

[EXTERNAL] Request for Input on Development of Post-2026 Colorado River Reservoir Operational Strategies for Lake Powell and Lake Mead Under Historically Low Reservoir Conditions

Douglas Blatchford <dblatchford@swh20.net>

Sat 8/27/2022 6:46 PM

To: CRB-Info, BOR <bor-sha-LCB-Info@usbr.gov>

Cc: Douglas Blatchford <dblatchford@swh20.net>

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Attached are written suggestions for operational strategies on the Colorado River. If there are questions or concerns, or if I can be of further assistance, please do not hesitate to contact me at the telephone number below, or at this email address.

respectfully,

Douglas Blatchford

--

Douglas B. Blatchford, PE, PH, CEM, CFM

President, Southwest Hydrology & Hydraulics, LLC

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Southwest Hydrology & Hydraulics, LLC

Experience in Water Resources

August 27, 2022

The Honorable Joseph R. Biden
President
The White House
1600 Pennsylvania Avenue, N.W.
Washington, D.C., 20500

The Honorable Debra Haaland
Secretary
U.S. Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

The Honorable Tanya Trujillo
Assistant Secretary for Water and Science
U.S. Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

The Honorable Camille Touton
Commissioner
U.S. Bureau of Reclamation
1849 C Street, NW
Washington, D.C. 20240

Dear President Biden, Secretary Haaland, Assistant Secretary Trujillo, and Commissioner Touton:

Given the dire conditions on the Colorado River, and clear lack of consensus, Southwest Hydrology & Hydraulics, LLC makes the following suggestions to close the gap between water supply and demand on the Colorado River (attached).

The following is recommended immediately:

Request for Input on Development of Post-2026 Colorado River Reservoir Operational Strategies for Lake Powell and Lake Mead Under Historically Low Reservoir Conditions

- Create a *National Water Czar*

To manage the Colorado River Basin's long-term water supply, various entities will require strong leadership at the Federal level; therefore, we suggest establishing a National Water Czar or equivalent that has authority to work across agencies at the Executive level, controlling both resources and funding. Maximizing the water storage capacity of the Colorado River Basin immediately is a challenging assignment that must coordinate the multi-agency, multi-Bureau, efforts.

- Invoke the Defense Production Act

Another Federal authority that could be utilized is the Defense Production Act (DPA). Water insecurity on the Colorado River translates to a major national security challenge for the United States, given the economies of the Basin States and Tribes, especially the defense industries in southern California, Arizona, and New Mexico, among many other locations. Invoking DPA would give the president of the United States broad emergency powers that could be delegated to the Secretary of the Interior, above and beyond powers granted through existing authorities.

- Streamline permitting

Specific authority should be provided to the National Water Czar or the Reclamation to expedite environmental permitting of water projects that enhance water supply and reduce water demand, with the intent to comply with the intent of environmental protections yet reduce the risk of third-party obstruction through environmental lawsuits.

Attached are letters outlining additional recommendations. Mr. John J. Entsminger, General Manager of the Southern Nevada Water Authority, notes the lack of political will to forge collective action. The Honorable Catherine Cortez Masto and Honorable Jackie Rosen recommend immediate implementation of SNWA's proposals. Additional recommendations from my experience on the Colorado River are attached.

With warm regards,

Douglas B. Blatchford, PE, PH, CFM
President, Southwest Hydrology & Hydraulics, LLC



SOUTHERN NEVADA WATER AUTHORITY

1001 South Valley View Boulevard • Las Vegas, NV 89153
(702) 258-3939 • snwa.com

August 15, 2022

The Honorable Debra Haaland, Secretary of Interior
Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

The Honorable Tanya Trujillo, Assistant Secretary for Water and Science
Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

The Honorable Camille Calimlim Touton, Commissioner
Bureau of Reclamation
1849 C Street, NW
Washington, D.C. 20240

Dear Secretary Haaland, Assistant Secretary Trujillo, and Commissioner Touton:

Sixty-two days ago, Commissioner Touton and I sat side by side in the United States Senate and conveyed to the world that the Colorado River is on the brink of a crisis. She testified that between two and four million acre-feet of additional conservation is needed to protect critical elevations in Lakes Mead and Powell in 2023 and every single year thereafter, and I testified that what has been a slow-moving train wreck for twenty years in accelerating and that our moment of reckoning is near. We were both right then and we're both right now.

Yet despite the obvious urgency of the situation, the last sixty-two days produced exactly nothing in terms of meaningful collective action to help forestall the looming crisis. The unreasonable expectations of water users, including the prices and drought profiteering proposals, only further divide common goals and interests. Through our collective inaction, the federal government, the basin states and every water user on the Colorado River is complicit in allowing the situation to reach this point.

In the absence of the political will to forge collective action, Nevada will continue our efforts to ensure the security and sustainability of our community. We have been clear-eyed and pragmatic about the realities of the situation confronting the river from the beginning. Nevada has spent the last two decades and billions of local dollars preparing for precisely the scenario that confronts us now. The Southern Nevada Water Authority invested \$1.4 billion engineering and constructing the third intake and low lake level pumping station to ensure our community's access to water in Lake Mead even if conditions deteriorate to the point that water cannot be released from Hoover Dam downstream to the country of Mexico and to water users in California and Arizona. Our community has blazed the trail for urban water conservation both nationally and internationally by reducing our consumptive use from the river by

SNWA MEMBER AGENCIES

Big Bend Water District • Boulder City • Clark County Water Reclamation District • City of Henderson • City of Las Vegas • City of North Las Vegas • Las Vegas Valley Water District

26 percent while adding more than 750,000 people to our valley. This year alone, we will leave sixty-five thousand acre-feet of water in Lake Mead – water that we’re legally entitled to divert and consume.

Nevadans are not the kind of people to rest on our laurels, and we are not stopping there. We have a workable plan to reduce water use from 110 gallons per capita per day to 86 gallons by 2035. These measures are not easy to implement. Every sector of our community has been – and will continue to be – required to make sacrifices, our elected officials will continue to make hard but necessary decisions, and we will continue to lead by example in the hopes that enough people of good will throughout the basin will join us on the path to water security.

To the broader river community, I say this: The Law of Mass Balance dictates that the Colorado River cannot provide enough water for the current level of use. The magnitude of the problem is so large that every single water user in every single sector must contribute solutions to this problem regardless of the priority system. The math is simple, even if the law and the politics are not: the bulk of the responsibility to reduce use falls upon water users downstream of Hoover Dam, because that is where the bulk of the water is used.

We are at the stage where basin-wide every drop counts, and every single drop we are short of achieving two to four million acre-feet in permanent reductions draws us a step closer to the catastrophic collapse of the system, as well as draconian water management practices to protect health and human safety that we have successfully staved off in the past through cooperation. Each temporary action must be a bridge to permanent reductions and must be implemented post-haste. We must not sit by and celebrate the small victories that fall short of the goal because to do so does a disservice to the communities we serve.

Our next chapter must be nimble, swift, decisive, and action-oriented. The Secretary of Interior has the tools to prevent the reservoirs’ decline if there is the support and fortitude to use them. To that end, we recommend the following actions be taken to minimize the consumptive uses of water from the Colorado River through existing federal authorities, programs, and appropriations:

- Create new beneficial use criteria for Lower Basin water users, eliminating wasteful and antiquated water use practices and uses of water no longer appropriate for this Basin’s limited resources
- Develop criteria for managing facilities, reservoirs, and projects for health and human safety operations in order to create certainty and predictability in the face of further reservoir declines
- Create a basin-wide municipal turf removal program to increase payments to customers where publicly available programs already exist
- Expand agricultural efficiency improvements that result in consumptive use reductions
- Eliminate wasteful municipal watering of non-functional turf and require seasonal irrigation schedules be implemented and enforced
- Invest in water reuse, water recycling, and desalination programs
- Purchase additional lands under the Lower Colorado River Multi-Species Conservation Program to prepare for habitat restoration under a significantly modified system
- Incentivize conversions to lower water-use crops
- Charge each contractor for evaporation and losses in the Lower Basin so that the Lower Basin can reduce its reliance upon excess water from the Upper Basin to balance reservoirs

- Reprioritize Salinity Control Act funding to only those projects that reduce consumptive uses of water, including following agreements and the purchase of marginal lands
- Accelerate and fund necessary improvements and modifications at Glen Canyon Dam that will increase predictability and reliability of releases under low reservoir conditions
- Prioritize federal funding for drought mitigation to those projects that provide meaningful long-term and permanent reductions in use

Without active and aggressive federal leadership, the states have always wallowed. We welcome an expedient and aggressive approach to implementing these actions. Writing the next chapter will require each and every water manager to convince their elected officials and governing bodies that sacrificing something is the only way to save everything. Should these efforts fail, we are ready to work with any of our willing partners on common-sense federal legislation that helps bring water usage in line with the river's modern-day hydrology. By missing this deadline, we are doing a disservice to every person, city, ecosystem, farmer, rancher, and tribal nation that relies upon the Colorado River; however, through bold and decisive action, we still have a chance to ensure the safety of all our communities.

Nevada stands ready.

Sincerely,

A handwritten signature in black ink, appearing to read "John J. Entsminger". The signature is fluid and cursive, with a long horizontal stroke at the end.

John J. Entsminger
General Manager

United States Senate

WASHINGTON, DC 20510

August 16, 2022

The Honorable Debra Haaland
Secretary
U.S. Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

The Honorable Tanya Trujillo
Assistant Secretary for Water and Science
U.S. Department of the Interior
1849 C Street, NW
Washington, D.C. 20240

The Honorable Camille Touton
Commissioner
U.S. Bureau of Reclamation
1849 C Street, NW
Washington, D.C. 20240

Dear Secretary Haaland, Assistant Secretary Trujillo, and Commissioner Touton:

We are writing to you regarding the worsening drought crisis in the Western U.S. and the recent actions taken by the Department of the Interior (DOI) to preserve the Colorado River System.

On June 14, 2022, Commissioner Touton testified before the Senate Energy and Natural Resources Committee about the urgent need for states and tribes throughout the Colorado River Basin to develop a plan to reduce water consumption to address the historic drought before an August 16, 2022 deadline.¹ Unfortunately, the deadline set by DOI has now passed without an agreement.² Following the recent announcement by the DOI asking Nevada, Arizona, and Mexico to make additional cuts to their water usage to conserve water along the Colorado River Basin,³ we call on you to take additional federal actions and measures to ensure *all* Lower Basin states are contributing to the Basin-wide conservation required to meet the severity of this crisis.

To assist with these efforts, we believe Nevada's decades of leadership in water conservation can provide a vital blueprint for the Colorado River Basin's future. Accordingly, we urge the expedient implementation of the proposals put forward by the Southern Nevada Water Authority (SNWA). These proposals, laid out in an Aug 15, 2022 letter to you by SNWA General Manager

¹ U.S. Congress, Senate Committee on Energy and Natural Resources. "*Short And Long Term Solutions To Extreme Drought In The Western U.S.*", Statement of the Honorable Camille Touton, 117th Cong., 2nd sess., June 14, 2022. Hereinafter "2022 Drought Hearing."

² Lochhead, Colton. "*Water authority chief blasts other states that rely on Colorado River.*" Las Vegas Review Journal. August 15, 2022. <https://www.reviewjournal.com/news/politics-and-government/water-authority-chief-blasts-other-states-that-rely-on-colorado-river-2623823/>.


³ Department of Interior. "*Interior Department Announces Actions to Protect Colorado River System, Sets 2023 Operating Conditions for Lake Powell and Lake Mead.*" August 16, 2022. <https://www.doi.gov/pressreleases/interior-department-announces-actions-protect-colorado-river-system-sets-2023>.

John Entsminger, will protect the near-term storage volumes across Western reservoirs along the Colorado River – including Lake Mead.⁴ While these will be vital first steps, implementing sustainable solutions will require continued, firm federal leadership, collective action, and coordination at all levels of government.

In an effort to protect the critical reservoir storage that remains, we urge the DOI to expedite the congressionally approved drought funding in the recently passed *Inflation Reduction Act* to assist with ongoing conservation efforts. While we recognize that there is not a one-size-fits-all solution to the prolonged drought in the Colorado River Basin, the \$4 billion provided via Section 50233 will create a critical pathway to permanent adaptation.

As you assess the proposals put forward by the partners in the region and establish guidelines for utilizing the drought mitigation resources provided in the *Inflation Reduction Act*, we also ask that you use DOI's authorities and influence to include all parties in the solution and provide Congress with routine updates on efforts, actions, and coordination underway at the Department. Moving forward, we look forward to continuing to work with you and our congressional colleagues on this critical matter, and echo SNWA General Manager Entsminger's message that Nevada stands ready to assist. We look forward to your prompt response.

Sincerely,



Catherine Cortez Masto
United States Senate



Jacky Rosen
United States Senate

⁴ Entsminger, John. August 15, 2022. <https://www.8newsnow.com/wp-content/uploads/sites/59/2022/08/SNWA-Letter-pdf-combined.pdf>



Southwest Hydrology & Hydraulics, LLC

Experience in Water Resources

DOWN 3 IN '23

*Request for Input on Development of
Post-2026 Colorado River Reservoir
Operational Strategies for Lake Powell
and Lake Mead Under Historically Low
Reservoir Conditions*

Prepared For: Department of Interior
Bureau of Reclamation
Washington, DC
August 2022

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I. INTRODUCTION

A. Background

On Friday June 24, 2022, the Department of Interior, Bureau of Reclamation issued a notice in the *Federal Register*,¹ requesting input on the development of post-2026 Colorado River reservoir operational strategies for Lake Powell and Lake Mead under historically low reservoir conditions (hereinafter referred to as 'Down 3 in '23'). This paper is an effort to compile strategies that are both realistic and practical given dire circumstances on the Colorado River. Detailed background regarding previous decisional documents can be found in the *Federal Register* and online, including the *2007 Interim Guidelines*,² *Minute 319*,³ *Minute 323*,⁴ *Drought Contingency Plans*,⁵ and other decisional documents.

B. Scope

The scope of this paper is limited to providing suggestions that could enhance water supply and reduce water demand, for both short term and long-term operations. The suggestions provided are by default conceptual and limited in detailed scope. Most of the technical suggestions have already been extensively studied and could possibly be used to ameliorate water supply and demand imbalances. As such solutions presented in this paper are more likely than not to be effective if implemented. The scope provided in this paper is limited to the framework of the *Law of the River*,⁶ and *Western Water Law (Figure 1)*,⁷ and is intended to include Indian Tribes⁸ (Figure 2), the Republic of Mexico (Figure 3), and Non-Governmental Entities (NGOs). This paper is designed as a living document with the expectation that ideas set forth will likely change as more information becomes available.

C. Disclaimer

This paper offers conceptual solutions to complex problems; typically, complex problems require solutions that are both well planned and laid out in specific detail. The conceptual solutions presented are more likely than not to be effective but will require additional, detailed work to complex problems. Solutions presented do not favor one stakeholder over another and therefore are intended to be politically neutral. Solutions may rely on proprietary information but are not considered endorsements. Finally, opinions and suggestions are by Southwest Hydrology & Hydraulics, LLC, and do not represent other third parties, such as the Secretary of the Interior.⁹

¹ <https://www.federalregister.gov/documents/2022/06/24/2022-13502/request-for-input-on-development-of-post-2026-colorado-river-reservoir-operational-strategies-for>

² <https://www.usbr.gov/lc/region/programs/strategies/RecordofDecision.pdf>

³ https://ibwc.gov/Files/Minutes/Minute_319.pdf

⁴ <https://ibwc.gov/Files/Minutes/Min323.pdf>

⁵ <https://www.usbr.gov/dcp/finaldocs.html>

⁶ <https://www.crwua.org/law-of-the-river.html>

⁷ <https://extension.unr.edu/publication.aspx?PubID=3750>

⁸ https://www.usu.edu/colorado-river-research-group/files/crrg_tribal_water_rights.pdf

⁹ <https://www.oge.gov/>

Figure 1: Colorado River Basin exports (taken from Reclamation)

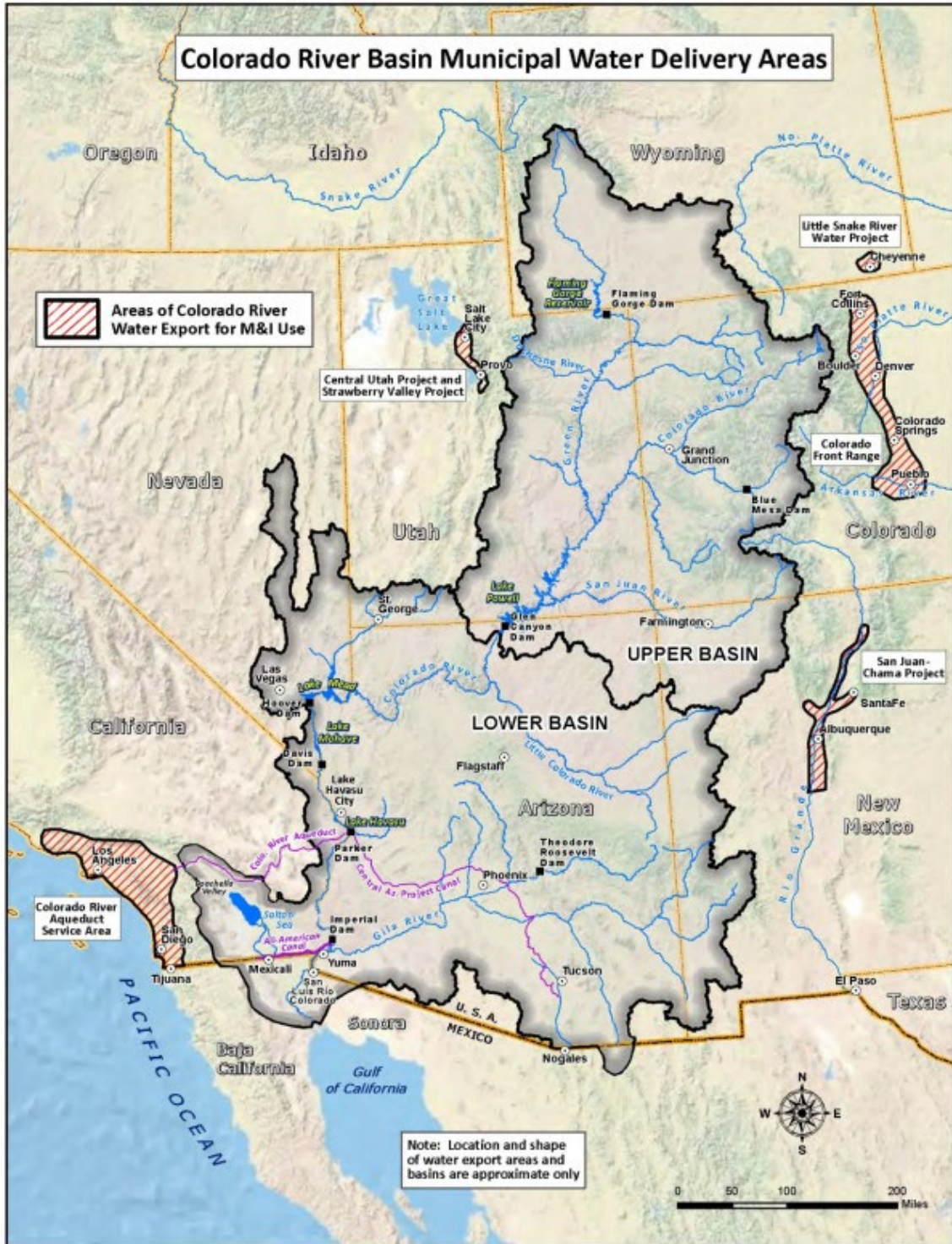


Figure 2: Colorado River Basin Indian Tribes (taken from UC Davis)

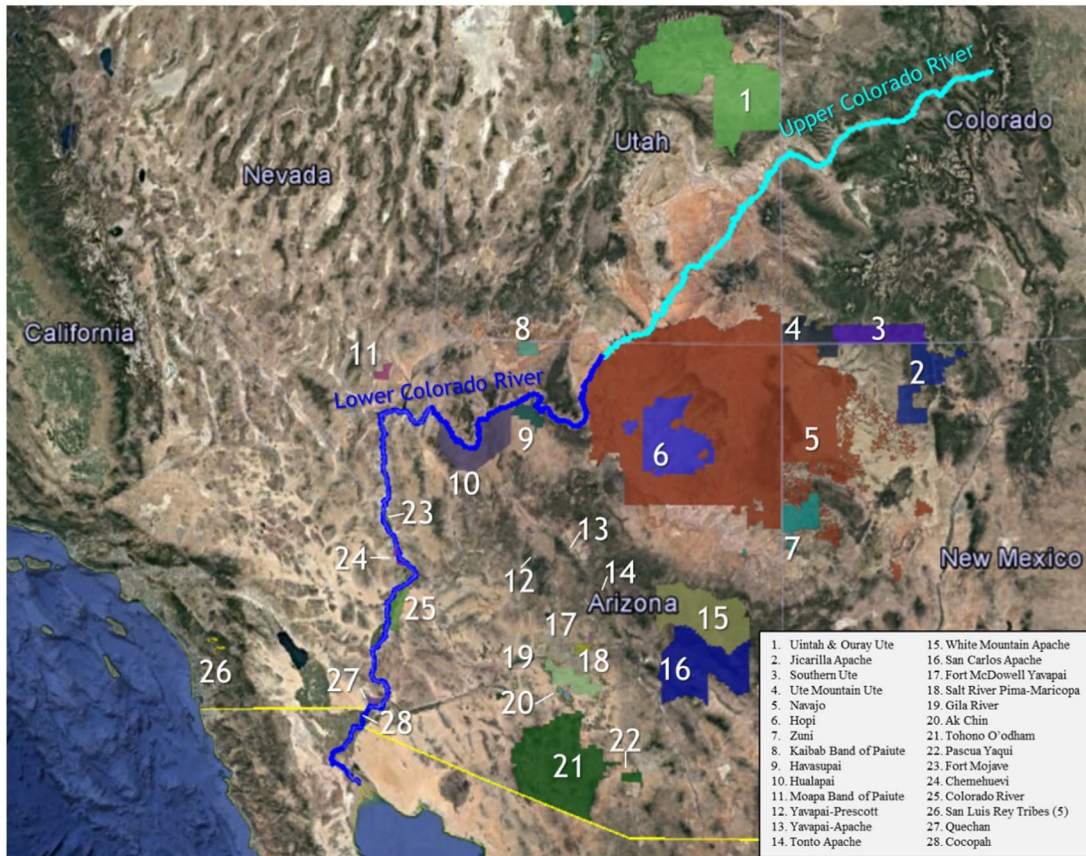


Figure 3: International Boundary with Mexico¹⁰ (taken from Brown)



¹⁰ <https://journals.openedition.org/vertigo/1883>

II. Operational Strategies

- Establish a National Water Czar
- Invoke the Defense Production Act
- Utilize the Defense Advanced Research Projects Agency
- Streamline the permit process
- Improve forecasting skill
- Expand scientific research and understanding in climate and hydrology.

A. Federal and Non-federal Integration

This strategy requires detailed coordination and integration of Federal Agencies, including but not limited to, the Department of Interior (DOI), the Department of Agriculture (USDA), Department of Commerce (Commerce), the Department of Defense, United States Army Corp of Engineers (USACE), Department of Homeland Security (DHS), Department of State, (State), the Environmental Protection Agency, (EPA), and others. As stated in the *Federal Register*, other non-governmental entities should also be involved including environmental and conservation groups, Indian Tribes, the Republic of Mexico, and the States.

To manage the Colorado River Basin's long-term water supply, various entities will require strong leadership at the Federal level; therefore, we suggest establishing a *National Water Czar*¹¹ or equivalent that has authority to work across agencies at the Executive level, controlling both resources and funding. Although the term Czar has different connotations, *Czar* is loosely defined as an individual or office who can spearhead major, authorized Federal action across multiple agencies, who has ultimate control over project funding, and has the authorization to prioritize or override disparate agency agendas. Establishing a *National Water Czar* may first be established at the Executive level but should also be authorized by an act of Congress and moved into a directorate free and independent of election cycles.

To be clear, an ideal office of *National Water Czar* should not be viewed as just another layer of Federal bureaucracy, rather, an instrument that assists the United States Government and the people of the United States in solving dire water related problems, especially on the Colorado River. It is recognized that the scope of this report is limited to the Colorado River; as such a *National Water Czar* would address the conditions on the Colorado River and other watersheds as well, such as the Columbia and Missouri watersheds. Maximizing the water storage capacity of the Colorado River Basin immediately is a challenging assignment that must coordinate the multi-agency, multi-Bureau, efforts.

B. Authorization

Amendment of the Colorado River Basin Project Act to prioritize actions to ameliorate and increase the water holding and storage capacity increases of all resources, and in particular the soil resources of the lands within the Colorado River Basin. Forest management amendments to law from prior USDA authorizations

¹¹ https://www.press.umich.edu/7774485/czars_in_the_white_house

must occur as well. The staff of the appropriate Subcommittees of the US Senate and House should be requested to develop appropriate bill language following transmittal of a Secretarial Plan to the Congress. As identified, appropriate changes to the 1956 Colorado River Storage Project or the 1968 Colorado River Basin Project Act to prioritize activities described below across the Colorado River Basin should be addressed. In addition, authorities for actions exist under current Federal statute.

Authorization for various projects should come from an act of Congress, or already exists under current Federal statute. For example, the 1968 Colorado River Basin Project Act¹² (Public Law 90-537), subparagraphs 102(a), and 102(b) read as follows, and could be amended to include specific action necessary to meet the 3 -4 MAF imbalance on the Colorado River:

“SEC. 102 (a) It is the object of this Act to provide a program for the further comprehensive development of the water resources of the Colorado River Basin and for the provision of additional and adequate water supplies for use in the upper as well as in the lower Colorado River Basin. This program is declared to be for the purposes, among others, of regulating the flow of the Colorado River; controlling floods; improving navigation; providing for the storage and delivery of the waters of the Colorado River for reclamation of lands, including supplemental water supplies, and for municipal, industrial, and other beneficial purposes; improving water quality; providing for basic public outdoor recreation facilities; improving conditions for fish and wildlife, and for the generation and sale of electrical power as an incident of the foregoing purposes.

(b) It is the policy of the Congress that the Secretary of the Interior (hereinafter referred to as the “Secretary”) shall continue to develop, after consultation with affected States and appropriate Federal agencies, a regional water plan, consistent with the provisions of this Act and with future authorizations, to serve as the framework under which projects in the Colorado River Basin may be coordinated and constructed with proper timing to the end that an adequate supply of water may be made available for such projects, whether heretofore, herein, or hereafter authorized.”

In addition to statutory authorities, the Secretary of the Interior was designated by the Supreme Court as water master of the Colorado River below the compact point at Lee Ferry.¹³ As such through delegated authority the Secretary of the Interior typically works with the Basin States to find water solutions, such as the recent Drought Contingency Plan (DCP).¹⁴ Although a Basin States cooperative decision is desired, usually through difficult negotiation, the Secretary has the authority to make decisions on behalf of the States if agreements cannot be reached. For example, on

¹² <https://www.usbr.gov/lc/region/g1000/pdffiles/crbproj.pdf>

¹³ <https://sgp.fas.org/crs/misc/R45546.pdf>

¹⁴ <https://www.usbr.gov/dcp/>

May 3, 2022, the Secretary of the Interior decided to withhold releases from Lake Powell to maintain reservoir elevations.¹⁵

a. Defense Production Act (DPA)

Another Federal authority that should be employed is the Defense Production Act or DPA.¹⁶ Water insecurity on the Colorado River translates to a major national security challenge for the United States, given the economies of the Basin States and Tribes. In addition, attention is drawn to the defense industries and facilities in southern California, Arizona, New Mexico, Colorado, Utah and many other locations. Invoking the DPA would provide the President of the United States broad emergency powers that could be delegated to the Secretary of the Interior, above and beyond powers granted already.

Recently the President has relied on the Defense Production Act to address national security issues related to the COVID-19 Pandemic. The DPA should be leveraged to spearhead solutions for the Colorado River and other areas under severe water stress. The DPA gives the Executive Branch the power to direct private companies through Executive Order to allocate materials, services, and facilities for national defense purposes.¹⁷

b. Defense Advanced Research Projects Agency (DARPA)

The Defense Advanced Research Projects Agency can be leveraged to advance science necessary to optimize operations or enhance existing ongoing research efforts.

The following is taken from the DARPA website:

“For sixty years, DARPA has held to a singular and enduring mission: to make pivotal investments in breakthrough technologies for national security.

The genesis of that mission and of DARPA itself dates to the launch of Sputnik in 1957, and a commitment by the United States that, from that time forward, it would be the initiator and not the victim of strategic technological surprises. Working with innovators inside and outside of government, DARPA has repeatedly delivered on that mission, transforming revolutionary concepts and even seeming impossibilities into practical capabilities. The ultimate results have included not only game-changing military capabilities such as precision weapons and stealth technology, but also such icons of modern civilian society such as the Internet, automated voice recognition and language translation, and Global Positioning

¹⁵ <https://www.usbr.gov/uc/water/crsp/cs/gcd.html>

¹⁶ <https://uscode.house.gov/view.xhtml?path=/prelim@title50/chapter55&edition=prelim>

¹⁷ <https://www.cfr.org/in-brief/what-defense-production-act>

System receivers small enough to embed in myriad consumer devices.

DARPA explicitly reaches for transformational change instead of incremental advances. But it does not perform its engineering alchemy in isolation. It works within an innovation ecosystem that includes academic, corporate and governmental partners, with a constant focus on the Nation's military Services, which work with DARPA to create new strategic opportunities and novel tactical options. For decades, this vibrant, interlocking ecosystem of diverse collaborators has proven to be a nurturing environment for the intense creativity that DARPA is designed to cultivate.

DARPA comprises approximately 220 government employees in six technical offices, including nearly 100 program managers, who together oversee about 250 research and development programs.

DARPA goes to great lengths to identify, recruit and support excellent program managers—extraordinary individuals who are at the top of their fields and are hungry for the opportunity to push the limits of their disciplines. These leaders, who are at the very heart of DARPA's history of success, come from academia, industry and government agencies for limited stints, generally three to five years. That deadline fuels the signature DARPA urgency to achieve success in less time than might be considered reasonable in a conventional setting.

Program managers address challenges broadly, spanning the spectrum from deep science to systems to capabilities, but ultimately, they are driven by the desire to make a difference. They define their programs, set milestones, meet with their performers and assiduously track progress. But they are also constantly probing for the next big thing in their fields, communicating with leaders in the scientific and engineering community to identify new challenges and potential solutions.

Program managers report to DARPA's office directors and their deputies, who are responsible for charting their offices' technical directions, hiring program managers and overseeing program execution. The technical staff is also supported by experts in security, legal and contracting issues, finance, human resources and communications. These are the people who make it possible for program managers to achieve big things during their relatively short tenures.

At the Agency level, the DARPA Director and Deputy Director approve each new program and review ongoing programs, while setting Agency-wide priorities and ensuring a balanced investment portfolio.

DARPA benefits greatly from special statutory hiring authorities and alternative contracting vehicles that allow the Agency to take quick advantage of opportunities to advance its mission. These legislated capabilities have helped DARPA continue to execute its mission effectively."

Clearly now is our "Sputnik moment" on the Colorado River – better late than never. A Basin-wide "Moon Shot" effort is required to reduce water demands and uses on the Colorado River!

c. Permitting

Specific authority should be provided to Reclamation or the *National Water Czar* to expedite environmental permitting of water projects that enhance water supply and reduce water demand, with the intent to comply with the intent of environmental protections yet reduce the risk of third-party obstruction through environmental lawsuits. The following illustrates one possible process associated with environmental permitting, taken from the July 14, 2022, Senate testimony of Mr. Patrick O'Toole:¹⁸

"We will continue to advocate for [advancing Chairman Barrasso's initiative to] streamline the current multi-agency permitting processes that can delay the construction of new or expanded surface water storage projects by creating a "one-stop permitting shop" process through Reclamation. Past legislation driven by the Chairman (like that introduced by Rep. McClintock - H.R. 1621, above) set a schedule and timelines for agencies to consult, cooperate and complete environmental compliance analyses on specified projects. This would also allow third parties to pay the costs of such permit processing to speed things up. Congress provided similar authorities to the Corps in the 2014 Water Resources Reform and Development Act (WRRDA 2014), P.L. 113-121, a law that was passed in both the House and Senate on a bipartisan basis and was signed into law by President Obama.

These provisions would direct the Secretary of the Interior (through Reclamation) to serve as a central hub for all federal permits, approvals, and decisions required related to new water storage projects. This includes permits for Clean Water Act (CWA), National Environmental Policy Act (NEPA), and Endangered Species Act (ESA) compliance, among others. In carrying out this task, Reclamation would be directed to identify all federal agencies with permitting responsibilities and/or authority, notify them of pending applications, and direct a schedule by which all cooperating agencies must complete and submit their reviews and permits. Cooperating agencies would be required to adhere to the coordinated schedule and use one unifying document for all

¹⁸ <https://www.c-span.org/video/?521021-1/senate-hearing-western-drought>

environmental reviews. These provisions would be intended to significantly reduce the time, cost, and inefficiencies associated with the existing multi-track, multi-agency NEPA analyses. Currently, each reviewing agency compiles its own data and reviews it separately in a vacuum.

These provisions should also allow willing states to participate as cooperating agencies. By allowing states to be involved at their discretion, the review process could include state developed and -compiled science, data, and technical materials. This section should also require that, consistent with existing law, all relevant project data be made publicly available online. Finally, in order to help make multi-purpose surface storage [and groundwater] projects more viable in an era of tightened federal budgets, this section of the bill should include a mechanism in which non-federal public entities are allowed to contribute financially to help defray the costs of the "one-stop shop" permitting review process.

An "opt-out" provision should be provided that would allow local project sponsors to proceed on a different project implementation path that had historically provided successful outcomes with another federal agency in the lead role. Meeting the challenge of expanding and modernizing the West's aging water infrastructure will require changes in priority. The coordinated considerations of highly qualified professionals serving both the public and private sectors are available to the Secretary in her Bureaus. Very rarely are there "one size fits all" templates that apply to management of Western water resources challenges but NOW there is a need to create additional storage capacity in the Colorado River Basin.

The need to reduce 2.0 to 4.0 MAF as testified to Congress requires a wholesale change in the DOI policy to encourage and proceed with increasing storage capacity at this time of priority NOW within the Colorado River Basin. The preceding multiple years of extreme drought (22 years) have created an imbalance in supply versus demand. The DOI responsibility is to now lead a coordinated approach across all agencies to prioritize their actions to increase water storage capacity in the Colorado River Basin.

In many cases, local water agencies have long-time relationships with local and regional Reclamation engineers and managers that have led to successfully completed projects, such as the ongoing collaborative work in the Yakima Basin in Washington State, where successful water and environmental projects are being completed with Reclamation functioning as the lead federal agency. In other cases, local entities have developed close working relationships with other federal water agencies such as the Corps. In these cases, local entities should be able to continue to work with the federal agency they successfully worked with in the past for projects of this nature. To cover this range of possibilities, the "opt-out" section should provide flexibility for local project sponsors to either 1)

engage with Reclamation in the facilitated permitting process articulated in this bill; or 2) opt-out and proceed on a project implementation path that has historically provided successful outcomes with another federal agency such as the Army Corps in the lead role.

We believe provisions should be included that require the Secretary of the Interior to submit to the non-federal entity an estimate of the total cost of the federal administrative permitting process for the proposed projects and to provide a scheduled update on the actual administrative costs with an appropriate explanation of any major cost differences.

This section should also include language with a specific reference to non-federal state and local water supply projects that could be integrated with the operation of federally owned facilities. We want to ensure Reclamation is the lead agency in the case of permitting a non-federally built storage project that has a direct federal nexus with a Reclamation project – i.e., Sites Reservoir (California)– where it will be integrated into the operation of the Central Valley Project (as proposed by the local Joint Power Authority) but remain a non-federally developed and owned facility. We would be happy to work with Committee staff to prepare specific language that will address concerns as they arise.

The recent SCOTUS ruling on EPA limitations¹⁹ would not apply to actions created through these programs authorized by the Congress.

C. Forecasting

a. Subseasonal to Seasonal (S2S) Forecasting

Increased forecasting skill²⁰ in both weather and climate forecasting is necessary for river operations such as on the Colorado River, and other river systems throughout the United States. Hydroclimatic conditions are changing rapidly, faster than expected for the 21st century. Rapid change in hydroclimatic conditions warrant faster adaptation, which in turn requires higher S2S forecast skill.²¹ As operation of the Colorado River is conducted via a decision support system, foreknowledge of seasonal water trends importantly influences risk, resource allocation, financing, contracts, permitting, construction, and agricultural related schedules.

¹⁹ West Virginia v. EPA ruling by the Supreme Court of the United States in July 2022. No slip opinion yet.

²⁰ https://www.cpc.ncep.noaa.gov/products/predictions/90day/skill_exp.html

²¹ https://westernstateswater.org/wp-content/uploads/2022/03/Jones_WSWC-S2S-san-diego-May-2022.pdf

The Western States Water Council issued a report titled *Improving Sub-Seasonal to Seasonal Precipitation Forecasting for Water Management*,²² which opens with the following:

"The Western States Water Council asks that the federal government provide resources for pilot projects to improve subseasonal to seasonal (S2S) precipitation forecasting to support water management in the western states, pursuant to the Weather Research and Forecasting Innovation Act. Pilot projects are needed for forecasts of winter precipitation (which provides the snowpack sustaining water supplies in mountain areas) throughout the West, and spring/ summer precipitation for agricultural water supply in the Plains states.

Western States experience great subseasonal, seasonal, and annual variability in precipitation, with serious impacts and consequences for water supply planning and management, drought and flood preparedness and response, water rights administration, and operation of water projects. Sound decision making to protect life and property by reducing flood risks and to inform decisions involving billions of dollars of economic activity for urban centers, agriculture, hydropower generation, and fisheries depends on our ability to observe, understand, model, predict, and adapt to precipitation variability on operational time scales ranging from a few weeks to a season or more.

Current skill in S2S forecasting is not adequate to support water management decision-making, and the federal government should place priority on improving S2S precipitation forecasting capability to support water management."

Reclamation, Scripps Institution of Oceanography (Scripps),²³ and the University Corporation for Atmospheric Research²⁴ – among others—have made excellent progress toward increasing S2S forecasting skill. For example, Reclamation's Science and Technology Office has sponsored prize competition "rodeos" for subseasonal forecasting.²⁵ The Modeling Group of Reclamation's Boulder Canyon Operations Office (located in Boulder, Colorado) has sponsored *The Colorado River Basin Operational Prediction Testbed: A Framework for Evaluating Streamflow Forecasts and Reservoir Operations*.²⁶ The Scripps Center for Western Weather and Water Extremes recently published *Understanding Relative Skill of Experimental S2S Forecasts: Winter 2021-2022 Review*.²⁷

²² https://westernstateswater.org/wp-content/uploads/2020/03/Improving-S2S-Precip-Forecasting-for-Water-Mngmt_brochure_2.pdf

²³ <https://scripps.ucsd.edu/>

²⁴ <https://www.ucar.edu/>

²⁵ <https://www.usbr.gov/research/challenges/forecastrodeo.html>

²⁶ <https://onlinelibrary.wiley.com/doi/full/10.1111/1752-1688.13038>

²⁷ https://westernstateswater.org/wp-content/uploads/2022/03/wswc2022_deflorio_s2s-1.pdf

Although these are all excellent efforts, enhanced and accelerated development is necessary to implement S2S forecasting by Reclamation and other entities operating western reservoir systems. Additionally, more research is necessary to understand the teleconnection of Sea Surface Temperatures (SST) to El Niño and La Niña cycles in the Pacific, and other regional/global oscillations.²⁸ Federal S2S forecasting funding should be increased with targeted expectations, within the context of applied scientific principles; although science cannot and should not be rushed, if more funding were available more resources could be applied to increasing forecast skill sooner rather than later. S2S funding has at times been overlooked for other projects, as S2S concepts are somewhat abstract to lawmakers, as compared to physically tangible projects such as a bridge project. DOI (Reclamation, USGS) and other federal agencies (NOAA, NASA, USACE, others) need to overcome communication barriers in Congress to expedite funding.

b. Short-term forecasting

Farmers in the Imperial and Coachella Valleys, and in southern Arizona often reset irrigation schedules based on rainstorm events. During a major rainstorm event, such as a North American monsoon, hurricane, or large Pacific driven storm, irrigation water is typically shut off creating the need to store water that has already been released from Parker Dam and is enroute to Imperial Dam for distribution to California, Arizona, and Mexican irrigators. Water ordered from Parker Dam, but not delivered because of a rainstorm, is stored either in Brock Reservoir or Senator Wash, or managed such that excess delivery to the southerly or northerly international border is minimized.

Although operation of Brock Reservoir and Senator Wash have minimized excess deliveries to Mexico, short term forecasting improvements could increase efficiencies in water use south of Parker Dam. For example, farmers in the Imperial Valley and Mexicali Valley rely on private²⁹ and/or non-Federal weather stations, and other weather data during a localized microburst rainstorm. These weather stations and services rely on federal forecast products which are post-processed into a usable format for real time visualization purposes. An extensive real time sensor network could be funded and established for the entire Imperial, Coachella, and Mexicali Valleys, and in southern Arizona that would provide operators real time data on the location, duration, and depth of precipitation. This network could then be fed to water control centers to inform Reclamation, irrigators and others regarding releases from Hoover-Davis-Parker Dams, ideally saving water in Lake Mead.

Although forecasting-based cuts to storage releases are beyond existing science, this ability is in the foreseeable future. Funding of short-term forecasting should be increased and integrated with S2S forecasting to optimize water operations. For example, should S2S forecasting accuracy

²⁸ https://westernstateswater.org/wp-content/uploads/2022/03/18May_Sengupta_Seasonal_Prediction.pdf

²⁹ <https://www.wunderground.com/wundermap?lat=32.848&lon=-115.569&zoom=8&radar=1&wxstn=0>

increase to reliably forecast El Nino, or La Nina related events, such as atmospheric rivers, operators upriver, or at the water control center at IID and Reclamation's Yuma Area Office, operational decisions could be adjusted to optimize the forecasted weather. The same concept would apply to forecasting the North American Monsoon, or microburst activity associated with Pacific (and occasional Atlantic) hurricane activity migrating north through the Gulf of Mexico to the Salton Trough.

c. Extreme events

Anecdotal evidence suggests that extreme events are increasing.³⁰ The Center for Climate Adaptation Science and Solutions (CCASS) associated with the University of Arizona recently published the following:

"Intersecting events such as major floods, decades-long megadroughts, and economic or governance upheavals could have catastrophic effects on the water supply for [the] 40 million people."

Not only are droughts becoming more extreme, the potential for large flood events on the mainstem of the Colorado River or its tributaries should be integrated into operations and dam safety preparations, primarily to optimize both water supply and dam safety.

Several extreme events have already occurred (likely associated with climate change effects) but were captured in either Lake Powell or Lake Mead. These events were controlled and contributed to the water supply. The events caused localized damage to infrastructure but did not pose dam safety risks to Glen Canyon Dam or Hoover Dam. For example, in the winter of 2005, the Meadow Valley Wash flood³¹ was caused by a rain-on-snow event that pulsed into Lake Mead and caused lake levels to rise over two feet in three days.³² Similarly, an extreme event occurred in October 2006 when an atmospheric river approached the continent at the international border with Mexico, then rotated north along the New Mexico/Arizona Stateline. Lake Powell increased over 7 feet in elevation between October 5 and October 18, 2006.³³ A rain-on-snow event causing flooding in Missouri River basin in May 2011 also contributed significantly to water supply in the Colorado River above Glen Canyon Dam, where Lake Powell increased at least 36 feet over a 2-month period.³⁴

Although these three examples occurred above Lakes Powell and Mead where flooding was captured and controlled, dam operations at smaller facilities may not have fared so well. Dam safety operations should be adjusted at smaller facilities to accommodate extreme events. For

³⁰ <https://eos.org/science-updates/reimagining-the-colorado-river-by-exploring-extreme-events>

³¹ <https://pubs.usgs.gov/fs/2006/3124/fs2006-3124.pdf>

³²

https://waterdata.usgs.gov/nwis/dv?cb_all_=on&cb_72036=on&format=gif_default&site_no=09421000&referred_module=sw&period=&begin_date=2005-01-10&end_date=2005-01-13

³³ https://www.usbr.gov/rsrvWater/HistoricalApp.html?jsessionid=zhbpbkVauk_tTdU0QeLO9Egmy7KL2x0-4DPI9MLnt.lxwf01:prod_rsvrwater_ha

³⁴ https://en.wikipedia.org/wiki/2011_Missouri_River_Flood

example, at Lake Havasu the operating differential is approximately 4.5 feet. In January 2005 (an El Nino year) Lower Colorado water operations took the lake level to the top of the dam. Had an atmospheric river provided additional precipitation downstream of the USACE Alamo Dam flood control facility, a pulse through the lake could have surged over the top of Parker Dam. This did not occur; perhaps operations can be adjusted to build reservoir space in smaller reservoirs based on better short term and S2S forecast capabilities. Dam safety considerations involving risk estimation should also be updated based on increased risk of flooding.

Black swan hydrologic events are a serious concern and should be integrated to both operations and dam safety programs³⁵. As quoted from Brad Udall:

"There is the sense that we will see things that aren't in the historical or paleo record and that's disturbing because it means unprecedented types of events could occur that our systems aren't designed for," said Brad Udall, senior research scientist at Colorado State University's Colorado Water Institute and a member of the Colorado River Research Group, a team of 10 veteran Colorado River scholars."

"Perhaps less appreciated are the risks of catastrophic flooding in the basin. The spillways at Glen Canyon Dam were significantly eroded by cavitation in 1983, as were those at Oroville Dam (in California) in 2017, when floodwaters exposed existing infrastructure weaknesses. Although weather prediction and water resource management plans have been improved and revised following the events at Glen Canyon Dam, there is nevertheless the possibility that an unusually large flood might occur in the basin headwaters. We know such great floods have occurred in the past (outside of the relatively short stream gauge period) based on field observations of the flood deposits and analysis of the paleohydrologic record. Even if Lake Powell and Lake Mead remain low, megaflood risk persists and is likely to be increasing. Precipitation intensity, and the amount of precipitation falling in the most intense events, are increasing globally and across the United States, in large part because sea surface temperatures and atmospheric water vapor content are both rising, increasing the odds of more extreme precipitation events. These trends will continue as long as emissions of greenhouse gases to the atmosphere continue."³⁶

The USGS also simulated a megaflood in 2010 in its ARkStorm Scenario.³⁷ A recent publication in *Science Advances* by Xingying Huang and Daniel L. Swain titled *Climate change is increasing the risk of a California*

³⁵ <https://www.watereducation.org/western-water/could-black-swan-events-spawned-climate-change-wreak-havoc-colorado-river-basin>

³⁶ https://www.usu.edu/colorado-river-research-group/files/crrg_thinking_about_risk.pdf

³⁷ https://www.usgs.gov/programs/science-application-for-risk-reduction/science/arkstorm-scenario?items_per_page=6

megaflood³⁸ summarizes risk of extreme flooding in California and arguably the Colorado River Basin.

The following is taken from the introduction:

California is a region more accustomed to water scarcity than overabundance in the modern era. Between 2012 and 2021, California experienced two historically severe droughts—at least one of which was likely the most intense in the past millennium (1, 2)—resulting in widespread agricultural, ecological, and wildfire-related impacts (3, 4) and ongoing drought-focused public policy conversations. Yet, historical and paleoclimate evidence shows that California is also a region subject to episodic pluvials that substantially exceed any in the meteorological instrumental era (5)—potentially leading to underestimation of the risks associated with extreme (but infrequent) floods. Observed extreme precipitation and severe subregional flood events during the 20th century—including those in 1969, 1986, and 1997—hint at this latent potential, but despite their substantial societal impacts, none have rivaled (from a geophysical perspective) the benchmark “Great Flood of 1861–1862” (henceforth, GF1862). This event, which was characterized by weeks-long sequences of winter storms, produced widespread catastrophic flooding across virtually all of California’s lowlands—transforming the interior Sacramento and San Joaquin valleys into a temporary but vast inland sea nearly 300 miles in length (6) and inundating much of the now densely populated coastal plain in present-day Los Angeles and Orange counties (7). Recent estimates suggest that floods equal to or greater in magnitude to those in 1862 occur five to seven times per millennium [i.e., a 1.0 to 0.5% annual likelihood or 100- to 200-year recurrence interval (RI)]. (5, 8)

D. Practical Research Programs

Reclamation should consider re-instating its relationship with the University Corporation for Atmospheric Research (UCAR) Postdocs Applying Climate Expertise (PACE) fellowship program.³⁹ As described by UCAR:

“The goal of this postdoctoral program is to grow the pool of scientists qualified to transfer advances in climate science and climate prediction into climate-related decision framework(s) and decision tools. The program pairs early-career climate scientists with two co-hosting institutions: one host provides the climate research expertise guidance, and the other host is a decision-making institution that provides the opportunity for the PACE fellow to immerse themselves in a decision-making culture and learn from each other.

³⁸ <https://www.science.org/doi/10.1126/sciadv.abq0995>

³⁹ <https://cpaess.ucar.edu/pace>

Demand for research and guidance in climate-related risk management and decision-making has increased in recent years. This is due in part to the work of those involved in the NOAA RISA (Regional Integrated Sciences and Assessments) program and to the efforts of a relatively small group of scientists working at the interface between climate science and its applications. A growing number of people and institutions are emerging to work at this interface, but demand for these people exceeds supply."

Since 2016 there have been no new PACE Fellows due to lack of funding. Reclamation is in a unique position to provide practical experience as applied to climate science. For example, Reclamation could grow a group of climate scientists focused on operations such as S2S or short-term forecasting, attached to the Boulder, Colorado office of the Boulder Canyon Operations Office in Boulder City, Nevada. Staffing is typically problematic; ideally the PACE Fellowship should be under the purview of BCOO but work closely with climate modeling and forecasting as a separately staffed office lending practical support to climate science. A group of at least 5 sponsored scientists per year would grow the climate science community with practical applications to forecasting or other climate research needs as related to Reclamation operations.

Typically, the PACE Fellowship is co-sponsored by Reclamation and another Federal agency, through a Reclamation interagency agreement with UCAR. For example, in 2015 Reclamation funding was matched by a grant from the NOAA Climate Prediction Office, to sponsor climate research on the Rio Grande River.⁴⁰ However, the PACE Fellowship does not necessarily require NOAA Climate Prediction Office matching funds, as other branches of NOAA could co-sponsor matching funds, or other agencies such as the US Air Force, US Naval Research Laboratory, the United States Geological Survey, or Lockheed Martin.

E. Hydrologic Work Group

*"It strikes me as a forgivable failure of imagination," said historian Christian Harrison, who earned his doctorate from UNLV. "They probably thought they would land people on Mars before we had so many people living in this valley"⁴¹.
--taken from Christian Harrison*

The possibility of extreme black swan events, both in flooding and drought conditions, warrants staffing a permanent hydrologic work group that is integrated with the latest scientific understanding of Colorado Basin hydrologic conditions.^{42,43} This working group should ideally be working with latest climate research should the PACE Fellowship be reinstated, along with short term and long-term forecast research needs. The 2010 Hydrologic

⁴⁰ https://www.usbr.gov/research/publications/download_product.cfm?id=2760

⁴¹ <https://www.reviewjournal.com/news/the-water-question/part-2-future-no-one-could-see-capped-nevadas-share-of-colorado-river-water-1603391/>

⁴² <https://www.colorado.edu/resources/colorado-river-resources/CRBreport>

⁴³ https://www.colorado.edu/sites/default/files/2021-06/ColoRiver_StateOfScience_WWA_2020_FullReport_hi-res.pdf

Work Group Charter lists the following priorities,⁴⁴ which needs to be reinstated:

- *Guided initially by the recommendations of the Climate Technical Work Group Final Report dated August 2007*
- *Pertinent to the Colorado River Basin*
- *Geared towards seeking the best available and most cost-efficient technology for midterm operations and long-term planning studies*
- *Brought into operations and long-term planning within a 1-to-3-year timeframe*

Reclamation brings valuable, practical operations experience to climate and hydrologic science, which should be leveraged to adjust operations models to reflect the latest state of the knowledge. Use of stress test hydrology from 1988 to 2019 to reflect low flows on the Colorado River system should be made a permanent part of operational models. Adjustments to the “stress test” hydrology needs to be made sooner rather than later to keep pace with the latest science, or possible low flow scenarios on the river. As noted by John Fleck, stress test hydrology could have been used much earlier in this current drought cycle:⁴⁵

“The method used to generate future inflows in the current projections includes resampling a subset of the historical natural flow record (1988-2019) using the Index Sequential Method (ISM), referred to here as “Stress Test” hydrology. In the past, the full historical record (1906-2019), known as the “Full” hydrology, was used to provide 5-year probabilistic projections. The Stress Tests hydrology scenario applies ISM to a shortened period of the natural flow record, 1988-2019, which removes the earlier portion of the natural flow record and focuses on the recent (approximately 30 years) hydrology. This period has a 10% drier average flow than the Full hydrology. Use of the Stress Test scenario is supported by multiple research studies that identified a shifting temperature trend in the Colorado River Basin in the late 1980s that affected runoff efficiency and resulted in lower average flows for the same amount of precipitation (McCabe et al. 2017, Udall and Overpeck 2017, Woodhouse et al. 2016).”

John [Carron], Eric [Kuhn], and Dave [Kanzer] reasoned nearly a decade ago that using a shorter record, focused on our climate-changed Colorado, might better help managers think about and plan for what to expect next. (Dave also famously provided the memorable Homer Simpson image for Eric’s CRWUA presentation).”

F. Other Operational Considerations

⁴⁴ https://www.usbr.gov/lc/region/programs/climate/research/Charter_CoRivHydroWG.pdf

⁴⁵ <http://www.inkstain.net/fleck/2021/09/taking-climate-change-seriously-the-colorado-river-stress-test/>

Although Brock Reservoir and Senator Wash Reservoir have considerably tightened excess deliveries to Mexico, planning should continue for construction of additional offline reservoir storage in the United States and Mexico to further operational flexibility. It may be necessary to plan for increased flow in the Gila River downstream of Painted Rock reservoir as a result of extreme events. Water delivered to Mexico is accounted for on a monthly basis and reset every month. Should the Gila River start to see increased flow from extreme events, this water may be saved in Lake Mead if it can be stored in coordination with Yuma and Mexican operations. Imperial Irrigation District's proposed reservoir at the head end of the Highline Canal off the All-American Canal provides an opportunity to improve water management within that Canal system. The Coachella Valley Water District's in-canal Coachella Canal Reservoir project will meet water management goals when constructed. A second cell at Brock Reservoir would be similarly useful.

III. Augmentation Projects

- Expedite a Salton Sea augmentation project
- Expedite State of Arizona and Mexico augmentation projects

Large capital improvement projects are suggested to provide a structural fix to the imbalance between supply and demand. Any large capital improvement project would require the leadership of the *National Water Czar* or other strong leadership authority.

As succinctly noted by Pat Mulroy:⁴⁶

"I know this is going to come up, somebody's going to say, 'Well, isn't that too expensive?' I think, sitting here today as we look at Lake Mead, the question isn't, 'Is it too expensive?' It's, 'Can we afford to not do it? Is the price of not doing it much greater than the price of not doing it?"

A. Salton Sea Pipeline

The Salton Trough and Gulf of California represent an important physiographic location of the Colorado River Basin that is exceptionally complex.⁴⁷ These complexities include water operations at the southerly and northerly international boundary that deliver water to agricultural users in Arizona, California, and Mexico, environmental considerations in the Limitrophe, environmental release flows, tribal lands, dust control, storage reservoirs such as Senator Wash⁴⁸ and Brock Reservoir⁴⁹, international relations with Mexico through the US and Mexican International Boundary

⁴⁶ <https://knpr.org/knpr/2022-05/former-southern-nevada-water-authority-chief-very-worried-about-lake-mead-level>

⁴⁷ https://www.usbr.gov/lc/yuma/programs/water_delivery.html

⁴⁸ <https://www.usbr.gov/projects/index.php?id=328>

⁴⁹ https://www.usbr.gov/lc/yuma/facilities/Brock/yao_brock.html

and Water Commissions,^{50,51} SCOTUS Decree accounting,⁵² geothermal energy sources, and more. As the Colorado River system is driven from the bottom up, this lower section of the river has comparatively greater control than upstream water uses.

Since 2003 the Salton Sea has been shrinking, as a result of operational decisions and agreements to transfer water to other locations that would normally drain to the Salton Sea.⁵³ As water levels dropped in the Salton Sea the receding water exposed a polluted lakebed playa that dried and contributed to toxic dust and health related problems.⁵⁴

Given the complexity and severity of environmental and health issues, various action has been taken to remediate the Salton Sea.^{55,56} Part of this effort was to solicit proposals from outside sources for innovative ideas to provide relief.⁵⁷ The first round of proposals was submitted in 2018 by various consultants,⁵⁸ followed by a second round of proposals which were either resubmitted or updated to the State of California for review.⁵⁹ The most recent review of proposals is a fatal flaw document, titled *Salton Sea Independent Review Panel Fatal Flaw Report*⁶⁰ (*Fatal Flaw Report*). The *Fatal Flaw Report* is an excellent document prepared by a panel of experts prepared for the Salton Sea Management Program, submitted by the University of California at Santa Cruz.

The central idea of Salton Sea proposals and the *Fatal Flaw Report* is pumping and transfer of sea water from the Gulf of California (Sea of Cortez) to the Salton Sea over the low topographic divide near the international boundary. This capital improvement project would replenish the Salton Sea, managing dust control, and provide the means to mitigate other issues.

Although the *Fatal Flaw Report* is an essential decision support document, it appears the scope of the review did not necessarily consider water supply to satisfy structural water deficits on the Colorado River. It is suggested here that – in addition to the ideas set forth the *Fatal Flaw Report*—a pipeline from the Gulf of California to the Salton Sea also supply a sufficient volume of water to compensate for the existing and future water supply-demand

⁵⁰ https://ibwc.gov/Water_Data/Colorado/Index.html

⁵¹ <https://ibwc.gov/Files/1944Treaty.pdf>

⁵² <https://www.usbr.gov/lc/region/g4000/wtracctypes.html>

⁵³ <https://www.watereducation.org/western-water/long-troubled-salton-sea-may-finally-be-getting-what-it-most-needs-action-and-money>

⁵⁴ <https://news.usc.edu/159380/salton-sea-shrinking-asthma-respiratory-health-air-quality/>

⁵⁵ <https://saltonsea.ca.gov/>

⁵⁶ <https://saltonsea.ca.gov/program/>

⁵⁷ <https://www.usatoday.com/in-depth/news/environment/2021/06/11/can-water-mexicos-sea-cortez-save-californias-salton-sea/4977601001/>

⁵⁸ <https://saltonsea.ca.gov/planning/2018-salton-sea-water-importation-proposals/>

⁵⁹ <https://saltonsea.ca.gov/2020/06/state-requests-proposals-for-water-importation-independent-review-panel/>

⁶⁰ <https://transform.ucsc.edu/wp-content/uploads/2022/07/Salton-Sea-Independent-Review-Panel-Fatal-Flaw-Report.pdf>

deficit on the Colorado. This would therefore serve as a water augmentation project in addition to protecting the Salton Sea and environment of the Imperial Valley. In the *Fatal Flaw Report*, Response R5⁶¹ planned for an import of 2.5 maf but was excluded because of construction in the Biosphere Reserve, use of unproven technology, and lack of longevity. Response R13⁶² planned for an import of 3.5 maf, but was excluded because of unproven technology, flooding, and lack of longevity. Disposal of brine from desalinization of sea water is key to making this project a success, and still needs to be addressed in an environmentally responsible manner.

A pipeline solution must also address and take into consideration (1) the Republic of Mexico, (2) Indian tribes, and (3) Environmental considerations. One weakness of the various proposals is the lack of proactive planning with both Mexico and the IBWC. It is suggested that an amendment to the 1944 Treaty (a Minute to the Treaty) is negotiated to hammer out details acceptable to both Mexico, the United States, the Basin States, Tribes and NGO's. Indian tribes on both sides of the international border should be included in the pipeline talks, such as the Cocopah,⁶³ Tohono O'Odham,⁶⁴ Quechan,⁶⁵ and other Indian nations along the International Border. Ideally, a Salton Sea pipeline would also integrate environmental remediation needs. For example, one drawback identified by the *Fatal Flaw Report* was construction within the Biosphere Reserve; perhaps if construction is allowed in the Biosphere Reserve the environmental impacts could be offset by annual pulse flows on the Lower Colorado, akin to those specified in Minute 319.⁶⁶ Should annual pulse flows be established as part of the Salton Sea pipeline project, NGO's involved in Minute 319 such as the Sonoran Institute,⁶⁷ Environmental Defense Fund,⁶⁸ and/or Pronatura,^{69,70} should be proactively engaged. Restoration of the Colorado River Delta should be part of the pipeline solution.

Creative solutions to construction of a Salton Sea pipeline should address California State and Federal environmental permitting requirements at the Federal and State executive levels. For example, the *National Water Czar* at the Federal executive level should take the lead, or delegate authority to Reclamation to expedite permitting. Much discussion has been made regarding the difficulty of permitting a Salton Sea pipeline, including challenges⁷¹ as identified by the Pacific Institute:^{72,73}

⁶¹GEI Consultants and Michael Clinton Consulting, LLC

⁶² Global Premier Development, Inc and Salton Power, Inc

⁶³ <https://www.cocopah.com/>

⁶⁴ <http://www.tonation-nsn.gov/>

⁶⁵ <https://www.quechantribe.com/>

⁶⁶ <https://pubs.er.usgs.gov/publication/70177847>

⁶⁷ <https://sonoraninstitute.org/>

⁶⁸ <https://www.edf.org/>

⁶⁹ <http://www.pronatura.org/en/>

⁷⁰ <https://sonoraninstitute.org/files/pdf/minute-319-factsheet-09152013.pdf>

⁷¹ <https://pacinst.org/salton-sea-import-export-plans/>

⁷² <https://pacinst.org/>

⁷³ <https://pacinst.org/salton-sea-import-export-plans/>

- *“Sea-to-Sea plans face many logistical, financial, and energy challenges.*
- *Designing, permitting, and acquiring rights of way for a project of this scale would be a tremendous undertaking that would require many years and multiple land use agreements.*
- *The costs of constructing a hundred or more miles of pipelines or canals would be measured in the billions of dollars.*
- *The additional energy demands of pumping tremendous amounts of heavy saltwater scores of miles and, in some configurations, up thousands of feet, would come while California seeks to reduce its carbon footprint.*
- *Many of the proposed plans would require negotiations with Mexico, adding many unknowns to the equation, including the amount of time needed to come to an agreement.*
- *Perhaps the greatest challenge, however, is the amount of time required for the plan to show results at the Salton Sea. As shown in the timeline [in the infographic] given the most ambitious, accelerated schedule indicates that Sea-to-Sea plans would not meet their own goals for at least 30 years. If a Sea-to-Sea plan were approved and adopted this year, the elevation and salinity of the Salton Sea would not stabilize until 2050, at the earliest.*
- *Such an approach would not solve the many short-term or medium-term problems of the declining Salton Sea, including the crash of the current ecosystem. It also means that public health would not be protected for a generation.*
- ***One of the biggest problems is that Sea-to-sea plans distract attention from feasible, practical plans that can be built quickly and can show results in the near future.***
- *Although Sea-to-sea plans are intuitive and appealing, they are not the answer to the imminent collapse of the Salton Sea. “*

B. State of Arizona and Republic of Mexico suggestions

Other variations should be considered by the *National Water Czar* or others. For example, pipelines from the Pacific Ocean have been considered to feed the Salton Sea versus the Gulf of California. The State of Arizona is also considering desalination ideas⁷⁴ as an extension of Minute 323, such as the “Extension of Cooperative Measures and Adoption of a Binational Water

⁷⁴ <https://www.azcentral.com/story/news/local/arizona-environment/2022/01/10/gov-doug-ducey-proposes-spending-1-billion-water-infrastructure/9164946002/>

Scarcity Contingency Plan in the Colorado River Basin⁷⁵ which considered the following:

- *Binational Desalination Plant at the Pacific Ocean coast*
- *Binational Desalination Plant in the New River*
- *Binational Desalination Plant at the Sea of Cortez*
- *Reuse of effluent from the Mexicali Valley wastewater treatment plants in wetlands or riparian restoration of the Colorado River*
- *Reuse in the United States of South Bay International Wastewater Treatment Plant effluent*

Arizona, the Salt River Project, and partners in Mexico, California, Nevada along with the federal government participated in a binational report on the desalination proposal in 2020. It is estimated that two plants, each situated on the sea's eastern shore south of Puerto Peñasco and each producing 100,000 acre-feet a year, would cost \$3 billion to \$4 billion in upfront costs. Those costs and annual operating costs would create a price of \$2,000-\$2,200 per acre-foot, which consultants determined would be in line with other potential sources of new water.⁷⁶

These suggested structural solutions do not appear to be opposed by environmental groups; however, it is noted that the time frame for implementation is roughly a decade from now. Further, these proposals would provide only a partial solution to the overall "structural deficit" that is shorthand for describing the Colorado River water supply/demand imbalance. The Environmental Defense Fund (EDF) supports broader measures such as water recycling and groundwater management, in combination with desalination:

"In addition to desalination, augmentation must include projects that treat and reuse wastewater, replenish local groundwater, and capture and recharge stormwater to benefit communities and ecosystems," said Kevin Moran, senior director of EDF's Colorado River program. "State lawmakers need to authorize rural Arizona communities to begin managing and conserving groundwater and strengthen our Active Management Areas' programs and standards."

IV. Watershed Management

- Enhance forest management
- Improve agricultural practices

⁷⁵ <https://library.cap-az.com/documents/departments/planning/colorado-river-programs/Binational-Desal-Study-Executive-Summary.pdf>

⁷⁶ <https://www.azcentral.com/story/news/local/arizona-environment/2022/01/10/gov-doug-ducey-proposes-spending-1-billion-water-infrastructure/9164946002/>

At the June 14, 2022, Senate Committee on Energy and Natural Resources^{77,78} Mr. Patrick O'Toole, President of the Family Farm Alliance (Alliance)⁷⁹ described the organization:

"The Alliance is a grassroots organization of family farmers, ranchers, irrigation districts, and allied industries in 16 Western states. The Alliance is focused on one mission: To ensure the availability of reliable, affordable irrigation water supplies to Western farmers and ranchers. We are also committed to the fundamental proposition that Western irrigated agriculture must be preserved and protected for a host of economic, sociological, environmental, and national security reasons – many of which are often overlooked in the context of other national policy decisions."

A. Forest Management

During his June 14, 2022, Senate testimony, Mr. O'Toole indicated that substantial water savings could be realized through proper watershed and forest management. O'Toole presented data demonstrating the U.S. Forest Service's own projections that the amount of water runoff to the North Platte River basin could be increased by 160,000 acre-feet per year through appropriate forest management (see page 14 of O'Toole's testimony). Pat O'Toole wrote in his submitted testimony:

"Two years ago, I testified before this Committee, where I referenced the Forest Service's figure that 160,000 acre-feet (AF) of water is not going into the Platte River system because of invasive species such as the pine beetle. The study I referenced relates to research⁸⁰ conducted by the Forest Service on the Upper North Platte River in 2000 and 2003. It shows that management restricting timber harvest had already severely impacted the watershed and water yield to the tune of a minimum of 160,000 AF⁴ per year. The Forest Service uses Equivalent Clear-cut Acres modeling to predict water yield associated with vegetation disturbance, primarily associated with timber harvest and wildfire. The literature and research show that implementing a 100-year rotation on all eligible timber lands would sustain an increase of 50-55,000 AF of water per year – for just one part of one forest in the state of Wyoming."

The 160,000 AF estimate is based on scientific measurements from paired watershed experiments conducted in the Battle Mountain area. Based on the number of federal forests that contribute water to the Colorado River in Wyoming, Colorado, Utah and New Mexico in the Upper Colorado River

⁷⁷ https://www.epw.senate.gov/public/_cache/files/c/3/c39018de-9db6-4e05-a3d7-c7fcf18a9762/53C2423FA0A7969A7E00F4616F87E150.o-toole-testimony-09.18.2019.pdf

⁷⁸ <https://www.energy.senate.gov/hearings/2022/6/full-committee-hearing-to-examine-short-and-long-term-solutions-to-extreme-drought-in-the-western-u-s>

⁷⁹ <https://www.familyfarmalliance.org/>

⁸⁰ https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5167188.pdf

Basin the amount of runoff increase that could be potentially created will be in the hundreds of thousands of acre-feet each year.

O'Toole also addressed forest floor management:

“Drought brings less snowfall in many areas. The snow that falls melts off up to 45 days earlier and runs off downstream on frozen ground. Therefore, the snowpack no longer functions as a reservoir delaying the release of water in a timely manner. However, the forest floor can be restored through thoughtful management. A responsible level of continuous fuels reduction includes a combination of robust mechanical thinning and prescribed fire. This can be employed to significantly reduce evapotranspiration, tree stress, disease, and pest infestation, preserve healthy forest conditions, and protect species and habitats.”

Investments MUST be made in forest management to augment runoff of the water supply falling on public lands. Maintenance of proper forest management practices MUST be an ongoing investment as well.

As emphasized by Pat O'Toole in his June 14, 2022 testimony: “Generating new water through landscape management practices should become a new priority in the Colorado River watershed and other parts of the American West.” Accordingly, participation by ALL the federal land management agencies is essential. Creating a priority requires agencies to consider whether their agency or others with whom they routinely interact has policies or practices that are materially detrimental to the desired priority of increasing the supply and reducing the consumption of Colorado River water.

B. Publicly owned and privately owned resources

Further improvements in watershed management will occur if activities on both public and private lands are integrated, requiring active cooperation between local soil and water conservation districts and the USDA Forest Service and the USDA NRCS. Early involvement and collaboration with USFWS and Reclamation personnel, all appropriate state agencies, and other interested parties would most certainly increase the effectiveness of such cooperative efforts.

C. Soil Management, Restoration and Regenerative Farming Practices

Soil management across the Basin is wanting and lacking. Regenerative farming and soil management practices can be implemented across the entire Colorado River Basin. Enormous impacts reducing many inputs and increasing water holding capacity through such practices can be realized. USDA has routinely disseminated information indicating that for each one percent increase in organic matter (carbon content) per acre that the

water holding capacity of that acre is increased by 25,000 gallons of water.⁸¹

Farm regenerative agricultural practices and restorative soil management actions are necessary to improve water holding capacity on a per acre management unit basis. The USDA NRCS has the current staff and staffing capabilities to administer large numbers of EQIP⁸² applications for conservation measures in the Colorado River Basin.

Lower Colorado River Basin farmlands routinely have between 0.5 and 1.0 percent organic matter. Restoring back into balance requires patience and programs that incentivize soil restoration conservation measures. This effort requires recognizing the long-term value of the enhanced soil environment across the Colorado River Basin and the large value and nature of the investment.

Colloidal clay compounds such as Nanoclay® add organic matter and carbon back into the soil and build up desert croplands.⁸³ This substance, which can be applied as a surface spray at a relatively affordable cost (currently as low as \$4 per acre), offers promise to improve soil structure, with the end goal of increasing water holding capacity. Soil structure and function is improved to "...what you might see in your garden," explains Ole Sivertsen, chief executive of Desert Control, the Norway-based business that has developed the nanoclay soil enhancement approach. "Thin soils with little to them struggle to hold onto moisture or allow plants to thrive. The presence of clay in the right proportions can drastically change all that," Sivertsen explains.

Using clay to improve soils is nothing new – farmers have been doing so for thousands of years. However, working thick, heavy clay into soil has historically been very labor-intensive and disruptive to underground ecosystems. Ploughing, excavating and turning the soil also comes at an environmental cost as sequestered carbon is exposed to oxygen and so is lost into the atmosphere as carbon dioxide. Coupled with this is the disruption to the incredibly complex soil biome that comes with cultivation.

Farm regenerative agricultural practices and restorative soil management actions are necessary to improve water holding capacity on a per acre management unit basis. The USDA NRCS has the current staff and staffing capabilities to administer large numbers of EQIP⁸⁴ applications for conservation measures in the Colorado River Basin.

STRIP AND CONSERVATION TILLAGE MUST BECOME PREDOMINANT. There are many valid reasons for engaging in restorative farming for reservoir recovery purposes. Farming practices need to change. In particular, the substantial investment in tillage equipment is a change-resistance

⁸¹ https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1082147.pdf

⁸² <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/>

⁸³ <https://www.bbc.com/future/bespoke/follow-the-food/the-spray-that-turns-deserts-into-farmland.html>

⁸⁴ <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/>

impediment. Rebates may very well be required to get farmers to make the required equipment changes. Making replacement of tillage equipment a NRCS EQIP conservation measure and eligible for federal conservation funding (with producers providing cost-share funding and having farmland conservation plans in hand) would be a valuable tool to adapt farming practices to the new reality of producing as much crop with less water applied per unit area.

The days of high-power, full-bore tillage in the Lower Colorado River valleys need to essentially come to an end. Land management practices need to adapt and change in accordance with water supply limitations. Strip tillage can be applied to work on beds which are irrigated with drip tape. While challenges will exist, the path forward must be trod.

D. Natural Features Resource Management

Natural features should be leveraged throughout the entire watershed, such as adopting/encouraging beaver dams and other natural means of conserving water. These include aquifer storage and recovery, water spreading, irrigation methods where appropriate, use of atmospheric modification techniques to augment precipitation, FOREST MANAGEMENT, and other implementable practical solutions that prove effective.

E. USDA NRCS Management Activities

The EQIP⁸⁵ program's priorities need to change to prioritize storage capacity development in the Colorado River Basin. The programs will increase recharge, storage capacity development and management thereof, resource management activities, and conservation measures across all resource management activities in the Colorado River Basin. The importance of the EQIP program as a change-agent in the Basin cannot be overstated.

As stated above, the USDA NRCS has existing staff (and staffing capabilities) to administer large numbers of EQIP⁸⁶ applications for the many necessary conservation measures that should be implemented in the Colorado River Basin. Beyond EQIP, there are numerous other applicable programs as described below. Farm Bill modifications by the Congress can be made, or directed by the National Water Czar

Resource conservation practices (RCPs) done by farmers are administered by the USDA. Other agencies' programs to implement RCPs should be conducted by the USDA to streamline the planning and implementing processes; thus, freeing up personnel resources in agencies that are now conducting those measures.

There is existing authority for doing joint USDA/USBR projects through the Regional Conservation Partnership Program (RCPP) set forth in the Farm Bill's

⁸⁵ <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/>

⁸⁶ <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/>

authorizations. As a voluntary collaborative program, it provides financial and technical assistance to help agricultural producers plan and implement natural resource conservation activities on agricultural land, nonindustrial private forest land, and Tribal land. RCPP was first authorized by Congress in the Agricultural Act of 2014 (2014 Farm Bill.) RCPP is being vastly underutilized and could be an immensely useful tool in the Colorado River Basin.

As implemented under the 2014 Farm Bill, conservation activities within each selected RCPP project are accomplished through a combination of partnership agreements (between the Natural Resources Conservation Service (NRCS) and a lead partner (such as Reclamation)), and contracts or agreements with eligible landowners, entities, and individuals under the regulations applicable to one or more covered programs:

- the Environmental Quality Incentives Program (EQIP),
- Conservation Stewardship Program (CSP),
- Agricultural Conservation Easement Program (ACEP),
- Healthy Forests Reserve Program (HFRP),
- in designated critical conservation areas (CCAs),
- the Watershed Protection and Flood Prevention Act (Public Law 83-566, hereafter PL-566), excluding section 14 (watershed rehabilitation) of the act (16 U.S.C. 1012).

The Agricultural Improvement Act of 2018 (2018 Farm Bill) modified the RCPP program.⁸⁷ Further modifications may be required to bring this program to the forefront and increase its usefulness.

F. Record Keeping

Collecting, compiling and comparing desert water use information, including consistent ET crop coefficients for the major 10 crops (alfalfa, carrots, onions, sugar beets, crucifers, melons...), and classifying all manners of sprinkler, drip, furrow irrigation and nutrient management (to the extent it is not already being done) will provide a useful database to make informed management recommendations and decision about implementing additional conservation measures and identifying their potential benefits. Prioritizing the activities of all DOI agencies and their coordination with other Executive Branch agencies (USDA in particular) to address the critical situation in the Colorado River Basin is required. Computations using delivered water amounts need to occur to demonstrate that water conservation/distribution improvements being made through investments in conservation are yielding real water savings. Improvements in estimating unmeasured return flows, accounting for reservoir evaporation and conveyance losses in the Lower Colorado River below Hoover Dam and other accounting improvements can assist in the

⁸⁷ As stated in: REGIONAL CONSERVATION PARTNERSHIP PROGRAM Programmatic Environmental Assessment, USDA NRCS, November 2020.

Accounting is critical to the functioning of these water management and water supply strategies. Accountability and transparency are key elements of these beyond current accounting actions that will be required.

H. Other Practices

Other practices include exchange-level transfers, marketing of seasonal rights and water bank transactions. These approaches may consider a Super Ditch approach to properly account for individual water resources conservation transactions across the Lower Colorado River Basin, including virtual water exports. Agency coordination and creativity through value engineering approaches and inclusion of all Reclamation offices who have legitimate interests and resources to offer is suggested.

Virtual water exports outside the Colorado River Basin should be controlled or curtailed.⁸⁸ The following is taken from the Wall Street Journal, published by Culp & Kelly LLP:⁸⁹

"In 2012, the drought-stricken Western United States will ship more than 50 billion gallons of water to China. This water will leave the country embedded in alfalfa—most of it grown in California—and is destined to feed Chinese cows. The strange situation illustrates what is wrong about how we think, or rather don't think, about water policy in the U.S."

V. Water Conservation

- Extend SNWA conservation practices on a basin wide scale
- Recycle water on a basin wide scale

Basin-wide water conservation should be implemented, like best practices established by the Southern Nevada Water Authority (SNWA). Although the magnitude of the required savings of 3-4 maf is way beyond a sole water conservation fix, this method is a necessary part of the entire Colorado River Basin's portfolio. Generally, this means removal of outside landscaping such as ornamental grass, and recycling indoor water use on a basin wide scale for all urban areas (Denver, Tucson, San Diego, Los Angeles, Las Vegas, St George, Albuquerque and other areas interconnected with the basin).^{90,91}

Water recycling should be extended throughout the basin as a regional norm. Excellent examples of water recycling occur in San Diego County where the Padre Dam Municipal Water District, City of San Diego, and Orange County have

⁸⁸ <https://www.wsj.com/articles/SB10000872396390444517304577653432417208116>

⁸⁹ <https://www.culpkelly.law/publications>

⁹⁰ <https://www.snwa.com/rebates/wsl/index.html>

⁹¹ <https://www.nytimes.com/2022/05/03/climate/las-vegas-lawn-grass-ban.html>

demonstrated advanced capabilities.^{92,93,94} Generally indoor water use should be recycled in one form or another; for example, indoor water use in Las Vegas is treated then returned to Lake Mead. In coastal California, wastewater can be treated and re-used to intercept the wastewater before it reaches the Pacific Ocean. Water recycling in eastern San Diego (Padre Dam MWD area) such as Santee is treated and re-used either for landscaping or drinking water through advanced treatment techniques and indirect potable reuse.⁹⁵

Reclamation should continue its research in partnership with local agencies to ensure water recycling becomes standard practice throughout the basin. For example, Reclamation recently partnered with UNLV, the City of San Diego, the Lake Arrowhead Community Services District, and others to develop a standard for mixing and assimilation of reuse effluent in lakes, using Lake Arrowhead in southern California as a test case.⁹⁶

VI. Groundwater

- Extend an integrated water resource approach to both surface water and groundwater on a basin wide scale.

A basin wide groundwater strategy should be implemented and integrated into water conservation and water operation efforts. This strategy should include an integrated water resource approach where surface water and groundwater are managed together. The overall basin groundwater management scope should include the transboundary aquifers on both sides of the US- Mexican international boundary.⁹⁷

Aridification and drought is causing agricultural users and municipalities to mine groundwater. For example, groundwater withdraws, and depletion is occurring in Pinal County, Arizona, as a direct result of Colorado River drought contingency plan and shortage criteria implementation.^{98,99,100}

The Morison Institute for Public Policy recently published *The Myth of Safe Yield: Pursuing the Goal of Safe-Yield Isn't Saving Our Groundwater*:

- Conservation, while necessary, is insufficient to achieve safe-yield.
- Too many users are allowed to pump groundwater in perpetuity, while others are allowed to initiate new uses of groundwater.

⁹² <https://www.sandiego.gov/public-utilities/sustainability/pure-water-sd>

⁹³ <https://padredam.org/129/Recycled-Water>

⁹⁴ <https://www.ocwd.com/what-we-do/water-reuse/>

⁹⁵ <https://sites.sandiego.edu/sdpollutiontrackers/2018/05/09/toilet-to-tap-not-as-horrendous-as-you-d-think/>

⁹⁶ <https://www.usbr.gov/research/projects/detail.cfm?id=1397>

⁹⁷ <https://wrrc.arizona.edu/taap>

⁹⁸ <https://new.azwater.gov/sites/default/files/media/CAP-FactSheet-CoRiverShortage-042721.pdf>

⁹⁹ <https://www.kunc.org/environment/2022-01-04/with-less-water-on-the-surface-how-long-can-arizona-rely-on-whats-underground>

¹⁰⁰ https://morrisoninstitute.asu.edu/sites/default/files/the_myth_of_safe_yield_0.pdf

- *Safe-yield has been subject to differing interpretations, complicating the assessment of meeting this goal.*
- *Achieving safe-yield will not prevent the lowering of groundwater levels in all areas of an AMA or the inherent consequences of long-term groundwater decline, including land subsidence, water quality degradation and aquifer compaction.*
- *Legislation since 1980 has created additional challenges for the sustainability of groundwater supplies in the AMAs.*

Given basin-wide aridification groundwater management on a basin-wide scale should be integrated into operations.¹⁰¹ For example, an advantage of groundwater banking in Arizona is to store unused apportionment on the Colorado River where the water is stored and available for future use. The following is taken from *Groundwater Recharge for Water Security: The Arizona Water Bank, Arizona*.¹⁰²

"The Arizona Water Banking Authority (AWBA) was established in 1996 to make full use of Arizona's Colorado River entitlement. It aims to address groundwater depletion in central Arizona and to protect Colorado River water users against future shortages due to interannual variability in water availability. Each year, the AWBA pays the costs to deliver any of the state's unused entitlement to Colorado River water into central and southern Arizona and to store that water underground. The AWBA stores water on behalf of Central Arizona Project municipal subcontractors, other mainstream municipal Colorado River water rights holders, and tribal entities. Through its interstate banking agreements, the AWBA can also store water on behalf of the states of Nevada and California. Water stored by the AWBA is accounted for using Arizona's statutorily created system of long-term storage credits (LTSCs), which allow future pumping of stored water within the same hydrologic basin. During shortage conditions in the Lower Basin of the Colorado River, the AWBA will distribute the LTSCs, enabling recipients to pump groundwater that otherwise would not be permitted. In this way, the AWBA serves as a unique insurance mechanism against shortages for users of Colorado River water in Arizona and the Lower Basin. To date, the AWBA's focus has been on storage, yet in the coming years, its activities will shift to recovery, and it will need to confront additional challenges associated with matching supplies with demands and limitations on water available for recharge."

¹⁰¹ <https://www.coloradoriverdistrict.org/water-banking/>

¹⁰² <https://online.ucpress.edu/cse/article/5/1/1113999/116771/Groundwater-Recharge-for-Water-SecurityThe-Arizona>

VII. Innovative Technologies

- Implement innovative technologies, such as:
 - Steam generation to create cloud streets
 - Cloud seeding
 - NASA's Earth Science Airborne Observatory
 - Data assimilation
 - Modify the dams
 - N-DRIP technology

A few of many innovative technologies are suggested here, such cloud streets, cloud seeding, and irrigation practices such as N-DRIP®. This section is not an endorsement and does not take potential legal aspects into account with various technologies.

A. Floating Steam Generator to Alleviate Drought by Making Clouds

Cloud streets are a type of organized convection that forms as an extended line of cumulus clouds parallel to wind direction.¹⁰³ Usually this type of cloud forms over a water body such as the Atlantic or Pacific Ocean, the Black Sea, Great Lakes, or Hudson Bay.¹⁰⁴ It is probable that injection of steam vapor into the atmosphere off the shore of California can accomplish weather modification. Clouds, in the form of linear cloud formations such as "cloud streets" would bring the water vapor inland where precipitation would occur. Chaining multiple units together to create a large, superheated steam output would create an opportunity to modify annual precipitation amounts. Research at the Massachusetts Institute of Technology (MIT) over the past decade demonstrates that it is practical to use the passive energy of sunshine to create superheated steam.^{105 106 107} The 2022 article describes this technology as being highly efficient (>80% solar-to-vapor conversion efficiency) and salt rejecting (20 weight % salinity).

Conceptually, relatively large-scale (for example, measured in tens of thousands of square feet) platforms moored in navigable coastal waters in the Pacific Ocean off the California coast could generate sufficient superheated steam to create massive steam thermals. As stated above, this vapor would move upward in the atmosphere to create cloud streets; these clouds would carry water vapor to the Colorado River basin and other areas in the drought-plagued West.^{108 109} As the clouds rise over

¹⁰³ <https://rammb.cira.colostate.edu/wmovl/vrl/tutorials/satmanu-eumetsat/satmanu/cms/clstr/index.htm>

¹⁰⁴ <https://earthobservatory.nasa.gov/images/82800/cloud-streets-over-the-atlantic-and-pacific-oceans>

¹⁰⁵ <https://www.nature.com/articles/ncomms5449>

¹⁰⁶ <https://www.nature.com/articles/s41467-018-07494-2>

¹⁰⁷ <https://www.nature.com/articles/s41467-022-28457-8>

¹⁰⁸ <https://www.osti.gov/servlets/purl/4146994>

¹⁰⁹ <https://earthsky.org/earth/what-are-cloud-streets/>

inland areas, the in-cloud water vapor would condense and yield the water they carry as snow and rain.¹¹⁰

The US Coast Guard will need to be involved in setting up buoys for protection and marking nautical charts. That agency might also be responsible for the transportation and operation of the floating steam generation platform. Due to the strategic importance of this facility, it could easily be considered a Department of Homeland Security item.

DARPA, partnering with MIT, could adapt their technology to develop proof-of concept working units in a reasonable timeframe. A one-year test in the Pacific Ocean off Southern California would provide data for second generation steam units. The test bed should at least 100 yards long and 50 yards wide to provide a significant quantity of information for further development.

A newly developed coating could be applied to the pontoons or other floating legs to prevent marine fouling. Slippery Liquid-Infused Porous Surfaces (SLIPS) technology, inspired by the slippery pitcher plant that repels almost every type of liquid and solid, is a unique approach to coating industrial and medical surfaces. It is based on nano/micro-structured porous material infused with a lubricating fluid. SLIPS technology creates slick, exceptionally repellent and robust self-cleaning surfaces on metals, plastics, optics, textiles and ceramics. These slippery surfaces repel almost any fouling challenge a surface may face—whether from bacteria, ice, water, oil, dust, barnacles, or other contaminants.¹¹¹

Additionally, NASA has created clouds using rocket technology.¹¹² These earlier efforts support the fact that cloud forming technology is feasible and could enhance water vapor flow inland from the Pacific Ocean. Use of the sun's energy within a passive system, such as described above, would avoid the need for a power source for operating this platform.

B. Additional Cloud Seeding

Cloud seeding is not a new technology and is routinely used to enhance precipitation at various locations throughout the Colorado River Basin.^{113,114} It appears more work needs to be done to expand on cloud seeding throughout the basin, if not already, through expanded research and a greater basin-wide approach.¹¹⁵

¹¹⁰https://www.weather.gov/source/zhu/ZHU_Training_Page/clouds/cloud_development/clouds.htm#:~:text=Clouds%20form%20when%20the%20invisible,a%20liquid%20or%20solid%20form.

¹¹¹ <https://wyss.harvard.edu/technology/slips-slippery-liquid-infused-porous-surfaces/>

¹¹² <https://www.space.com/7282-nasa-rocket-create-clouds-tuesday.html>

¹¹³ <https://www.coloradoriverdistrict.org/cloud-seeding/>

¹¹⁴ <https://www.coloradoriverdistrict.org/cloud-seeding/>

¹¹⁵ <https://www.mines.edu/undergraduate-research/wintertime-cloud-seeding-evaluating-the-cloud-seeding-renaissance-in-the-colorado-river-basin/>

C. **Earth Science Airborne Observatory**

NASA's Airborne Snow Observatory has been providing LiDAR and spectrometry data for various watersheds in California to survey snowpack and burn areas. This level of survey should be extended basin wide to provide better insight on snowpack and allow for better data collection and change management.

*"The Airborne Snow Observatory is providing California water managers the first near-real-time, comprehensive determination of basin-wide snow water equivalent," said Frank Gehrke, mission co-investigator and chief of the California Cooperative Snow Surveys Program for the California Department of Water Resources. "Integrated into models, these data will enhance the state's reservoir operations, permitting more efficient flood control, water supply management and hydroelectric power generation."*¹¹⁶

D. **Data Assimilation**

Use of massive data processing, especially in forecasting, can be utilized to enhance operations. Rather than waiting for attribution studies, data assimilation could be leveraged based on anecdotal evidence. For example, forecasting a river gage hydrograph 5 days out has large uncertainty, and is honed as the actual day of the event occurs. Data assimilation could be used to provide operators statistical data for compensating for forecast uncertainty and managing operational risks.

E. **Modify the Dams**

Both Glen Canyon Dam and Hoover Dam had river bypass tunnels during construction that discharged through the existing flip buckets. A tunnel boring machine could easily drill out the concrete/rock to the top of the sediment layer in the reservoirs to create a discharge method to get water out the dam below dead pool. Gates would be required for flow regulation, and in Mead, this could threaten the third intake for SNWA which is at 20 ft below dead pool at Hoover Dam.

F. **DRIP® Technology**

N-DRIP®¹¹⁷ is a proprietary, Israeli technology which was recently the subject of a completed a pilot study in Arizona, in conjunction with the Central Arizona Project, University of Arizona, and the Colorado River Indian Tribes¹¹⁸. The N-DRIP pilot study focused on:

¹¹⁶ https://www.nasa.gov/home/hqnews/2013/may/HQ_13-131_Airborne_Snow_Mission.html

¹¹⁷ <https://ndrip.com/>

¹¹⁸ <https://civicclerk.blob.core.windows.net/stream/CAPAZ/e02c09a8-ec58-4b01-8f57-9645e8fad6b7.pdf?sv=2015-12-11&sr=b&sig=VRUbkZi1Wmu1U5EpmYCOqkhBkWh47rleaiLyfFnu5M%3D&st=2021-10->

- “Cost-effective, innovative, adaptable, accessible irrigation efficiency water conservation technology
- Sustaining agriculture
- Conserving Colorado River water to benefit the Colorado River system and provide resiliency to CAP's water supply”

Results of the pilot study indicated a water savings of over 50% versus flood irrigation, with no new infrastructure required. Water savings were demonstrated with over 50% growing alfalfa, 40% growing sorghum, and 30% growing cotton.

Current and/or future proposal locations are slated for:

- Harquahala Irrigation District
- Colorado River Indian Tribes
- Yuma Mesa Irrigation and Drainage District
- CAP Tribal Partners
- Mexicali Valley

A 2022-2023 Alfalfa Study Project is planned at “Farm Scale” which demonstrates the conversion of flood irrigating alfalfa fields to N-Drip®, summarized as follows:

Project Scope:

- 200 acres total - 2 Separate Field Plots Of 100 Acre Each
- 2 equal size control fields
- Full monitoring of all fields, such as water consumption, yield, fertilizers and energy consumption
- 2-year project – determine feasibility and durability

Timeline:

- Planting – Oct 2021
- End Of Monitoring Period – September 2023

Partners:

- CAWCD
- Central Utah Project
- Denver Water
- MWD
- SNWA
- N-drip
- University Of Arizona
- CRIT Farms & Bill Perry (growers)

Given the proven and tested technology N-DRIP® one solution to the supply and demand imbalance on the Colorado River would be to deploy N-DRIP® at greater scale. For example, existing water contracts on the

Lower Colorado River could be honored by having the Federal Government subsidize the installation and maintenance of N-DRIP® systems at no cost to agricultural users, versus subsidizing users to fallow farmland.

VIII. International Considerations

- Showcase collaboration with Mexico, Tribes and NGOs in the Indo-Pacific

Although circumstances are dire in the Colorado River Basin the transboundary water collaboration between the United States, Mexico, Tribes, and NGOs provides an excellent opportunity to showcase how neighboring countries can collaborate to accomplish workable water compromises. The extensive cooperation between the United States and Mexico, through the International Boundary and Water Commission should be showcased by the State Department as an example for other global transboundary water flash points. For example, collaboration in the Colorado River Basin can be extended as soft diplomacy in the Indo-Pacific, Himalayan region, where rivers originating in Tibet cross from the Peoples Republic of China to southeast Asia. The Brahmaputra,¹¹⁹ Irrawaddy,¹²⁰ and Mekong¹²¹ originate in China and drain across the international boundaries with India, Bangladesh, Myanmar, Thailand, Vietnam, Laos and Cambodia. Climate stressors in southeast Asia such as drought and flood control need to be coordinated with river operations to ensure downstream water-using nations have a guaranteed and predictable water supply. Currently water deliveries for downstream counties are controlled by China with little transparency.

Riverine systems in China are also seeing the effects of climate change; perhaps the dire situation along the Yellow or Yangtze Rivers could be a common point of collaboration between the two competitors.

In Africa the *Grand Ethiopian Renaissance Dam* [GERD] is another point of friction between Ethiopia and downstream water users on the Nile, such as Egypt.¹²² Brookings is quoted as follows:¹²³

“Officials in Addis Ababa argue that the GERD will have no major impact on water flow into the Nile, instead arguing that the hydropower dam will provide benefits to countries in the region, including as a source of affordable electric power and as a major mechanism for the management of the Nile, including the mitigation of droughts and water salinity.

Egypt, fearing major disruptions to its access to the Nile's waters, originally intended to prevent even the start of the GERD's construction. Indeed, Egypt has called the filling of the dam an existential threat, as it fears the dam will negatively impact the country's water supplies. At this point,

¹¹⁹ <https://warontherocks.com/2020/12/a-conflict-prone-river-takes-a-step-backwards/>

¹²⁰ <https://wle-mekong.cgiar.org/changes/where-we-work/irrawaddy-river-basin/#>

¹²¹ <https://wle-mekong.cgiar.org/changes/where-we-work/mekong-river-basin/>

¹²² <https://www.washingtonpost.com/world/interactive/2020/grand-ethiopian-renaissance-dam-egypt-nile/>

¹²³ <https://www.brookings.edu/blog/africa-in-focus/2020/08/05/the-controversy-over-the-grand-ethiopian-renaissance-dam/>

though, the GERD is nearly completed, and so Egypt has shifted its position to trying to secure a political agreement over the timetable for filling the GERD's reservoir and how the GERD will be managed, particularly during droughts. One question that keeps coming up is: Will Ethiopia be willing to release enough water from the reservoir to help mitigate a drought downstream?

Sudan is caught between the competing interests of Egypt and Ethiopia. Although Khartoum initially opposed the construction of the GERD, it has since warmed up to it, citing its potential to improve prospects for domestic development. Nevertheless, Khartoum continues to fear that the operation of the GERD could threaten the safety of Sudan's own dams and make it more difficult for Sudan to manage its own development projects.

Although talks chaired by President Cyril Ramaphosa of South Africa on behalf of the African Union have resolved many GERD reservoir filling issues, there is still no agreement on the role that the reservoir will play in mitigating droughts. The three countries have agreed that "when the flow of Nile water to the dam falls below 35-40 billion cubic meters (b.c.m.) per year, that would constitute a drought" and, according to Egypt and Sudan, Ethiopia would have to release some of the water in the reservoir to deal with the drought. Ethiopia, however, prefers to have the flexibility to make decisions on how to deal with droughts. Afraid that a drought might appear during the filling period, Egypt wants the filling to take place over a much longer period."