

# Low flow in the Colorado River Basin spurs water shortage discussion among seven states

BY MELANIE LENART

The reservoirs in the Colorado River system provide a cushion in times of trouble, much like money in the bank. But about half of the rainy day water savings have been spent during the past five years of drought, spurring water managers in Arizona and New Mexico and the five other states that depend on the Colorado to seriously discuss how they might share a potential shortage.

The main issue of contention is that Glen Canyon Power will be unable to produce electricity by 2007 if the drought continues unabated and no changes are made in management decisions. At full capacity, the company uses Lake Powell to generate enough electricity to power about 1.5 million homes, including users in Arizona and New Mexico.

“We don’t know if this is a 5-year drought or the fifth year of a 15-year drought,” explained Robert Johnson, regional director of the Lower Colorado Region for the U.S. Bureau of Reclamation (USBR), which tracks and distributes Colorado River water. “From a management perspective, we’ve got to hope for the best and plan for the worst.”

Johnson displayed his optimism during a recent talk at the University of Arizona’s Water Resources Research Center. He noted that the reservoirs can store about 60 million acre-feet, about four times the Colorado’s annual average streamflow, mainly in Lake Powell and Lake Mead. Both lie along Arizona’s borders.

“What that means is we’ve got the ability to weather drought. In fact, we have weathered drought—we’ve had five years of drought and the reservoirs are still half full,” he told the group.

At the end of October, Lake Powell was filled to 38 percent of its capacity, while

Lake Mead was registering 54 percent of its capacity. However, USBR numbers indicate only about 12 million acre-feet could be jointly withdrawn from the two reservoirs before power production ceased completely, assuming no changes to the generating system and no additional water deposits beyond that for downstream use.

Timothy Henley, manager of the Arizona Water Banking Authority, found some reason for hope in that historic droughts affecting the Colorado River basin tend to last four to six years (see Table 1), based on instrumental records of streamflow since 1906. In October, storm fronts, including in northwestern Arizona, finally broke the nearly five-year streak of below-average monthly precipitation tallies that the Bureau of Land Management had been reporting for the watersheds feeding the Colorado River as a whole.

Colorado River flow throughout the system averaged 9.9 million acre-feet a year since 2000, which puts average river flow during this 5-year period even lower than during the 1950s drought and others of similar 4- to 6-year time spans (Table 1). Meanwhile, the seven western U.S. states and two Mexican states using Colorado River water consume about 96 percent of the annual average river flow. An acre-foot is roughly 326,000 gallons of water, enough to supply an average family of four for a year.

There have been media reports that Lake Mead, in particular, might never refill even if streamflow returned to its “average” of 15.1 million acre-feet a year, an estimate based on measurements since 1906. In the next couple of decades, basinwide water consumption is expected to grow with the population of the Upper Basin states to reach the allocated 16.5 million acre-feet from its current 14.5 million acre-feet a year (Table 2).

However, as a USBR slide show reminded, “we never get average hydrology.” The estimated natural flow of the Colorado River registers as a series of ups and downs that ranged from about 5 million acre-feet in 1977 to more than 24 million acre-feet in both the 1983 and 1984 calendar years, based on measurements at Lee’s Ferry in Arizona (Figure 1).

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**Table 1.** Average flow during the current drought (top row) was lower than during any other drought in the instrumental record.

Time frame	Duration	Average Annual Flow (in acre-feet)
2000–2004	5 years	9,900,000*
1953–1956	4 years	10,200,000
1988–1992	5 years	10,900,000
1959–1964	6 years	11,400,000
1931–1935	5 years	11,400,000

Source: U.S. Bureau of Reclamation.

\*Preliminary estimate.

**Table 2.** The Colorado River is overallocated even when the period of flow attains its natural flow average of 15.1 million acre-feet a year. However, the Upper Basin states are not using all of their allocations at this point in time.

Political Entity	Annual allocation (in acre-feet)
Upper Basin States	7,500,000*
Colorado	3,900,000*
New Mexico	800,000*
Utah	1,700,000*
Wyoming	1,000,000*
Lower Basin States	7,500,000
California	4,400,000
Arizona	2,800,000
Nevada	300,000
Mexico	1,500,000
Total	16,500,000

Source: U.S. Bureau of Reclamation.

\* The Upper Basin states use a percentage formula rather than acre-feet to divide its allocation, which is why these rounded-off numbers do not tally 7.5 million acre-feet. Also, New Mexico’s share comes from a Colorado tributary, the San Juan River.



## Low Flow, continued

“Between 1983 and 1986, we spilled about 45 million acre-feet of water to Mexico. If you see events like that, the reservoirs are going to fill,” Henley said.

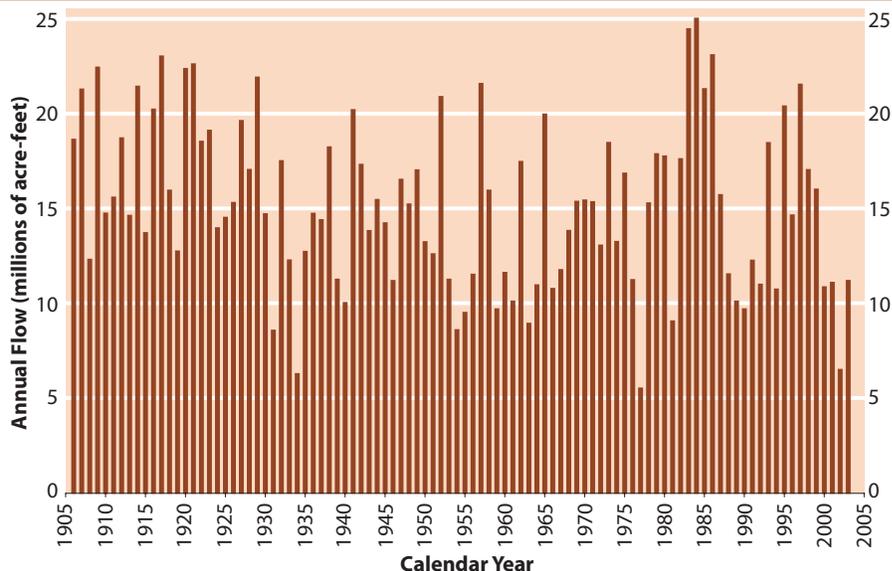
Henley, one of two Arizona representatives in ongoing discussions among the seven U.S. states vying for Colorado River water in these days of pending shortage, reported ongoing progress on interstate discussions during a November 9 public meeting at the Arizona Department of Water Resources’ (ADWR) headquarters in Phoenix. The interstate group is essentially hoping to buy time, working out interim agreements on how to share the shortage in the hopes that the river hydrology will shift into a more plentiful mode before they have to seriously weigh whether to short Arizona users or lose power.

If an official shortage were declared in the Lower Basin, non-Indian agricultural users of Central Arizona Project (CAP) water—the 336-mile long system of aqueducts that delivers 1.8 million acre-feet a year to Maricopa, Pinal, and Pima counties—legally would take the first cut. About 80 percent of Arizona’s share of the Colorado River goes to agriculture.

ADWR Director Herb Guenther reminded the approximately 75 people attending the Phoenix meeting that long-term records based on tree rings and isotopes indicate modern records might give an exaggerated version of “normal” streamflow.

“We’re concerned that we’re returning to a more ‘normal’ mode, rather than a ‘shortage’ mode,” Guenther said, alluding to the evidence that the Colorado has been running high for most of the instrumental record when compared to the longer records of past climate.

Tree-ring records also reveal evidence of infrequent but severe droughts that span decades, which climatologists call



**Figure 1.** Estimates of Colorado River flow from 1906–2003 show that river levels fluctuate extensively around the average flow of 15.1 million acre-feet a year. The estimates are for flow throughout Colorado River’s 246,000-square mile basin and were reconstructed by the U.S. Bureau of Reclamation based on gauged flow at Lee’s Ferry in Arizona.

“megadroughts.” Previous megadroughts, such as one in 16th century North America, wreaked havoc on local populations. However, even during a drought or megadrought, individual years of above-average streamflow can occur.

In fact, some note that the 1957 strong El Niño event that helped boost Colorado River streamflow to about 22 million acre-feet that year could be seen as an unusually wet year during a drought that actually stretched from 1953–1964. (See Table 1 and Figure 1 for illustration.)

However, even a couple of wet years like 1957 and 1958 within a stretch of dry years would do little to alleviate potential problems from the current drought, as researchers discovered when they modeled a long-term drought by adding the streamflow values for 1953–1964 to the current record.

Although the Lower Basin states theoretically could receive their full annual allocation during such a scenario, it would come at the cost of Glen Canyon hydropower. In the modeled “worst-case” scenario, Lake Powell’s levels would be too low to yield electrical power for 10 of the next 17 years, as Don Ostler of the Upper Colorado

River Commission summarized in a report available on the website for the ongoing Arizona Colorado River Shortage Workshops ([http://www.awba.state.az.us/annn/AZ\\_CO\\_river\\_shortages.htm](http://www.awba.state.az.us/annn/AZ_CO_river_shortages.htm)).

“Lake Powell takes most of the swings of the drought,” as the USBR’s Johnson noted. Lake Powell serves as the collection site for annual contribution from the Upper Basin states—New Mexico, Colorado, Utah and Wyoming—to the Lower Basin states of Arizona, California and Nevada.

After generating power through Powell’s Glen Canyon dam, the water is channeled to the slightly larger Lake Mead. Glen Canyon Dam’s power intake pipes are higher than the pipes that can supply water to the Lower Basin. As it is, electricity production is down to about 900 megawatts from its potential capacity of 1300, in part because the lower reservoir level means incoming water exerts less force on the turbines that generate power, explained Leslie James, executive director of the Colorado River Energy Distributors Association.

If push comes to shove, providing water to the agricultural users takes priority

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## Low Flow, continued

over providing power, according to one of the many legal agreements guiding Colorado River use. Also, legal agreements have been interpreted as requiring the Upper Basin states, which produce about 90 percent of the runoff that feeds the Colorado River, to pass along the water allocated to the Lower Basin states even if it means shorting its own users.

The Lower Basin states have always received at least the full 7.5 million acre-feet allocated to them, Johnson noted, plus half of the 1.5 million acre-feet promised to Mexico as part of a 1944 treaty. But now some Upper Basin state managers are challenging the need to deliver the usual 7.5 million acre-feet a year—pointing out that legally they must deliver 75 million acre-feet every decade—and arguing that Lower Basin tributaries should contribute to Mexico's share.

One potential bargaining chip held by the Upper Basin is that a shortage of power would hurt the Lower Basin states as well, beyond increasing the cost of electricity to those who normally depend upon Glen Canyon Power sources. The utility provides about three-quarters of the \$130 million Basin Fund revenues, some of which goes to protect endangered species, according to Ostler's report. So Arizona and New Mexico have more than a passing interest in reaching an interim agreement with the Upper Basin to avoid the need for official, and therefore heavily regulated, action.

*Additional coverage of Colorado River Basin issues can be found in other University of Arizona publications, including Arizona Water Resource, available at <http://www.ag.arizona.edu/AZWATER/awr/awrmain.html>, and Southwest Hydrology, at <http://www.swhydro.arizona.edu/>.*

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## Water managers share a range of viewpoints on the outlook for Colorado River water supplies

BY HOLLY HARTMANN

Do forecasts of El Niño, winter temperatures and precipitation, snowfall, and water supplies bode well for water managers in the Southwest? As with so many things in life, it depends on your perspective. A variety of viewpoints about future Colorado River Basin water supplies were in evidence at a recent interagency briefing held November 9 in Salt Lake City.

According to Tim Ryan, of the Bureau of Reclamation, Lake Powell and Lake Mead were at only 38 percent and 54 percent of 'live capacity' as of November 7, 2004. Lake Powell hasn't been this low since 1970, 6 years into the 16 years required for the reservoir to fill after completion of Glen Canyon Dam.

The Bureau sees the low levels as indicating successful water management, because the system was designed to have low water levels during times of drought. And there is no question the basin is experiencing drought. The 2000–2004 period has been the worst mid-range drought in historical records. Lake Powell had no above-average flows since September 1999, until they finally reappeared in October 2004.

Even with above-average flow, there's concern about the runoff efficiency of the basin. While precipitation has been about 85 percent of average, inflows to Lake Powell have been only about 50 percent of average. This results from soil moisture deficits, which Tom Pagano of the Natural Resources Conservation Service likened to high-interest credit card debts that take significant 'extra revenue' to pay back.

Soil moisture rose dramatically in parts of the Southwest with the extreme storms in October, to levels usually experienced only during spring snowmelt. But the Upper Colorado Basin notably missed out on that precipitation. Also, short-term relief of surface soil moisture should not be confused with long-term recovery to pre-drought groundwater, riverflow, or reservoir conditions. According to Doug LeCompte of the Climate Prediction Center, even the wettest winter on record

in the region would raise the Palmer Drought Index (an indicator of soil moisture) only slightly.

The Colorado Basin River Forecast Center has been making early outlooks of Lake Powell inflows using their probabilistic forecast system. Their most recent outlook, computed November 7, gives a 50 percent chance of unregulated inflows above 6.7 million acre-feet (MAF) during April–July 2005, but also a 50 percent chance of having lower inflows. That's higher than the 5.1 MAF outlook estimated in August, but still lower than the long-term average of 7.9 MAF.

There may be some cause for optimism based on the weak El Niño declared earlier this year. El Niño is sometimes correlated with increased winter precipitation for the Southwest. But as Klaus Wolter of the Climate Diagnostics Center stressed, El Niño has many flavors. This event's ocean temperature patterns are quite unlike the 1982/83 and 1997/98 events that brought wet winters and high water supplies to the Southwest.

In fact the hope of El Niño may turn to pessimism when looking at similar El Niño events in the past. One analog includes the dramatically dry winter of 1976/77 and others suggest a drier winter is more likely than a wetter winter unless the El Niño strengthens rapidly over the late winter and spring. Another concern is the strong trend of warmer winter temperatures that can decimate snowpacks and dramatically reduce subsequent river flows, like in March 2004.

A pragmatic perspective is to consider how to avoid the worst consequences if Colorado River flows and reservoir levels continue to be low—Lake Powell is unlikely to be refilled in 2005. But El Niño, watershed conditions, and climate outlooks should be monitored and reconsidered in a couple months before taking any irreversible actions.

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