	
Source	Water Atlas*	Water Atlas*	Dudek & Horner†
	million acre feet		
Developed water supply	21.90	11.33	13.31
Irrigation water applied	31.60	16.35	17.40
Deep percolation	6.20	3.21	2.39
Deep percolation recycled	6.20	3.21	1.78
Surface return flow	7.70	3.98	4.24
Surface return flows recycled	4.20	2.17	2.31
Surface return flows used for saline repulsion	0.40	0.21	0.22
Unrecovered recoverable return flows	3.10	1.60	2.32
Percent of:	%		
water applied	9.81	9.79	13.33
water supply	14.16	14.12	17.43

NOTE: Two other California Dept. of Water Resources studies support these results: *The Hydrologic-Economic Model of the San Joaquin Valley*, Bulletin 214, Dec. 1982, and the State Linear Programming Model, prepared by D. Turner.

* *California Water Atlas*, prepared by Governor's Office of Planning and Research and California Department of Water Resources, Sacramento, 1979.

† Daniel J. Dudek and Gerald L. Horner, "Integrated Physical Economic Resource Analysis: A Case Study of the San Joaquin Valley," U.S. Environmental Protection Agency Research Agreement No. 12-7-16-8-1985, Final Report (forthcoming).