April 2014

The State of the Colorado River

Executive Summary

The Colorado River Basin is now in its fifteenth year of drought. System runoff during this period has been comparable to or less than that in multi-decade mega-droughts identified in the paleo record.

In 2007, the Secretary of the Interior adopted the "Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead." Those Guidelines were based on an agreement reached among all seven Colorado River basin states and provided for quantified reductions in deliveries to Arizona and Nevada when the water level in Lake Mead falls below certain trigger elevations. The Guidelines were intended to provide certainty and predictability for reservoir management and shortage sharing.

CAP and Arizona are prepared for the voluntary reductions agreed to in the Guidelines. The reductions will directly reduce or eliminate deliveries to the CAP excess supply for underground storage, and severely reduce the volume of CAP water available for agriculture. The reductions prescribed in the Guidelines are not projected to impact deliveries to CAP M&I and Indian priority customers, but could trigger the need for recovery of water stored underground to firm those supplies.

It now appears that the delivery reductions in the Guidelines will be insufficient to prevent the continued decline of Lake Mead to critical elevations. Absent an equalization release from Lake Powell or other corrective measures, Lake Mead will fall below elevation 1000 within the next 6 to 8 years, even after deliveries are reduced in accordance with the Guidelines.

At elevation 1000, Southern Nevada Water Authority's ability to withdraw water from Lake Mead could be severely constrained, power generation at Hoover Dam would be significantly reduced and generators could be damaged, and there is not enough water left in storage even to satisfy California's needs for 1 year. At the same time, Lake Powell would likely be below its minimum power pool. Modeling shows that the system could take a decade to return to pre-shortage levels. Obviously, this scenario poses substantial risk to all Colorado River water users.

The continued decline in Lake Mead is due in large measure to the structural deficit that exists in the Lower Basin. Simply put, the Lower Basin uses about 1.2 million acre-feet more each year than it receives from Lake Powell and from side inflows. If steps are not taken in the next few years to correct the structural deficit, there is increased likelihood of conflict among the Basin States, the United States and Mexico.

Hydrologic shortages can still occur, even if the structural deficit is eliminated, and CAP is prepared to accept those shortages. But the current framework improperly transfers to Arizona and CAP the burden of Lower Basin system losses and federal treaty obligations. That is not what Arizona agreed to in accepting a junior priority for CAP in the 1968 Basin Project Act.

It is the responsibility of all Lower Basin states and water users and the United States to take action to close the structural deficit. Augmentation may be an effective long-term solution, but immediate action is needed to avoid critical reservoir elevations. The only available near-term options are those that reduce system losses and reduce consumptive use in the Lower Basin.

Background

As the 21st century began, the Colorado River system appeared to be in excellent condition. Lake Powell and Lake Mead, as well as other system reservoirs, were essentially full after years of abundant snow and runoff in the 1980s and 1990s. California was enjoying the use of nearly 800,000 acre-feet per year more than its 4.4 million acre-foot (MAF) annual apportionment, due in part to the abundant supply and also because the Central Arizona Project had yet to use Arizona's full apportionment from the river. But all of that soon changed.

In 2000, the observed inflow to Lake Powell was 10.5 MAF, or about 69% of the long-term average of 15.2 MAF per year. Runoff continued to decline, and in 2002 the inflow to Lake Powell was only 5.9 MAF (about 39% of average), resulting in the 2nd lowest inflow ever recorded in the 108-year observed record of Colorado River flows. In fact, the period of 2000 through 2004 saw the lowest 5-year cumulative inflow in the observed record.

By the time the drought was apparent, demands in Arizona and Nevada had increased to the point that those states were using their full entitlements of Colorado River water. California was still working on an intrastate agreement that would allow it live within its 4.4 MAF limit, which did not occur until 2003.

By mid-2005, the water level in Lake Powell had fallen to 3,555' above sea level from its July 1999 high of 3,694'—only about 5 feet below the top of its active conservation space. Likewise, Lake Mead had dropped from elevation 1214—9 feet *above* the top of the spillway—in January 2000 to elevation 1141 in May 2005.

This sharp decline in reservoir storage sparked renewed conflict among the Basin States: The Upper Basin argued that the Secretary of the Interior should reduce releases from Lake Powell to preserve storage there, while the Lower Basin, concerned about the decline in Lake Mead, argued that the Secretary was required to continue releases of at least 8.23 million acre-feet per year from Lake Powell. In 2005, then-Secretary Gale Norton warned the states that unless they reached agreement among themselves on conjunctive management of Colorado River reservoirs and Lower Basin shortage sharing, the Department of the Interior would develop its own guidelines.

The Basin States clearly heard the Secretary's message and devoted themselves to reaching an agreement on reservoir operation and shortage sharing that formed the basis for the "Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead" adopted by the Secretary of the Interior in December 2007.

Voluntary Reductions under the 2007 Guidelines and Minute 319

In addition to establishing rules for conjunctive management of Lakes Powell and Mead, the Guidelines provide for voluntary reductions in Lower Basin deliveries when the water level in Lake Mead falls below specified trigger elevations:

Elevation	Reduction
1075’	333,000 AF
1050’	417,000 AF
1025’	500,000 AF

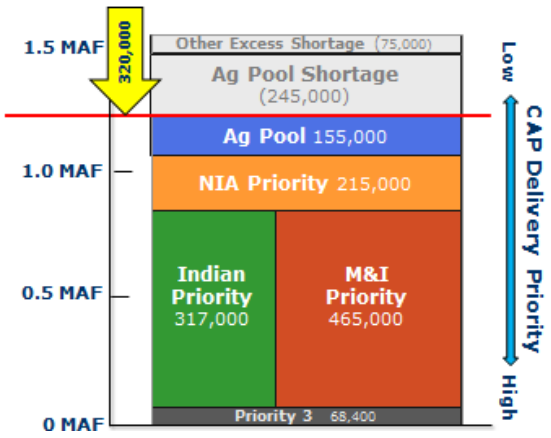
The Guidelines further provide that these reductions will be borne only by Arizona and Nevada; deliveries to California are not reduced under the Guidelines—a recognition of the junior priority imposed on CAP in the 1968 Basin Project Act. In 2012, the United States and Mexico entered into Minute 319 to their 1944 Treaty governing the Colorado River, pursuant to which Mexico also agreed to accept a voluntary reduction in treaty deliveries at the same trigger elevations specified in the Guidelines. As a result, deliveries of Colorado River water under the Guidelines and Minute 319 will be reduced in this manner:

Lake Mead Elevation	Arizona Reduction	Nevada Reduction	Mexico Reduction
1075’	320,000 AF	13,000 AF	50,000 AF
1050’	400,000 AF	17,000 AF	70,000 AF
1025’	480,000 AF	20,000 AF	125,000 AF

Modeling performed when the Guidelines were being developed showed—and the Basin States and Reclamation believed—that the delivery reductions specified in the Guidelines should be sufficient to prevent Lake Mead from reaching critical elevations through 2026, when the Guidelines expire. But if Lake Mead is projected to fall below elevation 1000, the Guidelines provide that the Secretary will consult with the Basin States to discuss further measures.

Current projections show a significant probability (55%) of a first-level shortage occurring in 2017. CAP and Arizona are prepared to manage the voluntary reductions in the Guidelines. The impact of shortage will fall to CAP excess water customers, primarily agricultural and underground storage and replenishment users. The figure on the next page shows that a shortage in 2017 will eliminate the excess water supply and reduce the agricultural supply by about 54%.

There will be no material impact to the CAP M&I and Indian priority users. The impact of deeper shortages within the context of the Guidelines will not significantly impact CAP M&I and Indian priority deliveries, but could trigger the need to recover underground storage to firm the supplies of some customers. CAP is implementing plans to prepare for the potential to recover underground storage to firm CAP water supplies.

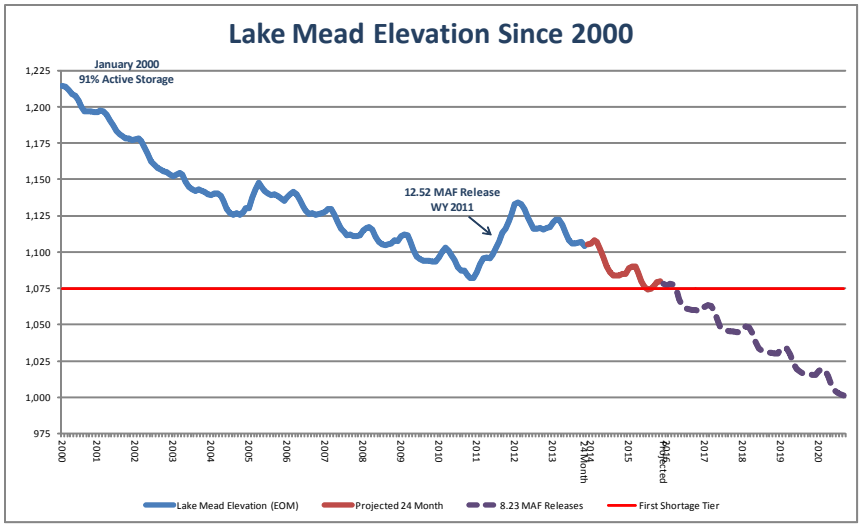


Operations Under the 2007 Guidelines

Unfortunately, the drought that led to the 2007 Guidelines did not end with their adoption. While 2005 appeared to provide some relief, low flows returned in 6 of the next 8 years. In fact, the flows in 2012 and 2013 were the lowest consecutive inflows ever observed in the Colorado River system. The current drought period (2000-2013) is the lowest 14-year period on record and is rivaled only in the flows from the mid-1100s as estimated from the paleo record.

These conditions led to the first ever annual release of less than 8.23 MAF from Lake Powell, with only 7.48 MAF being sent to Lake Mead in 2014. Reclamation now projects a 54 percent probability of shortage reductions in the Lower Basin in 2017.

As this graph shows, if the next few years do not produce a large equalization release, such as in 2011, and significant other steps are not taken to reduce usage or augment supply, then Lake Mead will continue its decline, reaching elevation 1000 within 6 to 8 years. *This will occur even though deliveries to Arizona, Nevada and Mexico are reduced to the maximum extent specified in the Guidelines and Minute 319*.



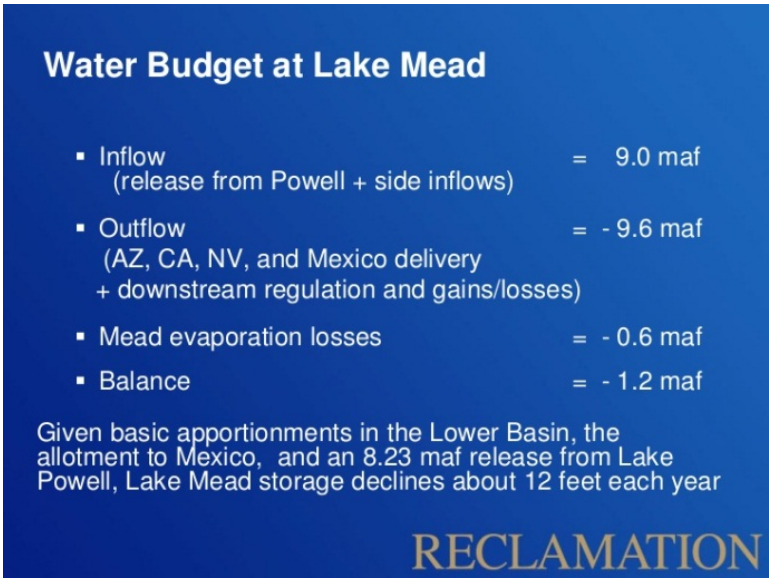
Elevation 1000 in Lake Mead should signal danger to all Colorado River water and power users because at that level:

- Southern Nevada Water Authority's ability to withdraw water from Lake Mead could be severely constrained.
- There is less than 4.3 MAF left in storage in Mead, not even enough to satisfy California's demands for one year.
- Hoover Dam's ability to generate electrical power will be greatly reduced and there could be cavitation or vibration damage to the generators.

Because Lake Mead and Lake Powell are managed conjunctively under the Guidelines, Lake Mead falling below elevation 1000 also indicates significant problems for the Upper Basin. Reclamation's modeling indicates that when Lake Mead is below 1000, Lake Powell will also be below its minimum power pool (elevation 3490) 75 percent of the time. At that elevation, there is only about 4 MAF left in storage in Lake Powell, so the Upper Basin may be unable to release even "normal" volumes of water to Lake Mead. In addition, the lack of power generation at Glen Canyon Dam will pose significant problems for Colorado River Storage Project (CRSP) power customers and for the endangered species act programs in the Upper Basin that are funded by CRSP power revenues.

<u>Why is Lake Mead Declining?</u>

It is tempting to assume that the decline in Lake Mead has been due to the drought that has gripped the Colorado River system for the past 14 years. But the simple fact is that the Lower Basin uses more water than the system normally supplies—about 1.2 MAF more each year. The result is a "structural deficit" that causes Lake Mead to drop by 12 feet or more in every year that there is a "normal" release of 8.23 MAF from Lake Powell. Under the 1970 Long Range Operating Criteria, 8.23 MAF is the "minimum objective release" from Lake Powell each year,



which is intended to satisfy Articles III(c) and (d) of the 1922 Colorado River Compact.[1]

Annual releases from Lake Powell were 8.23 MAF or more in every year from 2000 through 2013—even as much as 12.5 MAF in 2011—yet the elevation of Lake Mead fell 108 feet during that period. That is the inevitable result of the structural deficit in the Lower Basin. And the water level in Lake Mead will continue to fall unless and until annual releases from Lake Powell exceed about 9.5 MAF. Under the 2007 Guidelines, releases of greater than 9.5 MAF are only possible if Lake Powell is within the Equalization Tier—elevation 3,648 and above in 2014. (The equalization level rises every year under the Guidelines, eventually reaching elevation 3,666 in 2026.) From its current level, about 7 MAF would have to be added to Lake Powell storage to reach equalization—i.e., 7 MAF over and above the volume being released to Lake Mead, which is anticipated to be 9.0 MAF in 2015. In other words, equalization would require an inflow into Lake Powell of nearly 16 MAF, roughly the same as 2011, which was the 6th wettest year on record for the Colorado River system and resulted in the 14th highest flow observed into Lake Powell in the 108 year record.

Challenges Ahead

The coming years will present numerous challenges to Colorado River water users in the seven Basin States and Mexico:

- Minute 319 to the 1944 Treaty with Mexico, pursuant to which Mexico agreed voluntarily to share delivery reductions with U.S. water users, expires in 2017, and both nations have expressed a desire to negotiate a longer-term follow-on agreement. But Mexico has indicated that it is only willing to accept delivery reductions in the case of a real, hydrologic shortage—not one caused by over-allocation of the system.

- The 2007 Guidelines expire in 2026, but they require consultation between the Secretary of the Interior and the Basin States if reservoir elevations approach critical thresholds, and in particular if it appears that Lake Mead will fall below elevation 1000. The Secretary is required to initiate a formal review of the Guidelines by 2020 in any event. It will be difficult to reach agreement on new guidelines as long as the Lower Basin is addicted to equalization and the Upper Basin needs to maximize storage in Powell to protect its own uses against a Compact call.

[1] Article III(d) provides that the Upper Basin will not cause the flow at Lee Ferry to be depleted below an aggregate of 75 MAF over 10 years, and Article III(c) provides that the Upper Basin will supply one-half of the U.S. treaty obligation to Mexico when surplus water is not available for that purpose. However, the Upper Basin has long argued that it need only deliver an average of 7.5 MAF per year to the Lower Basin.

- The Colorado River Water Supply and Demand Study ("Basin Study")—a comprehensive, three-year effort by Reclamation and the Basin States completed in 2012—concluded that future water demands in the basin could exceed supply by several million acre-feet per year. It is clear that those future demands cannot be met without significant system improvements.

- Modeling by the Bureau of Reclamation and others suggests that climate change could reduce the annual yield of the Colorado River system by 10 percent or more. If that occurs, all of the problems the basin is already facing will be magnified.

If the Secretary and the Basin States do not act now to address the existing problems on the Colorado River—including, notably, the structural deficit in the Lower Basin—the chances of successfully resolving these future challenges are slim.

Corrective Action is Needed

The 1.2 MAF structural deficit in the Lower Basin necessarily drives the elevation of Lake Mead down. Reclamation's modeling indicates that the deficit must be reduced by at least 900,000 acre-feet per year to "bend the curve"—that is, to stop the automatic decline in Lake Mead water elevation under normal hydrologic conditions.

Ultimately, there are only three ways to reduce the structural deficit: reduce demands, increase supply or reduce system losses. Realistically, it will take a combination of all three to address the problems of the Lower Basin.

Augmentation

The 1968 Colorado River Basin Project Act directed the Secretary of the Interior to study long-range demands and supply availability and to develop a plan to meet the future water needs of the West. The resulting study, published in 1975, found that the natural water supply of the Colorado River system would be insufficient to meet the growing demands of the basin, thus leading to future shortages. The study concluded that, unless the Basin States were willing "to accept the limitation in water supply and pattern the economic and social future of the basin to that limitation," the only option available was "to augment the flows of the Colorado River thus increasing its water supply and permitting continued growth of water dependent developments."[2]

[2] U.S. Department of the Interior, Critical Water Problems Facing the Eleven Western States (1975), at 170-171.

Although Reclamation identified several viable means of augmenting the Colorado River, and in some cases even developed specific augmentation proposals, the United States has never initiated any augmentation program.

Several years ago the seven Colorado River Basin States renewed the investigation of augmentation and identified feasible augmentation alternatives. That report was published in 2008.

The more recent Basin Study builds on that earlier augmentation work and outlines four action portfolios to address the imbalance between Colorado River water supply and water needs in the basin. Each of those portfolios includes one or more augmentation components.

Augmentation options include desalination of seawater or brackish groundwater, importation of water from other basins, weather modification (cloud seeding) and vegetation management. Many of these options will be expensive and take a long time to implement. Work is ongoing to explore the concepts.

Reducing System Losses

Approximately 600,000 acre-feet is lost each year due to evaporation in Lake Mead. Reservoir evaporation in the Upper Basin is charged proportionally to each state as a consumptive use, but that is not the case in the Lower Basin where evaporation simply reduces the volume of water in storage and accelerates shortage. Because Lower Basin shortages fall primarily on the Central Arizona Project, it is CAP that effectively bears the burden of evaporation losses in Lake Mead.

Another 600,000 acre-feet is lost annually below Lake Mead. Some of that loss—about 100,000 acre-feet—results because the United States is not operating the Yuma Desalting Plant. The YDP was constructed to allow the United States to meet its treaty commitments to Mexico. In Minute 242 to the 1944 Treaty, the U.S. agreed to effect a “permanent and definitive solution” to address Mexico's salinity concerns. The United States determined that a desalting plant was the only alternative that would solve the salinity problem without unacceptable adverse impact on the Basin States’ water supply. The 1974 Colorado River Basin Salinity Control Act authorized construction of the YDP and made replacement of the YDP reject stream and any water bypassed to Mexico a national obligation. But the United States has elected not to operate the YDP, largely due to cost considerations. Because the agricultural drain water that was to be treated by the YDP is instead bypassed to Mexico without being credited against the U.S. treaty delivery obligation, Reclamation must release an equivalent volume of water each

year out of storage in Lake Mead. In effect, then, this portion of the "national obligation" to deliver water to Mexico will fall on CAP when shortage is declared.

Additional water is lost every year when Colorado River contractors do not take delivery of water that Reclamation released from Lake Mead at their request. CAP, in partnership with Southern Nevada Water Authority and the Metropolitan Water District of Southern California, funded construction of the Brock Reservoir in California to store such water. Although Brock Reservoir appears to be meeting or exceeding its projected savings, Reclamation still reports 60,000 acre-feet or more or water "ordered but not taken" each year. That loss also falls ultimately on CAP, rather than on the contractor that ordered the water.

Reducing Demand

Demand can be reduced by conservation, reuse and replacing Colorado River water with local supplies. All of these activities are already being implemented successfully in the Lower Basin. In Arizona, municipal water users have invested heavily in water conservation strategies resulting in part from the adoption of the 1980 Groundwater Management Act. More than 80 percent of Arizona's population resides in active management areas with statutorily mandated water conservation requirements. In the CAP service area, more than 90 percent of the population is served by cities that have implemented Best Management Practices.

Arizona also leads the nation in the implementation of water efficient reuse programs. More than 95 percent of treated wastewater generated within central Arizona is beneficially used for agriculture, municipal and industrial uses, groundwater recharge, power generation and turf irrigation.

To date, the water savings generated by conservation and reuse have been used to accommodate the rapid growth experienced by Arizona, California and Nevada. But fixing the structural deficit will require dedicating a portion of future savings for the benefit of the Colorado River system.