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Water

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So water managers are turning to techniques such as groundwater recharge, water recycling, storm water capture and desalination to get the most out of every drop of water that does come, either in the form of surface deliveries or rain.

Southern California's large urban centers have taken the lead in developing many of these methods. For instance, the Kraemer Basin in Anaheim, Calif., is just one of the Orange County Water District's groundwater recharge basins and provides much of the county's drinking water.

Many of the groundwater basins in Southern California were adjudicated long before the Legislature passed new statewide groundwater controls in 2014, and watermasters have authority to regulate extractions.

"These same groundwater basins that store storm water when it's available also ... take imported water," said Rich Mills, the state Department of Water Resources' chief of water recycling and desalination.

A simple idea

Pumping water from rivers during high flows to restore depleted underground aquifers is a deceptively simple idea.

While the basic concept may seem obvious, it's fraught with practical challenges — particularly for agriculture, since treating, pumping and conveying water entails increased costs that threaten to erase slim profits.

The aquifer storage and recovery system used by the City of Pendleton, Ore., shows how the process can be adopted successfully but also highlights the economic complications it presents to farmers.

"The key to aquifer storage and recovery is it doesn't work everywhere," said Bob Patterson, the municipality's public works director.

In Pendleton's case, the system evolved over time as the city's traditional water sources couldn't keep up with the demands of its population.

The city once relied on groundwater for more than 60 percent of its needs. It was supplemented with springwater.

In the 1990s, the city began examining new water options because its spring source was no longer sufficient. Meanwhile, the groundwater level in its aquifer was dropping 3.4 feet a year.

Though Pendleton had water rights to draw from the Umatilla River, that amount was still inadequate to meet its peak summer demand for landscape irrigation.

Storing winter water for later usage was a possible solution, but building an above-ground reservoir was expensive and potential locations were limited.

The city instead turned to aquifer storage and recovery, or ASR, forcing surface water through wells to help replenish groundwater.

"We're using the aquifer to store water," Patterson

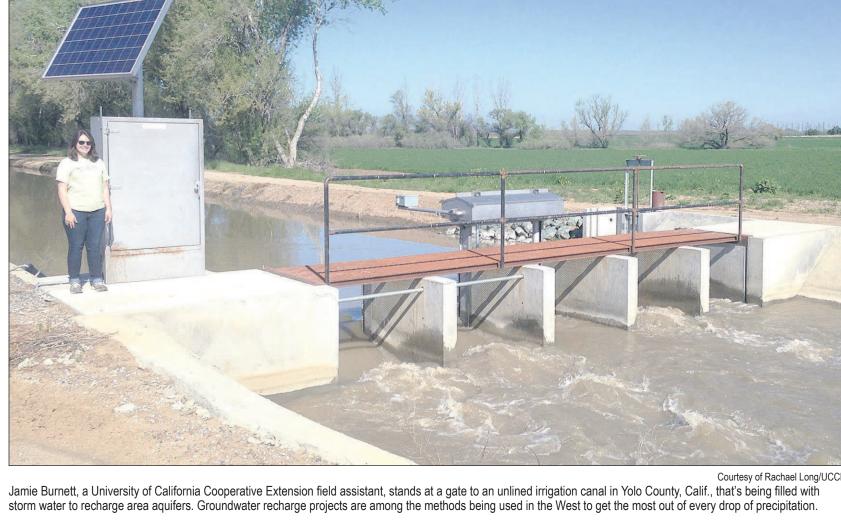
The city upgraded five wells to pump water into and out of the aquifer at a cost of \$750,000, less than onetenth the cost of a reservoir system that had been under consideration.

Pendleton also about \$950,000 outfitting the wells with small hydroelectric turbines to reduce the annual power expenses involved in pumping

Water usage drops off significantly during winter, so the city can divert roughly 80 percent of the amount it withdraws from the river into the aquifer during that portion of the year.

Surface water drawn directly from the river or from stored capacity has supplied about 87 percent of Pendleton's total demand since ASR began in 2003, with the rest drawn from native groundwater.

The shift to surface water



Courtesy of Rachael Long/UCCE



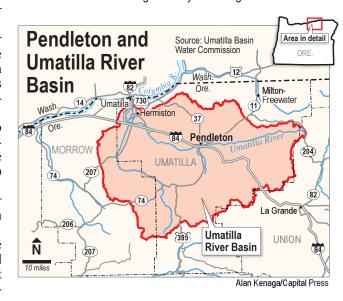
Courtesy of Calif. Dept. of Water Resources

The Coachella Valley Water District's Thomas E. Levy Groundwater Replenishment Facility in Southern California percolates imported Colorado River water into the eastern subbasin of the Coachella Valley's aquifer, replenishing 40,000 acre-feet of water annually.



Courtesy of Calif. Dept. of Water Resources

Anaheim Lake in Anaheim, Calif., is one of Orange County Water District's groundwater recharge basins. The district is responsible for managing the vast groundwater basin that provides most of northern and central Orange County's drinking water.



has greatly helped to conserve the aquifer, Patterson said.

The city's dependence on native groundwater further declined as the ASR program expanded and its consumption is now entirely met by surface water.

In 2014, for example, nearly 9 percent of the 842 million gallons diverted into storage were left in the aqui-

Groundwater levels are still declining, largely due to nearby irrigation withdrawals, but the rate has been reduced more than 75 percent, to an average 0.8 feet a year, Patterson said.

"We want to recover a balance to where we no longer have a decline," he said. Pendleton has used less

Oregon law, surface water pumped into the aquifer can't diminish the quality of the water already in it, he

native groundwater since

2012, when it converted additional wells to ASR and

expanded the capacity of its

water treatment plant, which

plays a key role in the sys-

lion building the plant in

2003 with the capacity to

treat 10 million gallons of

water per day, but the fa-

cility's footprint allows for

expansion to 15 million gal-

good position," Patterson

necessary because, under

"We're sitting in a very

The treatment facility is

lons per day.

said.

The city spent \$6.4 mil-

Filtration also makes sense for a practical reason: Removing sediment prevents it from plugging cavities in the aquifer and obstructing the recharge process, he said.

Cost an issue for ag

Pendleton is able to make the system pencil out financially in part because it uses a relatively small amount of water, at least compared to agriculture.

Municipalities, however, recover their costs from ratepayers who can afford to pay a higher price for drinking water than farmers can for irrigation water.

Growers in the region can't simply raise their prices to build a water treatment facility and upgrade wells to an ASR system — they're paid based on crop values set by the market.

For farmers in the nearby Umatilla basin to break even financially, that means spending no more on water than \$157 per acre-foot, the equivalent of nearly 326,000 gallons, said J.R. Cook, director of the Northeast Oregon Water Association, a nonprofit aiming to improve irrigation in the region.

Realistically, the combined cost of the ASR process and pumping water back out of the aquifer will exceed \$157 per acre-foot, he said.

The only way to make ASR work economically for agriculture is to blend that water with less expensive sources over the course of the irrigation season so the total cost falls below the break-even point, Cook said.

For example, in a drought year such as 2015, farmers may run out of surface water before irrigation demand

peaks in late summer. If they could build up groundwater supplies and tap into that more expensive water to get a full irrigation season, it may be worthwhile as long as the early-season water is sufficiently cheaper, he said.

The ASR process is used to replenish deeper, confined aquifers whose non-porous layers allow for better longterm storage, but it's also possible to recharge shallower, unconfined aquifers, Cook said.

These unconfined aquifers store water for less time but they're recharged with precipitation, water can be returned to them by filling a flood plain instead of through upgraded wells, he

Water recycling

In California's Monterey County, where salty ocean water has intruded into aquifers, a project in Castroville has attempted to treat wastewater and put it back into the groundwater supply to slow the intrusion, and agencies have also used fresh water from the Salinas River to recharge groundwater, Rich Mills, of the state's Department of Water Resources, said.

Overall, Mills estimates that more than 700,000 acre-feet of water statewide is recycled and reused each

While agriculture has been making some use of recycled water for more than a century, the prospect of someday seeing vast amounts of urban wastewater used in farm fields is unlikely, he said.

'They're not simple projects to build," Mills said of the pipelines that would be needed. "You're basically putting in another water system. ... The farther away from the wastewater treatment plant, the more expensive it gets (to deliver). So for non-potable treated wastewater, there's kind of a limit."

That said, some Central Valley communities are putting their treated wastewater in irrigation canals or into groundwater recharge, Mills said.

To cut down on transportation and storage costs, state scientists are studying the feasibility of treating wastewater at a high enough level that it could be put into the drinking water supply right away.

State funding

Building storage and recharging aquifers is expensive, and state governments have opened their check-

books to varying degrees. As the drought in California has spurred interest in alternative water sources, communities around the state have taken advantage of a State Water Resources Control Board low-interest loan program for wastewater and water use projects, Mills said.

In addition, more than \$800 million in applications have been submitted for water projects under Proposition 1, the \$7.5 billion water bond that passed in 2014.

In Idaho, the Legislature this year approved a one-time infusion of \$12.5 million to address declining aquifer levels and support water sustainability projects. Another \$10 million will be available for those efforts the next two years and then \$5 million in ongoing funds annually after that.

State water officials are also studying the feasibility of the proposed Weiser-Galloway Project, a reservoir which would have the capacity to store 750,000 acre-feet of water in southwestern Idaho if built.

The Idaho Water Resource Board in 2014 filed an application for a preliminary permit with the Federal Energy Regulatory Commission to study the possibility of building a hydro-power plant at the site. The plant would play a critical role in helping finance the Galloway project, which would cost an estimated \$500 million.

In Washington, the state has spent nearly \$200 million over the last decade to develop new water supplies for Eastern Washington farmers. But millions more will be needed to bring planned projects to comple-

In light of the economic and environmental benefits of developing reliable water supplies, state governments and private industries need to create innovative ways to pay for such projects so the cost doesn't entirely fall on irrigators, water managers

"Fish and farms don't write huge checks," J.R. Cook, of the Northeast Oregon Water Association,