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Managing the Colorado River in the 21st Century: Shared Risks and Collaborative Solutions

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Key Points:

- *The Colorado River is a crucial resource for 40 million people residing in seven U.S. states and two Mexican states.*
- *Running 1,450 miles from its headwaters in the Wyoming and Colorado Rocky Mountains toward the Gulf of California, the Colorado River provides water for four million acres of farmland, seven National Wildlife Refuges, and 11 National Parks.*
- *The Colorado River faces myriad threats as the limits of its ability to meet the diverse array of growing demands is tested by over-allocation and diminished streamflow, due in part to a 16-year drought considered among the worst in 1,200 years.*
- *Lake Powell and Lake Mead, two crucial storage banks on the river, have tempered the effects of the drought, but their falling levels jeopardize their ability to provide water to cities and farms, as well as to generate power, fund recovery programs for endangered fish species, and support recreational economies worth billions of dollars each year.*
- *Lake Powell and Lake Mead—both filled nearly to the brim in 2000—have shrunk due in part to the drought, are now less than half full, and continue to shrink.*
- *Apart from the current severe drought, Lake Mead is being overdrawn, creating a “structural deficit” amounting to about 1.2 million acre-feet a year, even under normal climatic conditions.*
- *The Colorado River rarely reaches its delta at the Gulf of California, except in a handful of high-flow years in the 1980s and ‘90s and more recently in 2014, when a special release was made under the terms of Minute 319, a binational agreement between the United States and Mexico.*
- *To address the lower basin’s structural deficit, as well as the likelihood of increasing demands on diminishing supplies basin-wide, the states, farmers, and other water users who share the Colorado River are working on cooperative solutions to reduce water use, share risks, and find creative, new river management tools.*



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The Colorado Foundation for Water Education promotes increased understanding of water resource issues so Coloradans can make informed decisions. CFWE is a non-advocacy organization committed to providing educational opportunities that consider diverse perspectives in order to advance the conversation on Colorado water.

Introduction

The Colorado River Basin is a crucial resource for about 40 million people across seven U.S. states and two Mexican states. However, it faces myriad threats and challenges as the limits of its ability to meet the diverse array of growing demands are tested by over-allocation and diminished streamflows.

The basin's current 16-year drought, widely believed to be among the worst in 1,200 years, shows little sign of easing. Lake Powell and Lake Mead—both filled nearly to the brim in 2000—are now less than half full and continue to shrink, jeopardizing their ability to provide water to cities and farms, as well as to generate power, fund recovery programs for endangered fish species, and support recreational economies worth billions of dollars each year.

Managing With Drought

Drought in the basin has materialized at different times and with varying levels of severity since 2000. Often, these periods of reduced precipitation and streamflow seemed temporary, and the states managed by imposing water restrictions and tapping deep into reservoir storage. But by 2005 it was clear that the shortages were becoming increasingly severe and longer in duration. Water levels in Lake Powell and Lake Mead were shrinking alarmingly. Conflict between the basin's two U.S. divisions—its lower and its upper basin states—came sharply into focus, causing the U.S. Department of the Interior to urge the states to come up with a new plan to manage the shrinking supplies and to balance storage between the two major reservoirs lest the federal government step in to do it for them.¹ (See map.)

It took two years for all seven states to agree to a new management regime for Lake Powell and Lake Mead, a regime that regulates the annual release made by the upper basin states of Wyoming, Utah, Colorado and New Mexico from Lake Powell in order to better share the risk of diminishing supplies. The agreement also called for the lower basin states of California, Nevada and Arizona to implement staged reductions in their water withdrawals if Lake Mead falls below a series of defined tipping points.²



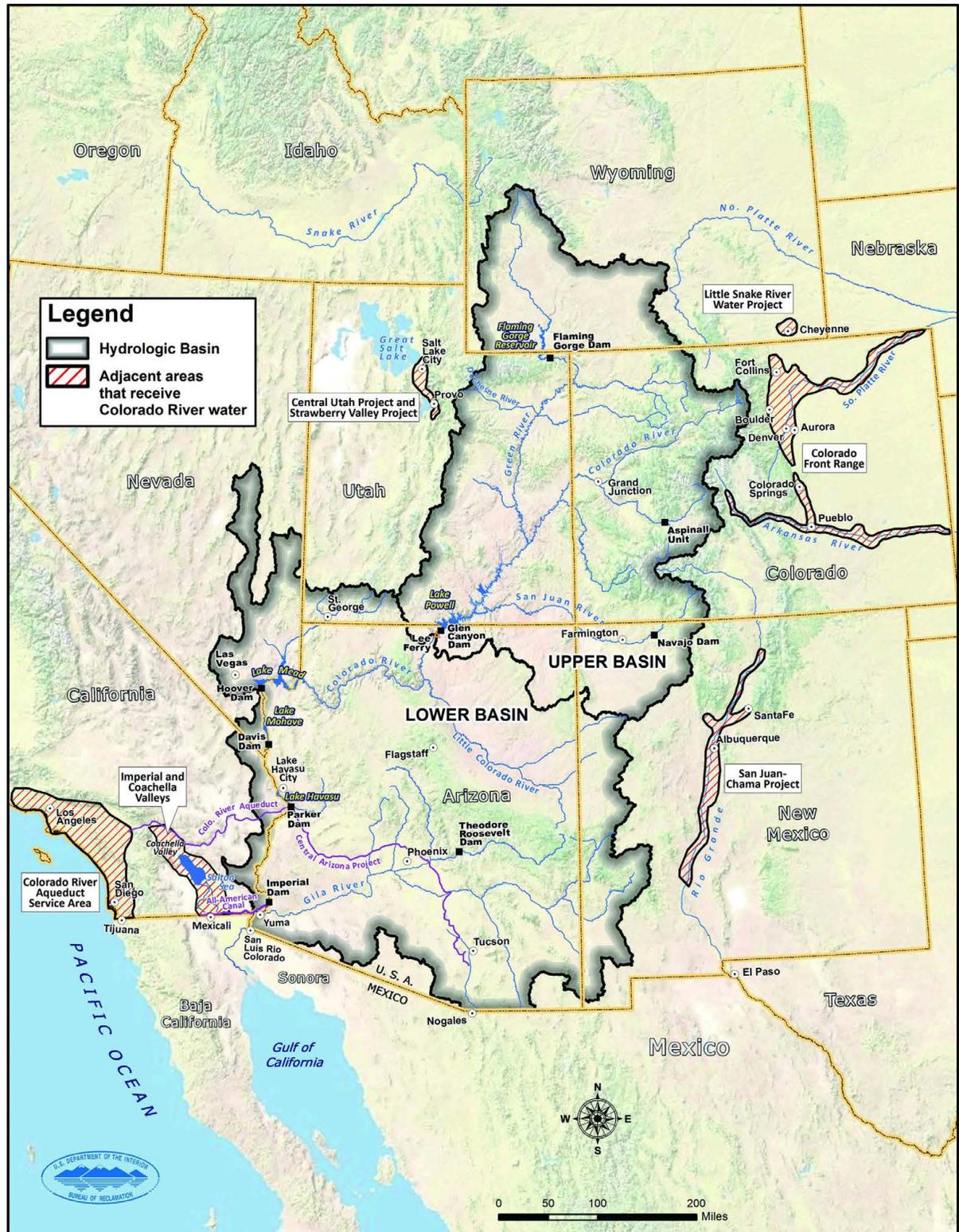
*White mineral deposits are visible on the sandstone that used to be underwater, and show the current low water level of Lake Powell, located in Glen Canyon on the border between Utah and Arizona. As of February 2016, Lake Powell was just 46 percent full.
© Jim Cole, Photographer / Alamy Stock Photo*

“*Flows across the basin in 2012 and 2013 were the lowest ever observed over a two-year period.*”

In 2007, when what became known as the Interim Guidelines for Lower Basin Shortages and Coordinated Operations were finally adopted, planners remained optimistic that those tipping points might not be reached until closer to 2026, when the guidelines are set to expire, if at all. But the persistent drought combined with overuse of the water stored in Lake Mead for the lower basin has drained the reservoirs faster than anyone predicted.

Flows across the basin in 2012 and 2013 were the lowest ever observed over a two-year period, raising particular alarm for the Central Arizona Project (CAP), which is subject to the earliest risk of water reductions in the lower basin under the unique priority system established by Congress nearly 50 years ago. Shuttling the vast majority of Arizona's share of the river to farmers and cities in the state, CAP delivers water to a region containing 80

The Colorado River Basin



percent of the state's population through a 336-mile-long system of aqueducts, tunnels and pipelines. It is also expected to be the hardest-hit under the 2007 Interim Guidelines. The CAP governing board predicts a 55 percent probability that starting in 2017 the farmers it supplies will lose slightly more than half of the surface water they use to irrigate, and the state will have to replace those supplies with water that it has cached underground for years for such a time as this. If the drought continues, its cities could face shortages in the very near future.³

In 2015, heavy spring precipitation in the Colorado and Wyoming mountains enabled the U.S. Bureau of Reclamation to release a small surge of water from Lake Powell of roughly 9 million acre-feet, up from the 8.23 million acre-feet it has released during "normal" years, dating back to 1970.⁴ The release of 8.23 million acre-feet from Lake Powell is dictated by the U.S. Bureau of Reclamation's operating criteria, and is intended to cover the lower basin's annual apportionment of 7.5 million acre-feet, minus 200,000 acre-feet for the inflow of the Paria River, which is downstream from Glen Canyon Dam but upstream of Lees Ferry (which is the dividing line between the upper and lower basins), plus half of Mexico's annual apportionment of 1.5 million acre-feet. The higher release from Lake Powell in 2015 should give Arizona some breathing room. But even if shortages don't occur in 2017, most observers expect them to arrive shortly thereafter.⁵

California, meanwhile, which gets nearly 60 percent of the lower basin's share of the Colorado River's flow, is mired in its most serious modern drought. In the winter of 2014-15, the Sierra Nevada mountains delivered just 5 percent of their annual average snowpack. The allocation that California gets annually from the Colorado River has been an invaluable water source as the state scrambles to implement emergency conservation measures and revise its laws and water management regime. Facing its own serious drought problems, California has thus far taken the position (grounded in the priority of appropriations established by Congress in the 1968 Colorado River Basin Project Act) that its water users need not reduce their use below the state's legally



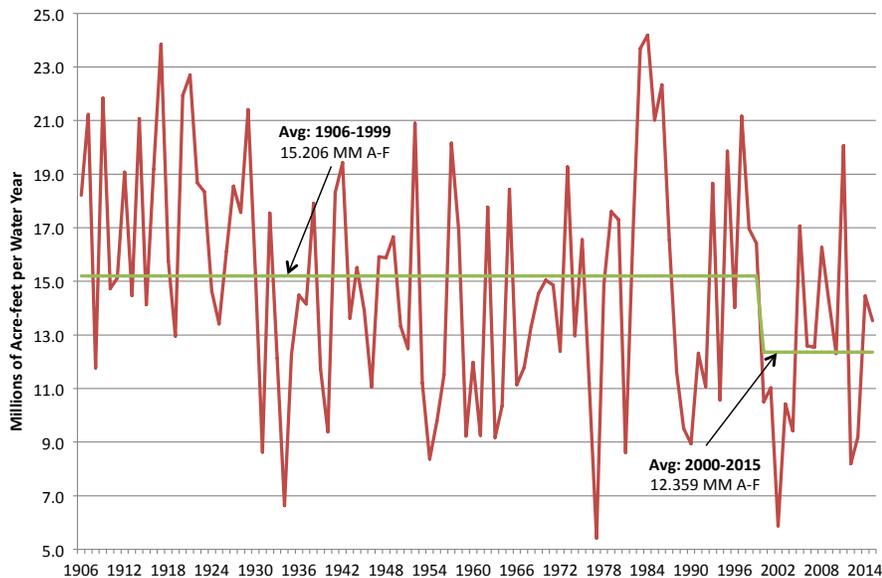
Hoover Dam is 726 feet high and located in the Black Canyon of the Colorado River on the border between Nevada and Arizona. Behind it is Lake Mead, the nation's largest reservoir. As of February 2016, Lake Mead was 40 percent full. © Shirley Kilpatrick / Alamy Stock Photo

allotted share of 4.4 million acre-feet per year. They have managed to reach that target over the last decade, gradually reducing their use of Colorado River water by 15 percent under an agreement signed in 2003 with the U.S. Department of the Interior.⁶ Under various legal agreements, Congressional statutes, and a U.S. Supreme Court decree, Arizona and Nevada will have to absorb the first lower basin shortages before California will have to implement further cutbacks. Nonetheless, California is still committed to bolstering the strength of the Colorado River system, averting lower basin shortages, and ultimately increasing the amount of water stored in Lake Mead, says Tanya Trujillo, executive director of the Colorado River Board of California.⁷

The upper basin states also face a risk of water shortages. In addition to the localized water reductions already experienced as a result of the basin's ongoing historic drought, the upper basin states face the very real possibility of not being able to utilize the full share of Colorado River water their delegates had hoped for when the 1922 Colorado River Compact was signed. Even if flows continue to diminish, they may still be required to meet legal obligations to the lower basin, resulting in less water for their own citizens.⁸

Colorado River Natural Flows at Lees Ferry AZ, 1906 - 2015

Millions of Acre-feet per Water Year



Source: U.S. Department of the Interior, Bureau of Reclamation

Falling Reservoir Levels

Over the past 16 years, the Colorado River has produced an average annual natural flow of just 12.4 million acre-feet at Lees Ferry, well below the long-term historical natural flow of 16.4 million acre-feet.⁹ (See *textbox and chart*.) The shortfall has been buffered by using the water stored in Lake Powell and Lake Mead. However, releases from Lake Powell continue to exceed inflows, and although the upper basin has so far been able to release the full amount required every year, the lower basin continues to withdraw far more water each year than what is delivered to Lake Mead.¹⁰ Both Lake Powell and Lake Mead are currently less than half full, and their surface levels continue to fall.

Several steps have been taken to help the states cope with their rising anxiety over the declines in these massive storage pools, most notably the Interim Guidelines finalized in 2007. This agreement stipulated that Lake Powell and Lake Mead, until then mostly managed independently of one another for the benefit of the upper and lower basin states, respectively, would be managed jointly. The goal of the coordinated operations is to minimize the risk of water shortages in the lower basin

while avoiding curtailment of upper basin uses and allowing for additional development by the upper basin.

The Interim Guidelines also dictate the amounts of the cutbacks that the lower basin states will have to absorb if the surface elevation of Lake Mead were to fall below 1,075 feet above sea level. At that elevation, Lake Mead is just over one-third full and the U.S. Bureau of Reclamation would implement the first of a series of shortages, or reductions in deliveries, to the lower basin in order to maintain reservoir storage and hydropower production. If Lake Mead reaches 1,075 feet, Arizona's Colorado River allotment is scheduled to be reduced by 11 percent, while Nevada will lose 4 percent of its share.

Depending on how much further Lake Mead falls, Arizona's reduction could climb to 14 or 17 percent,

Gauging the Colorado River's "Natural" Streamflows

The Colorado River streamflows have been measured every year at Lees Ferry, Arizona, since 1906. Lees Ferry is downstream from Lake Powell and the Glen Canyon Dam. Releases from Lake Powell dictate the actual mainstem streamflows for the portion of the river situated within the lower basin. Every year, however, scientists at the U.S. Bureau of Reclamation calculate estimates of the Colorado River's "natural flow," i.e., what the unregulated, undiverted streamflow would have been, absent human intervention. These estimates take into account the water depletions in the upper basin, all water diversions into and out of the upper basin, and evaporative losses from the reservoirs in the upper basin. These estimates of what the undiverted, unregulated streamflows would have been are commonly reported, and referred to, as the "Colorado River Natural Flows at Lees Ferry AZ." (See *chart in the text*.)

and Nevada's to 6 or 7 percent, while California takes no shortage. While Lake Mead did drop temporarily below 1,075 feet in June 2015 and continues to hover at precariously low levels, it recovered some elevation before August, or the end of the water year, when the U.S. Bureau of Reclamation formulates its projections for first-of-the-year levels to make a shortage determination. As a result, no shortages were implemented for 2016, allowing the states to catch their breath.¹¹

Some additional releases from Lake Powell over the past five years, as required by the Interim Guidelines, have helped to keep Lake Mead above the 1,075-foot elevation. But another key component of the Interim Guidelines that has contributed to averting shortage is a program called Intentionally Created Surplus, where lower basin states have the ability to shore up credits in Lake Mead of up to 2.1 million acre-feet through implementing practices that reduce consumptive use such as lining canals, fallowing and desalination, all of which are being pursued with varying degrees of success.

The Law of the River and Current Hydrologic Trends

The question of who gets how much water from the river is governed by the 1922 Colorado River Compact, the 1948 Upper Colorado River Compact, and a related set of laws, court decrees and an international treaty collectively referred to as the "Law of the River."

Some of the hydrologic assumptions made in establishing the 1922 compact, however, were flawed, in part because the record available to the compact's framers was for a relatively short and unusually wet period. The negotiators of the 1922 compact presumed that the river's flow would amount reliably to an average of 17 million acre-feet of water a year (as measured at a point on the river 10 miles downstream of Lake Powell's Glen Canyon Dam known as Lees Ferry), based on the assumption that major reservoirs would be constructed and available to store water in abundant years and even out low-flow water years. Streamflow records from 1902, for example, showed that only 9 million acre-feet of water were available in the Colorado River that year,

“*The question of who gets how much water from the river is governed by the “Law of the River.”*”

indicating that storage would be necessary to implement the compact.¹²

Rejecting some calls for a time-limited allocation, say for 50 years, the compact's framers divided, in perpetuity, 15 million acre-feet equally between the upper and lower basin states, allocating 7.5 million acre-feet of consumptive use to the three lower basin states of Arizona, California and Nevada, and 7.5 million acre-feet to the four upper basin states of Colorado, New Mexico, Utah and Wyoming. In the negotiations, the upper basin states were able to prevent the doctrine of prior appropriation from being applied across state lines to the allocation of Colorado River water. (This doctrine, used widely in the West, is often referred to as the "first in time, first in right" system, under which those users who are the first to put water to beneficial use are assigned first priority to the available water.) Otherwise, the upper basin states would have been deprived of their equitable share because they were not growing as fast as the lower basin states.¹³

Skeptical of the deal even back then, Arizona took more than 20 years to ratify the 1922 compact. The 1928 Boulder Canyon Project Act further divided the lower basin's share of mainstem water: California gets 4.4 million acre-feet, Arizona 2.8 million acre-feet, and Nevada 300,000 acre-feet.¹⁴

But under the Colorado River Basin Project Act of 1968, which authorized construction of CAP, among other projects, Congress required Arizona to subordinate the priority of CAP water supply to California in times of shortage. As a result, CAP has a lower priority than senior water users in Arizona, California and Nevada.¹⁵

The upper basin's share, though intended to be equal to that of the lower basin when established, was allotted with the provision that the upper basin states cannot cause the river's flow to fall below 75 million acre-feet at the Lees Ferry gauge over any 10-year period. As

a result, the upper basin has assumed the risk of any fundamental “flaws in the assumptions” underpinning the 10-year delivery requirement to the lower basin. Given the uncertainty over how much water the upper basin states would actually have left among them, they agreed in the 1948 Upper Colorado Basin Compact to divide their share on a percentage basis, with Arizona receiving 50,000 acre-feet (to address the sliver of Arizona which lies in the upper basin) and Colorado receiving 51.75 percent, Utah 23 percent, Wyoming 14 percent and New Mexico 11.25 percent of the remaining available water. Mexico in 1944 was allocated an annual 1.5 million acre-feet of the river’s flow by treaty with the United States.

In the decades after the 1922 compact was written, it became clear that the river does not generate the assumed annual average of 17-18 million acre-feet. In fact, over the past 16 years, the river generated only 12.4 million acre-feet per year, on average.

The Structural Deficit

For the lower basin, the threat of water shortages from the Colorado River is high and rising. The lower basin states are rapidly approaching a crisis point, not just because of the drought or reduced streamflows due to temperature shifts, but because they already overuse the river by 1.2 million acre-feet a year, even under normal conditions.¹⁶

This overuse is referred to as “the structural deficit” and is the result of a collection of overdrafts and system losses due to evaporation, treaty-required deliveries, and contracted water uses at Lake Mead and downstream. (See graphic.) This imbalance between water delivered into Lake Mead and water released has resulted in the reservoir’s surface level falling at a rate of roughly 12 feet per year even with a “normal” release of 8.23 million acre-feet from Lake Powell.¹⁷

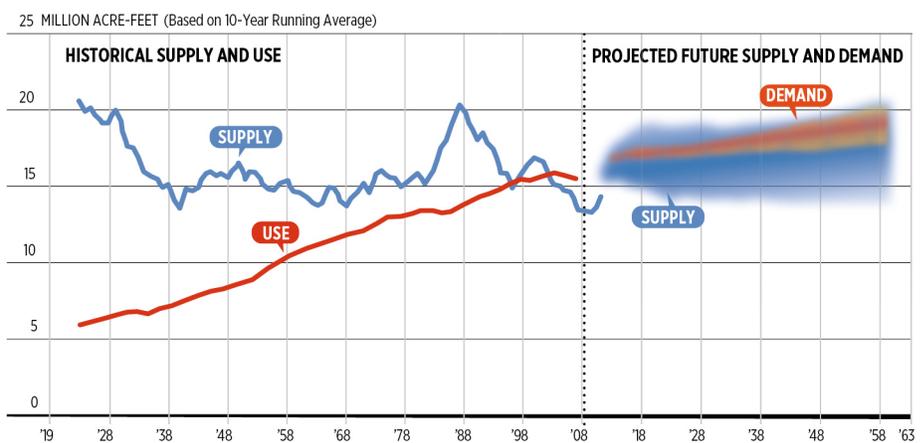
The prospective shortages that Arizona could face as early as 2017 can be handled, according to Tom Buschatzke, director of the Arizona Division of Water Resources, by cutting water deliveries to the state’s farmers and halting the underground storage program that Arizona has used for decades to protect itself against this woeful outcome. It has roughly 9 million acre-feet of water stored underground, much of it drawn from the Colorado River.¹⁸

Warming temperatures are expected to exacerbate the existing imbalance, potentially shrinking the river’s flows by 5 to 35 percent by the end of the century. As a result, not only is the welfare of the 40 million people who live and work within the Colorado River Basin at risk, but so is the river’s own ecologic health and viability.¹⁹

Vulnerability Analysis

Analysts are stepping up their efforts to quantify how much water the river needs to maintain its ecologic attributes, such as peak flushing flows and base flows that can support healthy ecosystems, in light of the widening imbalance between supply and demand. The science behind healthy streams continues to evolve, and the data needed to assess the ecologic attributes are more readily available in some reaches of the river than others.

Colorado River Basin Water Supply and Use – Historical and Projected



SOURCE: U.S. Bureau of Reclamation, 2012 Colorado River Basin Water Supply and Demand Study

Tribal Water Rights

In addition to the existing over-allocation of the river, another “new,” major demand is likely to come from Indian tribes, some of which have established the right to divert significant quantities of water but have not yet developed the infrastructure to do so, and others whose water rights are promised but have yet to be formally quantified. The latter is the case for 12 of the 28 tribes that reside in the Colorado River Basin.²⁰

In 1908, in a precedent-setting case creating what is known as the Winters Doctrine, the U.S. Supreme Court ruled that the establishment of Indian reservations implicitly and concurrently created tribal rights to water necessary to support the reservation, predating the rights of settlers who arrived later. The quantity of these tribal rights is linked to reservations’ “practicably irrigable acreage” and the seniority to the date the reservation was established, in accordance with the doctrine of prior appropriation and the Winters Doctrine established by the U.S. Supreme Court. In many cases, however, tribes without water engineering records or adequate resources to pay for court cases and water projects have not yet been able to fully claim or develop their share of the river.

The situation improved for the tribes in 1963 when the U.S. Supreme Court set guidelines for future quantification efforts, as part of the *Arizona v. California* decision. In 2014, Dan Cordalis, a tribal water rights expert with the nonprofit environmental law firm Earthjustice in Denver, wrote: “What we do know is that the 16 tribes in the basin that have quantified their rights have established the right to divert nearly 2.9 million acre-feet of water annually from the Colorado River system. It appears, therefore, the remaining tribal claims leave a significant ‘cloud’ over the certainty of existing non-Indian water rights and uses.” It is important to note that these reserved water rights don’t require that the tribes had an actual need at the time of the reservation’s establishment, but are instead based upon future uses of the reserved water. A U.S. Bureau of Reclamation study now underway in cooperation with the Ten Tribes Partnership, a coalition of tribes with Colorado River water rights, is working to determine how much water may be associated with those rights.

In the vulnerability analysis published in 2012 as part of its “Colorado River Water Supply and Demand Study,” the U.S. Bureau of Reclamation estimated the risk that streamflows in the Colorado River Basin will be impaired to the point where they fall below current targeted amounts necessary for recovery of threatened and endangered fish species and other ecologic indicators stood at 38 percent when projected 25 to 45 years out. On certain tributaries, that risk grew to as high as 52 percent. The majority of ecologic risk is confined to the upper basin, as well as the Colorado River directly below Lake Powell and some lower basin tributaries, whereas the lower basin along the mainstem has little native habitat remaining. These risks, the report points out, could be reduced if new river management regimes were implemented—or supplies augmented.²¹

In contrast, the risk that the deliveries from the river needed to support existing water users will be impaired is

just 7 percent in the upper basin and 19 percent in the lower basin. Under various scenarios modeled by U.S. Bureau of Reclamation, the risk of water delivery shortages to cities and farmers could be reduced to as little as 2 to 5 percent, depending on which solutions are used.

But for the river itself, the risk that flows could fall short of ecologic targets would be reduced only slightly. This risk would decline from 38 percent to about 30 percent on average basin-wide, regardless of which options are chosen to improve flows in the river, including reuse, desalination plants, better watershed management, and, perhaps most crucially, the use of water banks in the upper basin.

Under current law, the Endangered Species Act (ESA) is the most effective federal law protecting the ecology of the river. But Jennifer Pitt, director of the Colorado River Project at the National Audubon Society, says there are

many places “where rivers may be imperiled that won’t be protected by the ESA. We need to work more on developing tools and agreements to protect those places, not just to avoid species extinctions but to ensure we have healthy rivers to support nature and people.”²²

In some areas, federal agencies have applied for and received decrees for federal reserved water rights that mandate certain streamflows. Some federal agencies have also imposed conditions attached to agency-issued special use permits that require a certain amount of water to be bypassed through a diversion structure or dam. Several states also provide for minimum levels of flows to be protected in certain stream reaches through state-established legal mechanisms. For instance, the Colorado Water Conservation Board is authorized to appropriate instream flow water rights to preserve or improve the environment “to a reasonable degree.”

“*With no relief in sight, water planners say there is little question that this is a defining moment for the river.*”

Another significant concern in the upper basin is that hydropower production at Lake Powell could fall dramatically—or cease altogether—as reservoir levels decline. Glen Canyon Dam currently produces enough hydropower to supply 320,000 homes with electricity, providing an average of \$150 million in wholesale power revenues each year.²³ The concern about the declining reservoir isn’t just about how to replace the lost power, which is substantial, but also how to make up the revenue that would be lost. That revenue helps fund not only the operations and maintenance of Lake Powell and other major upstream reservoirs, but also the basin’s salinity control program, the upper basin’s recovery programs for several endangered fish species, and the Glen Canyon Dam Adaptive Management Program. Without these programs, and the cooperative management they support to provide things like targeted flow releases to critical river

reaches, invasive species removal, and hatchery-bred fish stocking, the federal government could be forced to consider shutting off water users, as it did in the Klamath River Basin more than a decade ago.²⁴

Facing Our Defining Moment On the Colorado River

Water scarcity issues connected with the Colorado River Basin are developing much faster than modern-day water planners ever imagined. The 16-year drought shows few signs of easing. States and water districts now realize that time is running out.

If water users don’t reduce their draw on the river, the situation will become dire quickly. Water managers up and down the basin are well aware that if Lake Mead’s surface level drops below an elevation of 1,075 feet, the pain of the shortages will become everyone’s pain, starting first in the lower basin.

Lake Mead reached 1,078 feet in mid-October 2015, which marked the beginning of the 2016 water year, just three feet above the 1,075-foot mark that triggers the first set of reductions under the 2007 Interim Guidelines.²⁵ With no relief in sight, water planners say there is little question that this is a defining moment for the river. Jocelyn Gibbon, a Phoenix-based water attorney and natural resources consultant who tracks Colorado River management issues, says she believes people will look back on this time period “and either be grateful we made the choices we did, or they will look back and say we let everything crash.”²⁶ Those choices include proactive measures designed to reduce water demands and prepare to respond to emergency rationing of Colorado River water supplies. Another choice is to do nothing, but failing to act would entail a high probability of untoward consequences.

If the flow at Lees Ferry were to fall below the 75 million acre-feet, 10-year running average due to upper basin withdrawals, the lower basin could exercise its right to call for its share. In that event, Lake Dillon, Denver Water’s largest storage pool with water rights on the Colorado River so junior that they date back only to the

1950s, might be among the first of many users whose water allocations would be curtailed. Depending on how the Upper Colorado River Commission, with delegates from the four upper basin states, plus the Colorado State Engineer decided to administer a compact call, it's possible that Denver Water's customers—1.2 million people on Colorado's Front Range—could face water shortages. Denver Water's CEO Jim Lochhead calls this a scenario with a "low probability of happening and a high consequence if it does."²⁷

Similarly, Phoenix, Las Vegas and the water supply entities constituting the Metropolitan Water District of Southern California could also face cut-offs. Though these major users don't agree on everything, they have signed on to several collaborative conservation efforts that show early promise in dramatically reducing agricultural consumptive water use. They see this as a way to secure additional municipal water while balancing demand with the river's available flows.

In Arizona, for instance, CAP plans to pay farmers to forego use of some Colorado River water and use the cash to install new highly efficient irrigation systems. To help farmers cope in the interim, they're tapping water that for years has been stored underground from past Colorado River diversions. And California over the past two decades has facilitated large-scale cooperative agreements between agricultural and municipal users in order to share and reduce water use and stay within its apportionment.²⁸

Risk Sharing

Every major user on the river understands who faces the greatest risk right now. Because of agreements forged in the late 1960s when Arizona campaigned to build CAP, which delivers more than half of its Colorado River apportionment, it has a subordinated water right. Under the Law of the River, CAP water users could practically go dry before California's water users would be affected.²⁹

Nevada also is at high risk, though it takes a much smaller amount of water out of the river—a maximum of 300,000 acre-feet or 4 percent of the lower basin's annual share. Las Vegas, the primary user of Nevada's Colorado River water, has moved the fastest to reduce



The Central Arizona Project (CAP) is a 336-mile, man-made river of canals that delivers water from the Colorado River uphill to service the water needs of southern Arizona, including Tucson and Phoenix.
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its risk. It has drastically reduced its water use and built \$1.5 billion worth of new diversion structures at Lake Mead that will allow it to pump water out even if the lake drops below the 1,000-foot elevation critical for its existing intake pipes.³⁰ Even if Lake Mead falls again in 2016 to 1,075 feet above sea level, where Nevada would have to give up 20,000 acre-feet of water under the 2007 Interim Guidelines, Las Vegas could absorb the hit, says John Entsminger, manager of the Southern Nevada Water Authority. As the Las Vegas Valley's water provider, the authority is only delivering about 225,000 acre-feet to its customers this year, 30 percent less than a decade ago. "Our community is positioned to absorb these reductions without having to take any drastic measures such as water rationing," Entsminger says.³¹

While the prospect of water reductions seems farther off in the upper basin, residents there do face a mounting risk associated with developing additional Colorado River supplies to provide water for growing communities and industries—and this risk is being factored into current conversations and decision making. The four upper basin states currently use roughly 60 percent of their allotted annual share of 7.5 million acre-feet under the Colorado River Compact, which would seemingly leave them plenty of room to grow.³² But as the Colorado River's

flows trend downward, the upper basin states are at risk of being unable to meet the terms of the 1922 Colorado River Compact, which in the absence of cooperative agreements obligates them to ensure they don't impair the lower basin's allotment through their own diversions. If necessary, the upper basin states may have to forgo some of their agricultural, municipal and industrial uses that have been developed and relied upon for nearly a century, in order to ensure they don't cause the flow of the river at Lees Ferry to fall below 75 million acre-feet on a 10-year running average. Because the Colorado River Compact grandfathers pre-compact water rights, those rights are not at risk of being impaired and are therefore the most valuable and dependable rights on the river.

Valuable Lessons

For everyone, the hunt is on, not just for new technologies and money to pay for conservation, but for ways to ensure that risks are shared and that no one state or city faces draconian water rationing or even a shut off.

Among the major consensus-based agreements that have been crafted are the 2007 Interim Guidelines. These dictated that Lake Powell and Lake Mead would be managed jointly, whereas previously they had been managed for the most part independently of one another for the benefit of the upper and lower basin states, respectively. The 2007 guidelines also established an "Intentionally Created Surplus" program, where lower basin states could accumulate credits in Lake Mead of up to 2.1 million acre-feet of water by implementing water-saving practices such as lining canals, fallowing and desalination. This was also one of the first times that Arizona and Nevada agreed to share shortages.³³

Then, in 2012 the United States and Mexico reached a five-year agreement known as Minute 319. Mexico agreed to accept a reduction in its water deliveries at the same critical Lake Mead elevations that would trigger Arizona and Nevada to cut back. In exchange, Mexico gained the right to store water in U.S. facilities, as well as the right to share in any surpluses, plus money toward conservation programs.³⁴

As a result of the agreement, Mexico and a coalition of major conservation groups such as The Nature Conservancy and the Environmental Defense Fund, among others, gained the ability to arrange for a pulse flow for the Colorado River delta at the Gulf of California, which has not consistently received flows since the 1960s. Despite some wet years in the 1980s, the delta has remained one of the most at-risk ecosystems on the river. Both Mexico and the United States provided water for the flow, and the NGOs, including the Mexican conservation group Pronatura Noroeste, contributed one-third of the water.³⁵

Minute 319 is set to expire in 2017. Out of international necessity, the federal government has been the lead negotiator in most of the critical talks with Mexico. It is also helping guide the next round of talks that river users hope will lead to an extension of Minute 319, or a successor agreement, to continue the critical work of sharing shortages while ensuring badly needed environmental water supplies.

How much more the federal government can or is willing to do to help modernize river management isn't clear. And the seven basin states differ in their views of what the federal government should be doing. But few question that it was then-U.S. Interior Secretary Gale Norton's public threat to intervene that helped drive the creation of the 2007 Interim Guidelines.³⁶ Plus, in the past five years the federal government has proven willing to contribute cash to help move important conservation programs forward. The \$3 million it has pledged to a multi-jurisdictional agreement to pilot test market-based conservation programs in the basin was the largest contribution among the participants, which include some of the most powerful entities on the river. Together, the five parties to the agreement—the Metropolitan Water District of Southern California, the Central Arizona Project, the Southern Nevada Water Authority, Denver Water and the U.S. Bureau of Reclamation—agreed to ante up \$11 million to evaluate ways to stabilize the system so that no one will have to be curtailed or involuntarily rationed.³⁷

Most experts believe that it will take much more than \$11 million to fix the overdraft on the Colorado River, but this initial investment toward reduced consumption is considered an important step that could lead to a scaled-up approach.³⁸ For perspective, the Australian government has authorized several billion dollars to implement water-saving programs in the Murray-Darling Basin, a river that shares many similarities with the Colorado, including a recent drought of historic proportions.

Water Markets

Certain states are also contemplating increased establishment of private water markets. Such markets would allow people to sell or lease water rights freely, where the price would be dictated by the balance between demand and supply and the infrastructure exists to move the water easily from seller to buyer, all within current legal frameworks. In the past, water markets have proven unpopular in the Colorado River Basin due to political constraints. In the upper basin, for instance, water users have historically feared that if they agree to lease their water once, it could harm their future right to the water.

Advocates maintain, however, that water markets could help create more realistic pricing that reflects how much water actually costs and will help distribute it to those who need it most—or, at least, to those who are most willing to pay.³⁹

Such markets are probably best suited to intrastate transactions. However, interstate markets are already operating in the lower basin, with a large deal inked in September 2015 between the Southern Nevada Water Authority (SNWA) and the Metropolitan Water District of Southern California, which lost roughly half of its water supplies in 2015 when the Sierra Nevada mountains saw almost no snow. Under the deal, the California district will pay \$44.4 million to SNWA for the Las Vegas water provider to release 150,000 acre-feet of water it has stored in Lake Mead. That amounts to half of Nevada's annual Colorado River share, but just 10 percent of the supplies the state has stored away,

“*Within the Colorado River Basin, water users must find ways to reduce their use by at least 600,000 to 1.2 million acre-feet a year—and soon.*”

including through the Intentionally Created Surplus program in Lake Mead. Under the agreement, SNWA maintains the option to pay California back and reclaim that water down the road, if needed.⁴⁰

A mechanism sometimes used to facilitate water marketing within a region is called a water bank. These structures can be physical, administrative or legal—or all three—but in concept they allow water to be saved by a water user in a stream system and subsequently diverted to—or protected for—another purpose.

To work well, water banks must be located in regions where water can be physically and legally transferred readily between participants without harming other water rights. The water's physical movement also must be easily tracked. Ideally, they would be established on streams that need higher environmental flows—conservation groups point out that these higher stream flows will help to mitigate the vulnerability risks discussed earlier—but also where reservoirs exist that can hold “banked” water until it is needed. The bank could release water from one area, then protect it as it runs through a critical stream reach on its way to meet another water demand. Also, like financial institutions, water banks would need to generate some kind of revenue to cover the cost of operations and accounting. Successful water banking programs will also rely on new science, new engineering, and new farming methods to make water available, and then to transfer and store it in ways that adhere to the states' and river's existing laws.

System Conservation Agreement

Perhaps one of the most ambitious programs now underway between four powerful water users and the federal government is a broadly based conservation agreement. The main parties are Denver Water, the SNWA, the Central Arizona Water Conservation District, the Metropolitan Water District of Southern California, and the U.S. Bureau of Reclamation.

In mid-2014, Colorado River water users, faced with the growing threat of an imbalance between water supply and demand, launched an \$11 million multi-state, multi-jurisdictional pilot project to experiment with irrigation projects, aggressive conservation efforts and temporary water transfers that are designed to stretch available water. Their innovative effort, called the Colorado River System Conservation Program (CRSCP), seeks to develop voluntary, market-based measures that reduce water demand based on modeling developed by the U.S. Bureau of Reclamation.⁴¹

The CRSCP working group, which includes the Upper Colorado River Commission, is evaluating various proposals to reduce water use. Toward this end, they need to persuade farmers, city utilities and large industrial users to voluntarily curtail their consumptive uses in exchange for cash. The saved water would be used to replenish Lake Powell and Lake Mead and avoid future shortages.

But much of the work lies in developing precise and credible ways to measure how much water can be freed up through projects like deficit irrigation, where crops are grown using less water in a carefully managed system, and how saved water can be moved through the system without being diverted by other users. In some cases,

legislatures may have to amend existing laws or write new laws to allow water to be managed differently. Despite the challenges, each party has agreed to contribute cash toward pilot projects. The non-federal entities will contribute \$2 million each, while the U.S. Bureau of Reclamation will contribute \$3 million.

Pilot programs in the lower basin are being managed by the U.S. Bureau of Reclamation, while the Upper Colorado River Commission is overseeing pilot programs in the upper basin. Applications for individual projects have been evaluated and approved based on their cost-effectiveness per acre-foot of water saved, ease of verification, and geographic diversity.⁴² Each state and agency will continue to select the conservation measures most appropriate for its region and water users.

At least \$2.75 million of the funding will be used for pilot projects in the upper basin states of Colorado, New Mexico, Utah and Wyoming. The first effort, in Colorado's Yampa River Basin, began in July 2015. It entails splitting the hay irrigation season so that two hay cuttings instead of three are irrigated. The experiment, on the historic Carpenter Ranch, means growers will get paid for the loss of that third cutting while the unused water will be kept in the system.

Denver Water CEO Jim Lochhead and others believe that this innovative approach will be an important proving ground for even more aggressive efforts to keep water in the river and in reservoirs. "It's not agriculture. It's not urban. It's not environmental. It's all the sectors in the basin working together."⁴³

Conclusion: Re-Imagining the Colorado River

Within the Colorado River Basin, water users must find ways to reduce their use by at least 600,000 to 1.2 million acre-feet a year—and soon. Such savings would amount to a total reduction of between 4 and 9 percent of current consumptive water use basin-wide—a level of savings that is doable, according the U.S. Bureau of

Reclamation, but would only be a start. It would help offset the structural deficit in the lower basin, but still wouldn't provide water for environmental restoration or to act as a cushion for growth in the upper basin or against further reductions in streamflows due to additional increases in average temperatures like those already seen.⁴⁴

The U.S. Bureau of Reclamation's "Moving Forward" report, published in 2015 as a follow-up to its 2012 "Colorado River Basin Water Supply and Demand

Study,” stated that utilities basin-wide are planning 1.1 million acre-feet per year of water conservation and reuse by 2030. Yet at the same time, they face increased demands from growing populations.⁴⁵

In addition, agricultural users may also have to reduce their consumptive water use in the Colorado River basin in order to balance water use with the available supply. Agricultural conservation efforts, estimated to have already “saved” 1 million acre-feet over recent decades, are difficult both to calculate and to sustain. Not only are producers wary of losing productive acreage and seeing rural economies decline, but past conservation efforts haven’t necessarily translated into more water in the system. Rather, they’ve translated into increased crop yields using the same amount of water.⁴⁶

For this reason, various projects to evaluate the potential of maintaining viable agricultural operations with less water—through practices such as deficit and partial-season irrigation—are critical. The goal is to reduce actual consumptive use on farms and ranches across the Southwest without harming producers and rural communities. That will require ensuring mutual benefits—and sufficient payouts—to compensate farmers justly for their efforts.⁴⁷

Given the diversity of the basin’s states and their varying geographies, economies and laws, each state will need to choose those methods that prove most effective, as well as economically and politically feasible. Those concerned about the river’s health contend that the states must continue to adopt modern river management methods and regulations to protect flows and to better reflect the 21st-century values, such as river recreation and healthy ecosystems, embraced by the people who live and work within the basin.

From his perspective in the lower basin, Southern Nevada’s John Entsminger believes a more collaborative era is emerging and gaining traction. “The Colorado River has continually redefined itself. This is not a new dialogue, but rather one that has evolved—and continues to progress—over time.”⁴⁸ ■

Appendix: The Law of the River

The Law of the River governs how much water each of the seven states in the Colorado River Basin is entitled to draw from the river, under varying conditions. It embodies the Colorado River Compact of 1922, the Boulder Canyon Project Act of 1928, the Upper Colorado River Basin Compact of 1948, and a related set of laws and decrees, as well as an international treaty with Mexico.

1922 Colorado River Compact

This compact divided the Colorado River Basin into two hydrologic and political basins, the upper and lower. The upper basin is comprised by the states of Wyoming, Colorado, Utah and New Mexico, as well as the sliver of Arizona above Lees Ferry. The lower basin is comprised by Arizona, Nevada and California, as well as the parts of New Mexico and Utah below Lees Ferry. The compact allocated 75 million acre-feet of water for consumptive use over a running 10-year period, or an average of 7.5 million acre-feet annually, to the lower basin and assumed an equal share for the upper basin. However, the terms of the compact specify that the upper basin cannot cause the flow at Lees Ferry to fall below the 75 million acre-feet earmarked for the lower basin over any 10 years. The droughts of the 1930s, 1950s, and the 16-year period from 2000 to 2016 demonstrate that coordinated operation of Lake Powell and Lake Mead has been essential to operation of the compact.

1928 Boulder Canyon Project Act

This legislation ratified the 1922 Colorado River Compact. It also authorized the construction of Hoover Dam, which created Lake Mead, as well as the Imperial Diversion Dam and All-American Canal System to deliver water to the Imperial and Coachella valleys in California. The act also divided the lower basin's annual 7.5 million acre-feet as follows: 4.4 million acre-feet to California, 2.9 million acre-feet to Arizona, and 300,000 acre-feet to Nevada.

Mexican Water Treaty 1944

This treaty, negotiated by the United States and Mexico governments with the basin states involved merely as

observers, allocated to Mexico 1.5 million acre-feet of water annually from the Colorado River, subject to an undefined water-shortage provision. The fulfillment of the treaty water is currently met equally from the upper basin and lower basin releases. The upper basin states still dispute the decision by the federal government not to require that a share of the water come from the Colorado River tributaries in the lower basin, which would shift more of the fulfillment obligation to the lower basin.

Upper Colorado River Basin Compact, 1948

This compact allocated the portion of Colorado River water available to the upper basin states according to the following shares: Colorado 51.75 percent, Utah 23 percent, Wyoming 14 percent, and New Mexico 11.25 percent. These percentages are calculated from the total available after Arizona receives 50,000 acre-feet of the upper basin water for the portion of the state above the upper and lower basin dividing line at Lees Ferry.

Colorado River Storage Project Act, 1956

This act authorized the construction of the reservoirs, dams and power plants that would be used in the upper Colorado River Basin to regulate the flows of the Colorado River and allow storage for beneficial use, including power production. These included the Aspinall Unit in Colorado, Flaming Gorge Dam and Reservoir in Utah and Wyoming, Navajo Dam and Reservoir in Colorado and New Mexico, and Glen Canyon Dam, which created Lake Powell.

Arizona v. California, 1963

This 1963 U.S. Supreme Court ruling settled most of a dispute between Arizona and California, confirming the apportionments made to each state from the Colorado River mainstem, which provided the initial basis for Arizona to pursue the Central Arizona Project so it could fully utilize its compact entitlement.

Arizona v. California, 1964

The court ruled in 1964 that the issues in an original lawsuit Arizona brought against California about how much

Continued on page 16

The Law of the River, continued

water the states had the right to use from the Colorado River and its tributaries fell under the Boulder Canyon Project Act and not the Colorado River Compact. The Boulder Canyon Project Act dealt with mainstem Colorado River water only.

Colorado River Basin Project Act of 1968

This act authorized the construction of the Central Arizona Project (CAP) but in doing so also conferred to California a senior priority to its 4.4 million acre-foot allocation from the 7.5 million acre-foot allocation to the lower basin under the Colorado River Compact. This means Nevada and Arizona must be first to take a shortage.

Interim Guidelines 2007

This agreement, signed by the seven U.S. states that share the Colorado River and the U.S. Department of the Interior, established the conditions under which the Secretary of the Interior will declare a shortage condition in the lower basin. The agreement also established coordinated operations between Lake Powell and Lake Mead, dictating the releases that will be made from each reservoir to avoid the curtailment of uses in the upper basin while also minimizing shortages in the lower basin.

Minute 319

This binational agreement, signed by the United States and Mexico in 2012, allowed Mexico to store surplus water in U.S. facilities, while at the same time Mexico agreed to take a shortage under the same conditions that would trigger the lower basin states in the U.S. to take a shortage. The agreement also made it possible for the two nations, with support from a coalition of non-governmental organizations, to designate a pulse flow and ongoing base flows over a five-year period targeted toward restoration work along the Colorado River's channel near the river's delta in Mexico.

For additional information about the Colorado River Compact and Law of the River, see the Colorado Foundation for Water Education's report, "Citizen's Guide to Colorado Interstate Compacts," at:

https://www.yourwatercolorado.org/onlinestore/view/productdetails/virtuemart_product_id/18/virtuemart_category_id/1

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