

Evaluation of the Hydrologic System and Selected Water-Management Alternatives in the Owens Valley, California

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"We shall not cease from exploration and the end of all our exploring will be to arrive where we started and know the place for the first time."

—T.S. Eliot

Abstract

The Owens Valley, a long, narrow valley along the east side of the Sierra Nevada in east-central California, is the main source of water for the city of Los Angeles. The city diverts most of the surface water in the valley into the Owens River–Los Angeles Aqueduct system, which transports the water more than 200 miles south to areas of distribution and use. Additionally, ground water is pumped or flows from wells to supplement the surface-water diversions to the river–aqueduct system. Pumpage from wells needed to supplement water export has increased since 1970, when a second aqueduct was put into service, and local residents have expressed concerns that the increased pumping may have a detrimental effect on the environment and the native vegetation (indigenous alkaline scrub and meadow plant communities) in the valley. Native vegetation on the valley floor depends on soil moisture derived from precipitation and from the unconfined part of a multilayered ground-water system. This report, which describes the evaluation of the hydrologic system and selected water-management alternatives, is one in a series designed to identify the effects that ground-water pumping has on native vegetation and evaluate alternative strategies to mitigate any adverse effects caused by pumping.

The hydrologic system of the Owens Valley can be conceptualized as having three parts: (1) an

unsaturated zone affected by precipitation and evapotranspiration; (2) a surface-water system composed of the Owens River, the Los Angeles Aqueduct, tributary streams, canals, ditches, and ponds; and (3) a saturated ground-water system contained in the valley fill.

Analysis of the hydrologic system was aided by development of a ground-water flow model of the "aquifer system," which is defined as the most active part of the ground-water system and which includes nearly all of the Owens Valley except for the area surrounding the Owens Lake. The model was calibrated and verified for water years 1963–88 and used to evaluate general concepts of the hydrologic system and the effects of past water-management practices. The model also was used to evaluate the likely effects of selected water-management alternatives designed to lessen the adverse effects of ground-water pumping on native vegetation.

Results of the model simulations confirm that a major change in the hydrologic system was caused by the additional export of water from the valley beginning in 1970. Average ground-water pumpage increased by a factor of five, discharge from springs decreased almost to zero, reaches of the Owens River that previously had gained water from the aquifer system began losing water, and total evapotranspiration by native plants decreased by about 35 percent.

Water-management practices as of 1988 were defined and evaluated using the model. Simulation results indicate that increased ground-water pumpage since 1985 for enhancement and mitigation projects within the Owens Valley has further stressed the aquifer system and resulted in declines of the water table and reduced evapotranspiration. Most of the water-table declines are beneath the western alluvial fans and in the immediate vicinity of production wells. The water-table altitude beneath the valley floor has remained relatively constant over time because of hydrologic buffers, such as evapotranspiration, springs, and permanent surface-water features. These buffers adjust the quantity of water exchanged with the aquifer system and effectively minimize variations in water-table altitude. The widespread presence of hydrologic buffers is the primary reason the water-table altitude beneath the valley floor has remained relatively constant since 1970 despite major changes in the type and location of ground-water discharge.

Evaluation of selected water-management alternatives indicates that long-term variations in average runoff to the Owens Valley of as much as 10 percent will not have a significant effect on the water-table altitude. However, reductions in pumpage to an average annual value of about 75,000 acre-ft/yr are needed to maintain the water table at the same altitude as observed during water year 1984. A 9-year transient simulation of dry, average, and wet conditions indicates that the aquifer system takes several years to recover from increased pumping during a drought, even when followed by average and above-average runoff and recharge. Increasing recharge from selected tributary streams by additional diversion of high flows onto the alluvial fans, increasing artificial recharge near well fields, and allocating more pumpage to the Bishop area may be useful in mitigating the adverse effects on native vegetation caused by drought and short-term increases in pumpage.

Analysis of the optimal use of the existing well fields to minimize drawdown of the water table indicates no significant lessening of adverse effects on native vegetation at any of the well

fields at the end of a 1-year simulation. Some improvement might result from pumping from a few high-capacity wells in a small area, such as the Thibaut–Sawmill well field; pumping from the upper elevations of alluvial fans, such as the Bishop well field; or pumping in an area surrounded by irrigated lands, such as the Big Pine well field. Use of these water-management techniques would provide some flexibility in management from one year to another, but would not solve the basic problem that increased ground-water pumpage causes decreases in evapotranspiration and in the biomass of native vegetation. Furthermore, the highly transmissive and narrow aquifer system will transmit the effects of pumping to other more sensitive areas of the valley within a couple of years.

Other possible changes in water management that might be useful in minimizing the short-term effects of pumping on native vegetation include sealing well perforations in the unconfined part of the aquifer system; rotating pumpage among well fields; continuing or renewing use of unlined surface-water features such as canals and ditches; developing recharge and extraction facilities in deeper volcanic deposits near Big Pine or in alluvial fan deposits along the east side of the valley; installing additional wells along the west side of the Owens Lake; and conjunctively using other ground-water basins between the Owens Valley and Los Angeles to store exported water for subsequent extraction and use during droughts.

INTRODUCTION

The Owens Valley, a long, narrow valley along the east flank of the Sierra Nevada in east-central California (fig. 1), is the main source of water for the city of Los Angeles. Precipitation in the Sierra Nevada and the Inyo and the White Mountains, which surround the valley, results in an abundance of water flowing into this high desert basin. Because the valley has no surface-water outlet, streams historically have flowed into the Owens Lake, a large saline body of water at the south end of the valley, and evaporated.