

APPENDIX A: THE STRUCTURAL DEFICIT

The structural deficit—historical context and implications for the future

In 2012 the Bureau of Reclamation, in collaboration with the seven Basin States, published the results of the Colorado River Basin Water Supply and Demand Study, also known as the “Basin Study” (Bureau of Reclamation, 2012). The goal of the Basin Study was to quantify historical, current, and projected supplies and demands. The multi-year study projected out approximately 50 years to identify and quantify any supply and demand imbalances. The study also identified specific “options” that could be implemented to reduce, if possible, any imbalances. Reclamation solicited these options from any interested stakeholder, and modeled their effects using Reclamation’s technical modeling software. Modeling a variety of supply and demand scenarios, the Basin Study concluded that demands will continue to rise and supplies will stay roughly the same or be slightly reduced. Both contained some uncertainty, especially the supply scenarios, but overall the median difference between supplies and demands by 2060 was a 3.2 million acre-feet shortfall.

Irrespective of future supply and demand imbalances, however, current demands from Lake Mead (the primary “bank account” for the Lower Basin) are greater than average inflows to Lake Mead (outflows from Lake Powell). In an average year, Lake Powell releases 8.23 million acre-feet to satisfy the Upper Basin’s obligation not to deplete the flows at Lee Ferry below 75 million acre-feet over any ten-year period, as well as the Upper Basin’s half of the 1.5 million acre-feet delivery obligation to Mexico, per the Colorado River Compact of 1922 and Mexican Water Treaty of 1944. Downstream of Lee Ferry, approximately 750,000 additional acre-feet enters the main stem from tributaries in or around the Grand Canyon. Therefore, in average years, approximately 9 million acre-feet flows into Lake Mead. From Lake Mead, there are numerous releases to satisfy demands of the Lower Basin States, Mexico, and downstream regulation and gains/losses. These outflows total 9.6 million acre-feet. Additionally, approximately 600,000 acre-feet is lost to evaporation at Lake Mead in an average year. Given these average inflows and outflows, in most years Lake Mead loses 1.2 million acre-feet more than is replaced. This 1.2-million-acre-foot imbalance is known as the Lower Basin structural deficit.

The structural deficit, in combination with projections that increase the supply and demand imbalance, has created a situation where more water is allocated than is physically available in most years and this situation will get worse in the coming decades. What this has translated to is a relatively steady decline in Lake Mead elevation levels for the past 15 years. While the structural deficit is a relative non-issue in big snowpack years (e.g., 2011) because there are additional releases above 8.23 million acre-feet from Lake Powell, Lake Mead nonetheless continues to decline: it has

been drawn down from about 91% full in 2000 to approximately 40% full in the spring of 2017.

Despite the structural nature of this supply and demand imbalance, until recently the term “structural deficit” was a politically sensitive term and was not often discussed openly—similar to climate change. Accordingly, there have been no explicit attempts to fix the problem. More recently, however, water managers and stakeholders are willing to openly discuss both the structural deficit and climate change. The people negotiating Colorado River Basin decisions and policies know that the long-term situation needs restructuring. As one person interviewed for this project put it, “They all know their current uses are not sustainable.”

Because the structural deficit is the result of management of the river and not a hydrological phenomenon, the logical question is how the situation came to be. Specifically, how did the river become over-appportioned leading to outflows greater than inflows to the system’s main reservoir storage? Many have suggested the fatal flaw in Colorado River Basin management dates back to the creation of the original Colorado River Compact of 1922. The average flow of the River around the time the Basin States representatives were negotiating how best to allocate its waters was substantially higher than what became the contemporary average flow. It is assumed that because of this, the representatives simply thought there was more water available in the River than would turn out to be the case. According to the minutes of the Compact negotiations, however, it seems that the representatives did recognize that the flow of the Colorado River would not always be as high as it was during that time period. Despite this, the representatives assumed there would always be sufficient water available to the Basin States, especially because they knew large storage projects would eventually be built throughout the Basin.

Shortly after the Compact was signed in 1922, Secretary of Commerce Herbert Hoover—who was the federal representative for the negotiations and a signatory to the Compact—testified about the Compact before the House Committee on Irrigation and Reclamation. His testimony is quite illuminating about the negotiators’ intent with the Compact and their confidence in its allocations. At the time of his testimony in 1926, Arizona had not yet agreed to the Compact citing concerns over Arizona’s potential allocation. Discussing these concerns, Hoover describes:

“I feel that this opposition so far as water rights are concerned arise out of a miscalculation as to the resources of the Colorado River. Certainly for all practical development that could be undertaken within the next 75 years there is more water than can be used by the whole of the 7 states. The Colorado River compact allots approximately 60 per cent of the water. 40 per cent of it as provided in the compact can be reallocated at the end of 40 years. There is ample

provision therefore for readjustment in the respective rights of the different states based upon the merits at that time” (Hoover, 1926, p. 5).

Clearly the negotiators thought there was plenty of water for the foreseeable future, and that should states want to develop additional water they could do so after 40 years of the Compact being in place. More interesting, however, is that Hoover goes on to discuss how in general they did not have the audacity to think they could actually allocate the Colorado River indefinitely and for future generations:

“It seems to me almost fantastical to be fighting the shadows of what may happen under these circumstances 75 years hence. Suppose we had endeavored in 1850 to determine and settle for today what would have been the best solution of any of a hundred problems. For instance, Faraday’s great discovery in electrical induction, from which the whole electrical development of the world has sprung – who could have foreseen its effect on the best solution.

I am one of those who have a great deal of confidence that all anticipations over physical questions inevitably bend themselves to the forces of the life *and that if we can provide for equity for the next 40 to 75 years we can trust to the generation after the next to be as intelligent as we are today. They will settle it in the light of the forces of their day*” (emphasis added) (p. 6).

This suggests, at least from Hoover’s perspective, that the negotiators of the Compact did not intend to make the original allocations of the Compact static. In fact, though the Compact was put in place indefinitely, the negotiators included a clause for modification of the Compact. Article VI of the Compact allows for States to modify or adjust the Compact if all States agree and are given approval by each State’s legislature. Further, Article X of the Compact allows for the termination of the Compact at any time, given unanimous agreement by the Basin States.

In addition to this understanding of the original intent of the Compact, in the decades following its conception a recognition emerged regarding the specifics of how the Colorado River might be over-allocated. Engineering studies began to determine that if many of the projects that Reclamation and the States had started to propose were finally built, the system would not be able to sustain all those demands. For example, Reclamation released a report in 1946 about development potential throughout the Basin (Bureau of Reclamation, 1946). Using historical records and gauge station data from 1897-1943, Reclamation estimated that the annual average virgin flow of the Colorado River at the International Boundary was 17,720,000 acre-feet. Further, Reclamation estimated that if existing, authorized, or potential projects identified were fully developed, present and potential stream depletions could be as large as 20,197,200

acre-feet annually. It is important to note that Reclamation's long-term estimate of flow at the International Boundary (17,720,000 acre-feet) is well above the 1922 Compact apportionments and subsequent 1944 Treaty with Mexico apportionment. Indeed, as Secretary Hoover noted in his testimony above, they believed there was plenty of water available for the foreseeable future. It is equally important to note that many of the potential projects identified by Reclamation have not come to fruition and will most likely never be built (e.g., Marble Canyon Dam in northern Arizona). In other words, this specific study included more projects than are currently built (or proposed), but the 1946 Reclamation Report is important because it was the beginning of the recognition that the Colorado River Basin had long-term limits on what could reasonably be developed.

Similarly, and also in 1946, a prominent water attorney for California, Northcutt Ely, wrote a report for the Colorado River Water Users' Association (CRWUA) about the recent ratification negotiations for the 1944 Treaty with Mexico (Ely, 1946). In this report, Ely presents a Lower Basin water budget based on the Compact allocations at that point in time. Ely's budget demonstrated that if California were to receive its full allocation of 5,400,000, then there would only be 1,000,000 acre-feet for Arizona (as opposed to its 2,800,000 acre-foot Compact apportionment). Conversely if Arizona were to receive its full 2,800,000 acre-foot allocation, then California would only be able to use 3,600,000 acre-feet (as opposed to its full 5,400,000 acre-foot Compact apportionment). It is important to note that this budget is based upon California using 5,400,000 acre-feet as opposed to its original allocation (and what they are currently limited to today) of 4,400,000 acre-feet. Despite this difference in California's use, some basic accounting revealed what could happen, and indeed what is happening today, with the structural deficit. As noted by Ely in his conclusion, "No sound planning can be done for new projects until the water budget is balanced again in some way" (p. 20).

In the following decades, it became more clear that Reclamation may have over-estimated Colorado River flows and that the basic apportionments in the 1922 Compact may not be fully achievable. In 1955, a report by private consultants for the Colorado Water Conservation Board used updated streamflow records to determine the viability of the Upper Basin's apportionment. The report concludes, "All of the 7,500,000 acre-feet of water per annum apportioned to the Upper Basin by the Colorado River compact may not actually be available for use because of the requirement that 75 million acre-feet be delivered at Lee Ferry during each consecutive 10-year period" (Colorado Water Conservation Board, 1955, p. 29). Specifically, the study found that the Upper Basin's total depletions could be no more than 6,200,000 acre-feet annually if they were to comply with the 1922 Compact. It has been suggested this was the first official documentation that even the original Compact may have over-apportioned the River and the Upper Basin might not be able to use its full apportionment (McClurg, 1997, p. 38).

A decade later, the Upper Colorado River Commission contracted an engineering firm to again examine the reliability of the Upper Basin's basic apportionment. The 1965 report determined that the long-term average that the Upper Basin could expect to be available was closer to 5,800,000 acre-feet annually (Tipton & Kalmbach, 1965). Wayne Aspinall, a prominent lawyer and politician from Colorado, later expressed concern about this already occurring short-fall of the Upper Basin's apportionment during congressional testimony in 1968 regarding additional Colorado River Basin development. Citing these previous engineering studies, Aspinall explains, "Thus, due to the vagaries of nature, the Upper Basin States are already suffering curtailment in their total water resource development to an amount 20% under that apportioned to them by the Colorado River Compact. The risks involved in further curtailment of the Upper Basin's social economic development as the result of further curtailment of their water uses are real, not imaginary" (Colorado River Basin Project-Part II, 1968, pp. 753–754). Aspinall was concerned that additional development of the River in the Lower Basin would exacerbate an already problematic situation for the Upper Basin.

Specifically, Aspinall's concern regarded the proposed Colorado River Basin Project Act. This Act would authorize a number of projects throughout the Basin, most notably the Central Arizona Project (CAP) which would bring a large share of Arizona's Colorado River apportionment to Central Arizona for agricultural and municipal use. As such, there was significant debate about water supply availability for the CAP. Many of the large projects had been built by this time (e.g., Hoover Dam, Glen Canyon Dam)—and in light of the engineering studies discussed above—leading some decision-makers to express uncertainty as to just how much water might be available for long-term use by the CAP.

At the heart of this uncertainty was how much water the CAP could come to rely on in the long-term as both the Lower and Upper Basin moved towards utilizing their full allocations. The Bureau of Reclamation examined this question, and presented some of their findings to Congress in 1965. Reclamation's Commissioner at the time, Floyd Dominy, argued that the CAP should have a reliable supply for the first decade or so, but, as additional developments occurred throughout the Basin, the CAP's supply would gradually decrease. Specifically, he thought that through 1990 the CAP could reliably divert 1,200,000 acre-feet annually. By the year 2000 this would decrease to approximately 900,000 acre-feet, and finally by the year 2030 this would be down to approximately 580,000 acre-feet. The cause for this decline, Dominy suggested, was increasing depletions in the Upper Basin (Subcommittee on Irrigation and Reclamation, 1965). This suggestion that the available supply for the CAP would decline over the coming decades is quite revealing, given that Dominy was a prominent supporter of many of the existing or proposed projects, including the CAP.

Given this acknowledgement of over-allocation and recognition that the CAP would eventually have to reduce its use, how could Dominy and others still support the Colorado River Basin Project Act? Indeed, the Act was ultimately signed into law in 1968, authorizing the CAP and a number of other development projects. The justification for the Act revolved around a key concept of river basin development that was often discussed in that time period: augmentation. Reclamation, the States, and others knew the only long-term solution to balance the Colorado River budget—especially once projects such as the CAP came online—was to augment the supply of water from other river basins in the United States. Only once new water was brought into the Colorado River Basin could each of the States have a long-term, reliable supply.

Not only did the Act include explicit augmentation language, but much of the discussion during Congressional hearings before the Act passed revolved around augmentation. During the same Congressional testimony where Dominy had discussed a declining availability of water for the CAP, many of the Act's proponents and Congressmen had many discussions about augmentation. For example, Congressman Harold Johnson from California was questioning Secretary Udall and Dominy about some of the proposed projects. Congressman Johnson wanted to know more about the specifics of augmentation, and whether it would have an impact on California's Colorado River apportionment:

"Mr. Johnson: In your statement you recognize the fact that you can reclaim a considerable amount of water in the Colorado River Basin at the present time, taking it away from the phreatophytes and other means of diverting water from the river, with lined canals and works of that nature which would recover, I believe you said, something like 650,000 acre-feet of water. Then as we move out into the other areas we have the desalinization program being carried on and other developments in northern California.

I want to say we are now going to be diverting into southern California approximately 2 million acre-feet of water in the near future, and the north coastal area has water not being put to beneficial use at the present time. It is not my understanding that this legislation calls for any of that water to be taken from the 4.4 million acre-feet of water. This legislation would guarantee California 4.4 million acre-feet of water from the Colorado as its proper share.

The legislation does not entail, if we were to bring in a source of saline water for an additional source of water to northern California, that this

would have anything to do with the reduction of the amount of water from the Colorado into 4.4 million acre-feet. Is that correct?

Secretary Udall: The gentleman is correct in that assumption.

Mr. Johnson: As we look to the Pacific Northwest and other areas of the United States for water to bring into the Colorado River watershed this would build up the additional 2.5 million acre-feet which you figure is absolutely necessary, and those studies are provided in the legislation.

Secretary Udall: That is correct" (Subcommittee on Irrigation and Reclamation, 1965, p. 131).

A few years later during additional Congressional testimony in 1968, it is evident again that the idea of augmentation is neither controversial nor far-fetched. Congressman Mo Udall from Arizona pressed Dominy on whether or not the CAP had a favorable benefit-cost ratio. To clarify the argument, Udall posited a hypothetical where both the Upper and Lower Basins utilized their full compact allocations, and questioned whether the CAP would have to reduce its Colorado River use in that scenario. Udall included in this hypothetical an assumption that is particularly revealing: "Let's assume there is no augmentation in the river—not a drop. I think this is a very violent assumption, *because I am as sure as anything in this life that there will be augmentation*" (Colorado River Basin Project- Part II, 1968, p. 837; emphasis added). Clearly Udall thought that augmentation at some point in the future was a given, and water managers could count on supplemental supplies as demands continued to increase.

A book published in 1977 by author Rich Johnson detailing the history of the CAP from 1918-1968 further reveals this focus on augmentation. In the book, Johnson recounts discussion about a previous legislative attempt to authorize the CAP. In 1966, the House was considering H.R. 4671, which would have authorized the CAP and several other Lower Basin projects (this was the predecessor to the Colorado River Basin Project Act). Johnson notes:

"Secretary Udall and Commissioner of Reclamation Floyd Dominy appeared in support of H.R. 4671. *Both agreed that augmentation of the Colorado River water supply would be necessary if all long-term needs of the Basin were to be met*, and Secretary Udall indicated that such augmentation could be achieved by desalting sea water or by importing fresh water from northern California or from the Columbia River below Bonneville Dam" (Johnson, 1977, p. 186; emphasis added)

As mentioned above, the Colorado River Basin Project Act actually contained specific language about the need for augmentation. In Title II, Section 202 of the final version, there is a revealing paragraph about obligations under the Mexican Water Treaty of 1944 and augmentation:

“Accordingly, the States of the Upper Division (Colorado, New Mexico, Utah, and Wyoming) and the States of the Lower Division (Arizona, California, and Nevada) shall be relieved from all obligations which may have been imposed upon them by article III(c)²⁹ of the Colorado River Compact *so long as the Secretary shall determine and proclaim that means are available and in operation which augment the water supply of the Colorado River system in such quantity as to satisfy the requirements of the Mexican Water Treaty together with any losses of water associated with the performance of that treaty;*

Provided, That the satisfaction of the requirements of the Mexican Water Treaty (Treaty Series 994, 50 Stat. 1219), shall be from the water of the Colorado River pursuant to the treaties, laws, and compacts presently relating thereto, *until such time as a feasible plan showing the economical means of augmenting the water supply available in the Colorado River below Lee Ferry by two and one-half million acre-feet shall be authorized by the Congress and is in operation as provided in this Act*” (emphasis added).

The recognition of the need for augmentation was so prevalent among those crafting the legislation that it concerned Senators in the Pacific Northwest, as much of the discussion was about utilizing the waters of the Columbia River for Colorado River Basin augmentation. These Senators were concerned about potential harm to the Columbia River Basin if significant quantities of water were to be transferred out of that Basin and into the Colorado River Basin. The concern was so strong that in order to get those Senators’ support for the Act, the bill’s proponents had to include language that would not only halt proposals for augmentation from any river basin in the United States, but would also halt any *studying* of augmentation for a ten-year period. Title II, Section 201 states:

“For a period of ten years from the date of this Act, the Secretary *shall not undertake reconnaissance studies of any plan for the importation of water into the Colorado River Basin from any other natural river drainage basin lying outside the States of Arizona, California, Colorado, New Mexico, and those portions of*

²⁹ Article III (c) of the Colorado River Compact specified how future Mexico allocations would be supplied.

Nevada, Utah, and Wyoming which are in the natural drainage basin of the Colorado River” (emphasis added).

The tension between policy-makers in the southwest and the Pacific northwest is illuminated by a conversation remembered by Colorado River Scholar Brad Udall. During a 2005 talk to the Colorado River Project Symposium in Santa Fe, New Mexico, Brad recalled a conversation between Senator Henry “Scoop” Jackson of Washington and Brad’s father, Representative Mo Udall of Arizona, regarding importation of water into the Colorado River Basin. After the language regarding the outlawing of studying importation for ten years was added to the bill, Brad Udall recalled this conversation regarding importation: “my father asked Scoop one time if he could dream about it, if he could even just dream about it, and Scoop said, ‘Mo, you’re not allowed to dream about it, you’re not to think about it. The only thing you’re allowed to do is forget about it’” (McClurg, 2005, p. 109). Despite this tension, the Act was ultimately passed and signed into law, in part because of the ten-year moratorium on augmentation reconnaissance.

In sum, it appears the source of the structural deficit is not just because the Colorado River Compact of 1922 was negotiated during a particularly “wet” period. But rather, the intentions of the negotiators were such that future generations could reallocate the Colorado River, as Secretary Hoover put it, “in the light of the forces of their day”. Further, many of the negotiators and decision-makers assumed that long-term reliability on the system required augmentation from outside the hydrologic basin. Specifically, they knew that completion of the proposed projects would over-allocate the system, but by the time that over-allocation would physically occur the federal government would have built sufficient augmentation projects to supplement the water of the Colorado River. For a variety of reasons, those augmentation projects have not been built and most likely will never be built. Thus, the structural deficit exists today and decision-makers are struggling with the consequences. Or, as the interviewee quoted at the beginning noted, “They all know their current uses are not sustainable.”

References:

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