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December 20th, 2022

Comments on Supplemental Environmental Impact Statement for December 2007 Record of Decision Entitled Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations For Lake Powell and Lake Mead Sent via email to CRinterimops@usbr.gov.

Reclamation 2007 Interim Guidelines SEIS Project Manager
Upper Colorado Basin Region
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To Whom it May Concern:

Thank you for the opportunity to comment on the Supplemental Environmental Impact Statement for December 2007 Record of Decision Entitled Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations For Lake Powell and Lake Mead.

1. Introduction

The fate of the entire Colorado River system is in a drastic state of uncertainty. While the circumstances we face as a basin are unprecedented, they are not unpredicted. The scientific community has long acknowledged that the Colorado River is over allocated, and that consumption has outstripped supply for most of the past two decades[1]. Furthermore, the deleterious effects of climate change have compounded this supply/demand imbalance, with numerous studies expounding the impacts of a warming basin and modeling future scenarios[2].

[1] http://www.inkstain.net/fleck/2022/08/how-we-got-into-this-mess-on-the-colorado-river/
[2] https://scholar.colorado.edu/concern/parent/8w32r663z/file_sets/ng451j49n

Every climate study that has been done on the Colorado River Basin predicts there will be less runoff in the years to come.

The speed at which climate change is reducing runoff on the Colorado River dictates that overhauls of the river's management will be necessary. Reclamation acknowledged this in its June 2022 announcement asking states to find a path to reducing consumptive use by 2-4 million acre feet by August of 2022. This was in addition to immediate reduction in the amount of water released to Lake Mead and the movement of 480,000 acre-feet of water from Flaming Gorge to Lake Powell. No reduction agreement was made between basin states, and the path to broad reductions of use is unclear.

The development of updated operational strategies for the river must be aggressive, forward thinking and embrace a significantly lower water supply. Reclamation should be applauded for taking action in demanding conservation from Basin states — the only path toward a sustainable river system. The framework of the SEIS and subsequent operational guidelines should emphasize water conservation at every possible juncture.

The scope of operating criteria to be assessed in this SEIS should include a wide range of alternatives - well beyond anything considered in the 2007 guidelines. Reclamation's October projections shows the possibility of Lake Powell falling below minimum power as soon as December 2023, even with the extensive efforts to prop up the reservoir in 2021 and 2022.

An analysis[3] released by Glen Canyon Institute, Utah Rivers Council, and Great Basin Water Network shows that if the Colorado River system experienced a series of water years like 2000-2004 or even 2017-2021, Lake Powell could easily drop within range of dead pool. Managing Lake Powell near dead pool comes with a host of challenges, including structural challenges of operating Glen Canyon Dam solely with the use of the river outlet works, managing recreation and safety at a wildly fluctuating reservoir, and serious impacts to the Grand Canyon downstream. But the most important consideration is that at elevation 3,430 feet above sea level, Glen Canyon Dam cannot release enough water to meet its downstream delivery obligations to the lower basin[4].

In a webinar for this SEIS, Reclamation released its own analysis, resulting in similar projections to reservoir levels in GCI's analysis. By modeling reservoir elevations at Lake Powell and Lake Mead under hydrologies similar to those in the early 2000's, it's clear that both reservoirs could quickly fall below near pool and near dead pool levels. The scenarios presented by BOR entertain different actions aimed at protecting Lake Powell versus Lake Mead. In the webinar, it was expressed by Reclamation officials that there is great concern of Glen Canyon Dam operating solely by its river outlet works (ROW's), and that there may be a need to withhold releases downstream to "prop up" Powell and delay it from relying on it's ROW's.

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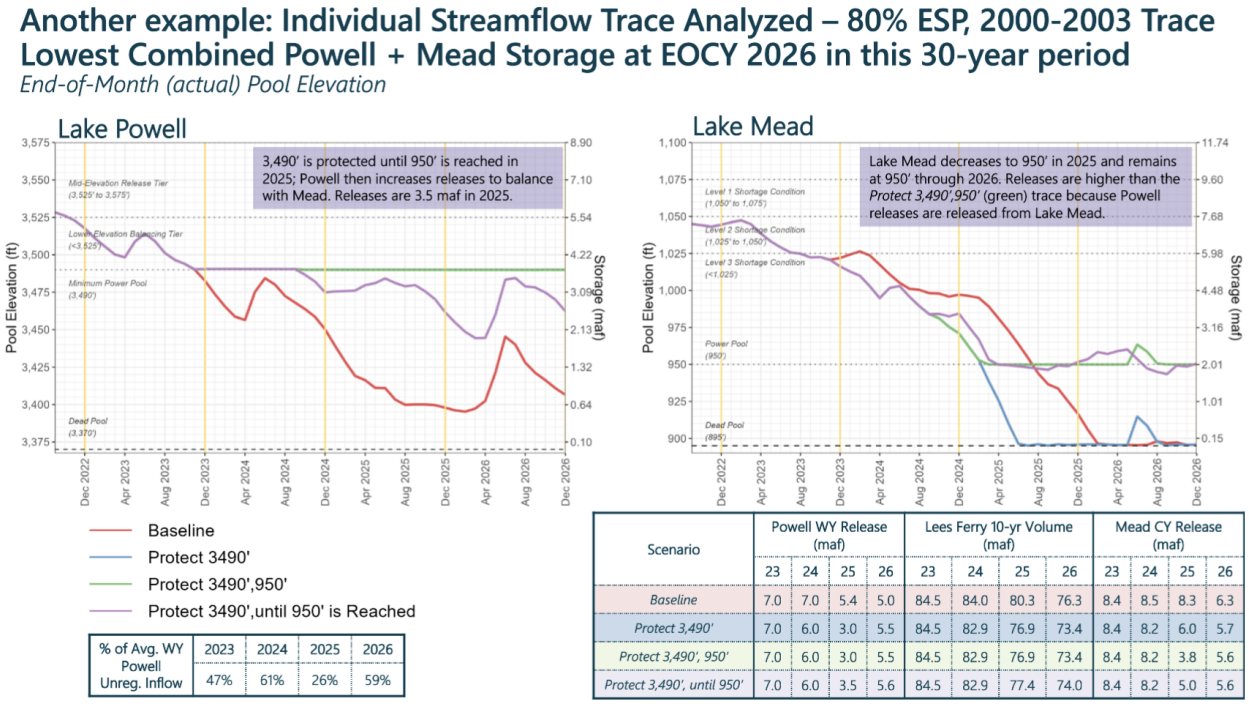
[3] https://www.glencanyon.org/wp-content/uploads/2022/08/Final-Antique-Plumbing-at-Glen-Canyon-Dam.pdf
[4] https://gcnr.usu.edu/coloradoriver/files/CCRS_White_Paper_1.pdf, Page 10

Given the probability, even with efforts to “save Powell first”, that Lake Powell could drop below minimum power pool and Glen Canyon Dam will operate solely on its ROW’s[5], and given that this SEIS will likely shape future management strategies, including the post-2026 guidelines, there is a significant need to consider physical modifications to Glen Canyon Dam.

At the SEIS webinar on December 2nd, Glen Canyon Institute asked whether Reclamation’s studies to modify Glen Canyon Dam[6] would be incorporated in the SEIS. Reclamation indicated that the studies would not be completed in time to be evaluated in the SEIS, but would be evaluated in the post-2026 EIS.

But the NOI presented for the SEIS states that, “the Department recognizes that operational strategies for 2023-2024 may need to be further revisited for subsequent operating years”[7]. Even if the studies to modify Glen Canyon Dam aren’t completed in time to be evaluated in this SEIS in 2023, it should include a mechanism to incorporate new information as it becomes available so that strategies can be revisited — especially information about modifications at Glen Canyon Dam.



% of Avg. WY Powell Unreg. Inflow	2023	2024	2025	2026
	47%	61%	26%	59%

Scenario	Powell WY Release (maf)				Lees Ferry 10-yr Volume (maf)				Mead CY Release (maf)			
	23	24	25	26	23	24	25	26	23	24	25	26
Baseline	7.0	7.0	5.4	5.0	84.5	84.0	80.3	76.3	8.4	8.5	8.3	6.3
Protect 3,490'	7.0	6.0	3.0	5.5	84.5	82.9	76.9	73.4	8.4	8.2	6.0	5.7
Protect 3,490', 950'	7.0	6.0	3.0	5.5	84.5	82.9	76.9	73.4	8.4	8.2	3.8	5.6
Protect 3,490', until 950'	7.0	6.0	3.5	5.6	84.5	82.9	77.4	74.0	8.4	8.2	5.0	5.6

Graph from Bureau of Reclamation presentation December 2nd, 2022

With this SEIS likely influencing the structure of the post-2026 guidelines and the long term management of the Colorado River, it's imperative that it allow a way for upcoming information on Glen Canyon Dam modifications to be included if/when strategies must be revisited. This

[5] Slide from BOR SEIS webinar, December 2nd, 2022, featured on page 3 of this document.
[6]https://www.msn.com/en-us/entertainment/news/the-daily-buzz-why-the-feds-want-to-study-glen-canyon-dam-modifications/ar-AA10KPCj
[7]https://www.federalregister.gov/documents/2022/11/17/2022-25004/notice-of-intent-to-prepare-a-supplemental-environmental-impact-statement-for-december-2007-record

includes scenarios where Glen Canyon dam is re-engineered so that it can function as a “run of river” facility, allowing for the full downstream release capabilities. While this concept is controversial to some, it may prove to be the best option under future circumstances. To not include such an alternative for analysis would be a major flaw in an EIS meant to carry the basin into a drier future.

The “run of river” option should include an in-depth analysis of the many considerations that that type of management regime would entail, including but not limited to: engineering costs and timeline, policy framework options for Upper Basin water storage, potential water savings from reduced ground seepage, recreational opportunities and impacts in Glen canyon, environmental impacts and benefits in the Grand Canyon, use of Glen Canyon Dam facilities for flood protection, implications for surrounding tribes, and ecological, recreational, and cultural resources emerging in restoring sections of Glen Canyon that were once inundated by the reservoir.

2. The hydrologic reality of the Colorado River, and the need to use better forecast modeling for management

The impacts of climate change on the Colorado River have been widely studied for decades, with almost every study indicating that warming temperatures in the basin have already and will continue to reduce runoff[8]. The question isn’t whether or not this trend will continue, but by how much. With a wide range of future impacts, scientists have concluded that we have not yet seen the worst, with the potential to see an additional 40% of flow reductions by mid-century[9].

The impacts being experienced in the Colorado River are unlike anything that’s been seen in over a thousand years, which is one of the reasons current modeling used by Reclamation, the Colorado River Mid-term Modeling System (CRMMS), informed by Colorado River Forecast Center hydrologic assessments, has been overly optimistic for most of the past decade. A 2021 white paper The Futures of the Colorado Group evaluated these Colorado River projections and found that the agency has consistently underestimated the impacts of climate change and overestimated the amount of water projected to flow in the Colorado River, specifically into Lake Powell.

As described in the Futures of the Colorado River Project’s White Paper #7[10], Reclamation's 24-month studies have consistently overestimated runoff of the studies’ 2nd year “most probable” projection. The study found that the Bureau’s “most probable projected inflows were higher than what actually occurred by as much as ~7 million acre feet (maf) in some years, and predicted reservoir elevations were also higher than what occurred in some years.” This is most aptly demonstrated by White Paper #7’s Figure 7, which has been reproduced below as a single graph.

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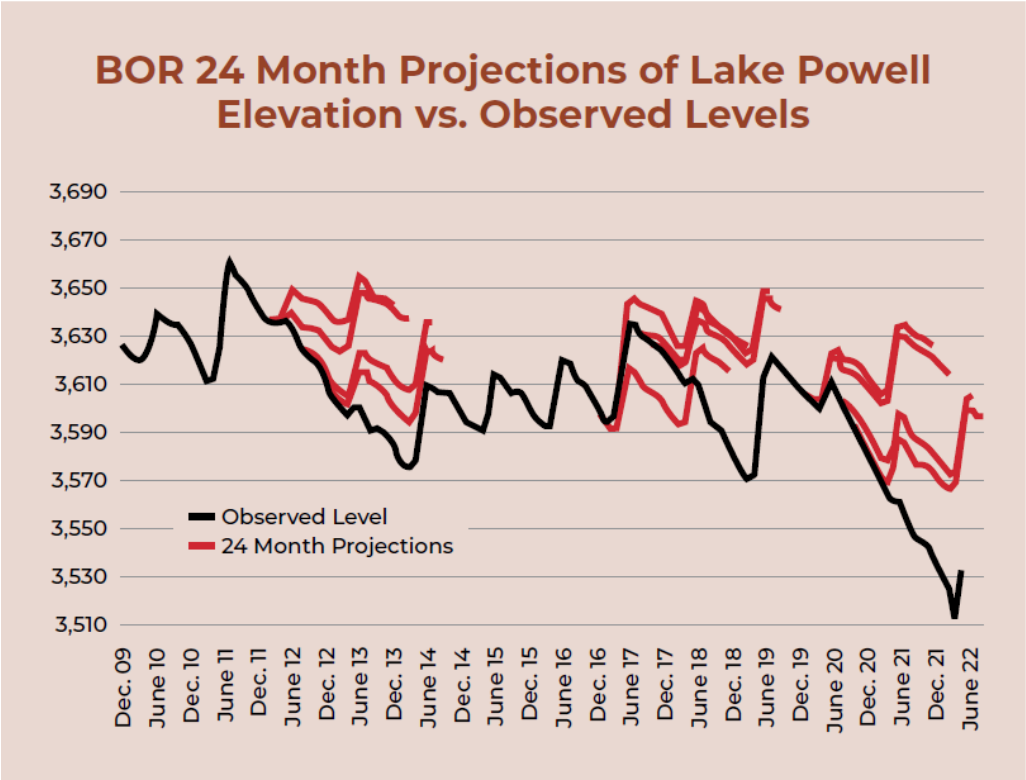
[8] https://www.usu.edu/colorado-river-research-group/files/crrg_reflections_on_two_decades.pdf

[9] Milly, P. C., & Dunne, K. A. (2020). Colorado River flow dwindles as warming-driven loss of reflective snow energizes evaporation. Science, 367(6483), 1252-1255. Bradley Udall & Jonathan Overpeck, The Twenty‐first Century Colorado River Hot Drought and Implications for the Future, 53 WATER RESOURCES RES. 2404 (2017)

[10] https://qcnr.usu.edu/coloradoriver/files/WhitePaper_7.pdf



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The above figure, showing levels of Lake Powell between December 2009 and June 2022, demonstrates how far Lake Powell water levels have declined over time, as shown in black. The red lines are Bureau of Reclamation 24 month “most probable” forecasts which demonstrate a bias to overestimating the amount of water that will be in Lake Powell. Reproduced from White Paper #7, Figure 7.

The use of the 30-year statistical modeling is standard for water managers, but in the Colorado River Basin it has been proven to be outdated and leaves water managers and stakeholders unprepared. Reclamation should incorporate a wider set of data, like those used by the Futures of the Colorado Group[11] and Western Water Assessment[12], in 24-month and 60-month projections.

3. The likelihood of future declines at Lake Powell

Climate change has reduced the Colorado River’s average annual flow roughly 20% over the past two decades, compared to the 20th Century average, resulting in dramatic water level declines at Lake Powell[13].

[11] https://www.science.org/doi/10.1126/science.abo4452

[12] https://scholar.colorado.edu/concern/reports/8w32r663z

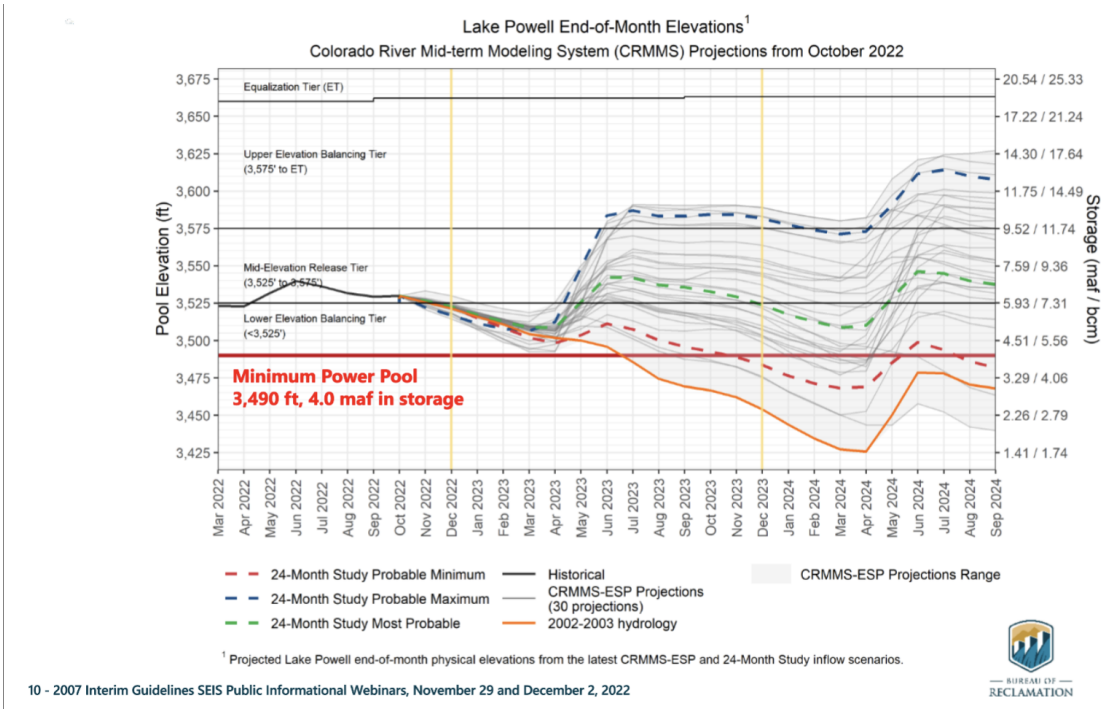
[13] Bureau of Reclamation. Natural Flow and Salt Data. (2022).

Water Flow Scenario

Flow reduction of the Colorado River at Lee Ferry	Naturalized flow at Lee Ferry
20th Century Average (1906-1999)	15.2
5% Decrease	14.4
21st Century Average 19% Decrease	12.4
20% Decrease	12.2
40% Decrease	9.1

Table 3. From 2000 to 2018, the Colorado River flowed at an average 12.4 million acre-feet per year, a roughly 20% drop in flows from the 15.2 million acre-feet experienced for most of the 20th century.

The table above summarizes the range of Colorado River flow declines projected by peer-reviewed scientific papers. This material is reproduced from A Future on Borrowed Time [14], an analysis of Upper Colorado River Basin water budgets. Flow declines are shown as a percent decrease from the 20th Century Average of 15.2 million acre-feet, and both the 20th and 21st Century. For comparison purposes, the water year 2022 unregulated inflow for Lake Powell was just over 6 maf.



Slide from BOR SEIS presentation, December 2nd, 2022

[14]https://static1.squarespace.com/static/5a46b200bff2007bcca6fcf4/t/620a935ebcb00a3f5258e71b/1644860263000/Future+on+Borrowed+Time.pdf

Reclamation recently took steps to prop up Lake Powell, releasing an additional 500,000 acre feet of water from Flaming Gorge and holding back 480,000 acre feet of water from being released to Lake Mead downstream[15]. Even with these efforts, the Bureau projected in its December webinar, under the most probable scenario, Lake Powell's elevation will drop to approximately 3,510 fasl by April 2023, 12 feet lower than the reservoir's 2022 low point[16]. Under minimum probable inflow projections, the Bureau estimates that Lake Powell could fall as low as 3,470 by March 2024.

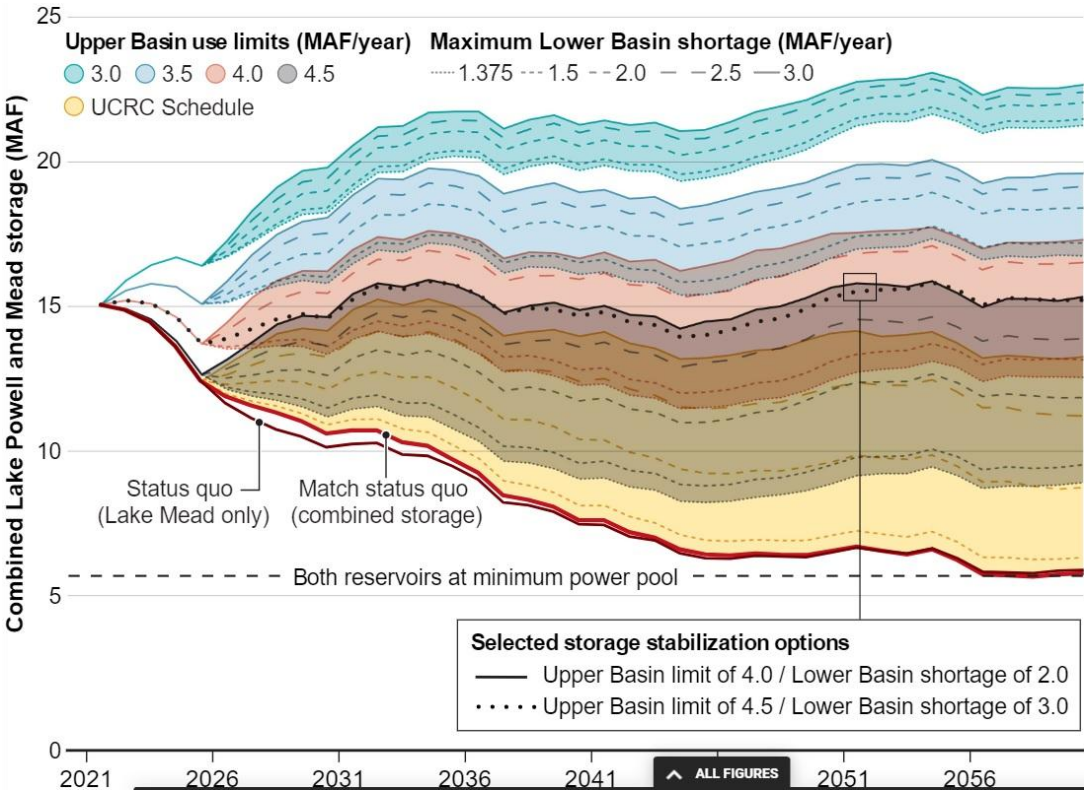


Figure from What will it take to stabilize the Colorado River?, *Science Magazine*

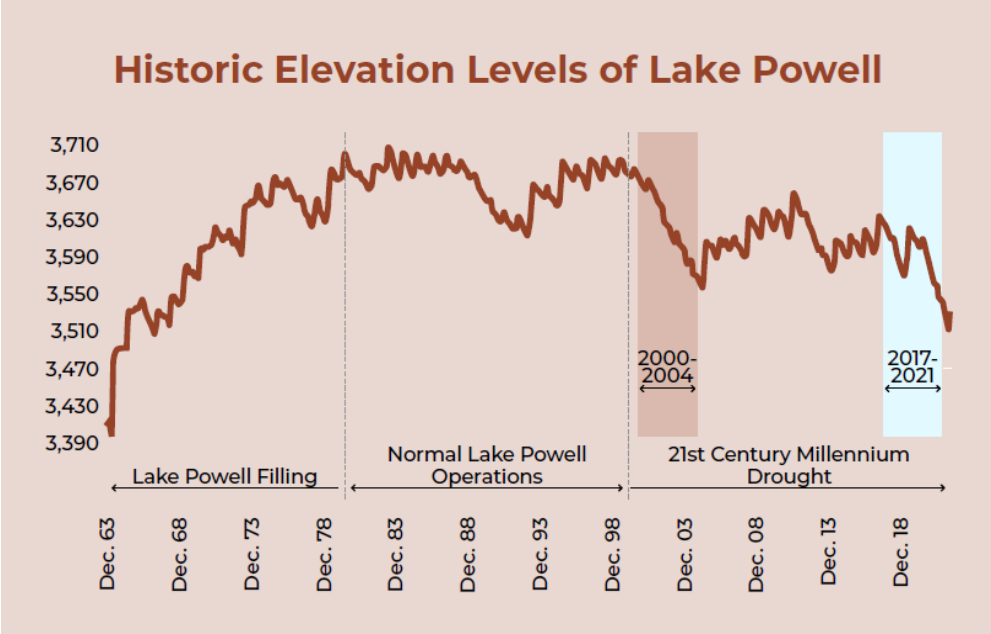
The figure above, from Wheeler et al. in *Science*[17], shows an array of future possibilities of combined storage totals between Powell and Mead, based on existing shortage curtailment schedules and different Upper Basin depletion scenarios. The figure shows that with climate impacts not getting worse, and significant reductions implemented from the Upper and Lower Basin, system storage will still only stabilize, not increase. It's also worth noting that this graph assumes a starting point of 15 million acre feet of live storage between Powell and Mead. As of

[15] Trujillo, Tanya. Letter to Colorado River Basin State Managers on Coordinated Actions & DROA. (May 2, 2022)
[16] Slide from BOR SEIS presentation, December 2nd, 2022
[17] https://www.science.org/doi/10.1126/science.abo4452#

December 2022, the reservoirs' combined storage is 12.86 million acre feet[18][19], lower by more than 2 million acre feet.

Based on the Wheeler et al. projections, if Basin states cannot come to an agreement on widespread reductions of consumptive use and/or climate continues to reduce runoff, storage at Powell and Mead will continue to drop precipitously. As stated earlier, climate science suggests runoff will get worse, the fundamental issue of whether the Basin states can agree to widespread cuts remains unclear[20].

For another perspective of what the reservoir's future could look like and provide another possible prediction of what could happen in the years ahead, an analysis was conducted by Utah Rivers Council, Glen Canyon Institute, and the Great Basin Water Network[21] The analysis projected potential future Lake Powell water levels by simply using observed historical data. Two historical five-year periods were chosen and assessed what Lake Powell's water level would be if future conditions resembled those observed in either of these periods[22] The figure below shows the entire history of Lake Powell's water levels and illustrates the two color-coded periods used by the report to project future Lake Powell levels, from 2000-2004 and from 2017-2021.



Historic elevations of Lake Powell and the two historic periods chosen to forecast possible future declines.

[18] http://lakepowell.water-data.com/

[19] http://lakemead.water-data.com/

[20] https://www.latimes.com/environment/story/2022-08-16/colorado-river-basin-states-fail-to-reach-drought-agreement

[21] https://www.glencanyon.org/wp-content/uploads/2022/08/Final-Antique-Plumbing-at-Glen-Canyon-Dam.pdf

[22] Bureau of Reclamation. Annual Operating Plan. (2021). https://www.usbr.gov/uc/water/rsvrs/ops/aop/AOP21.pdf. Bureau of Reclamation. Natural Flow and Salt Data. (2022). Bureau of Reclamation. 24 Month Study. (June 2022). https://www.usbr.gov/uc/water/crsp/studies/24Month_06.pdf

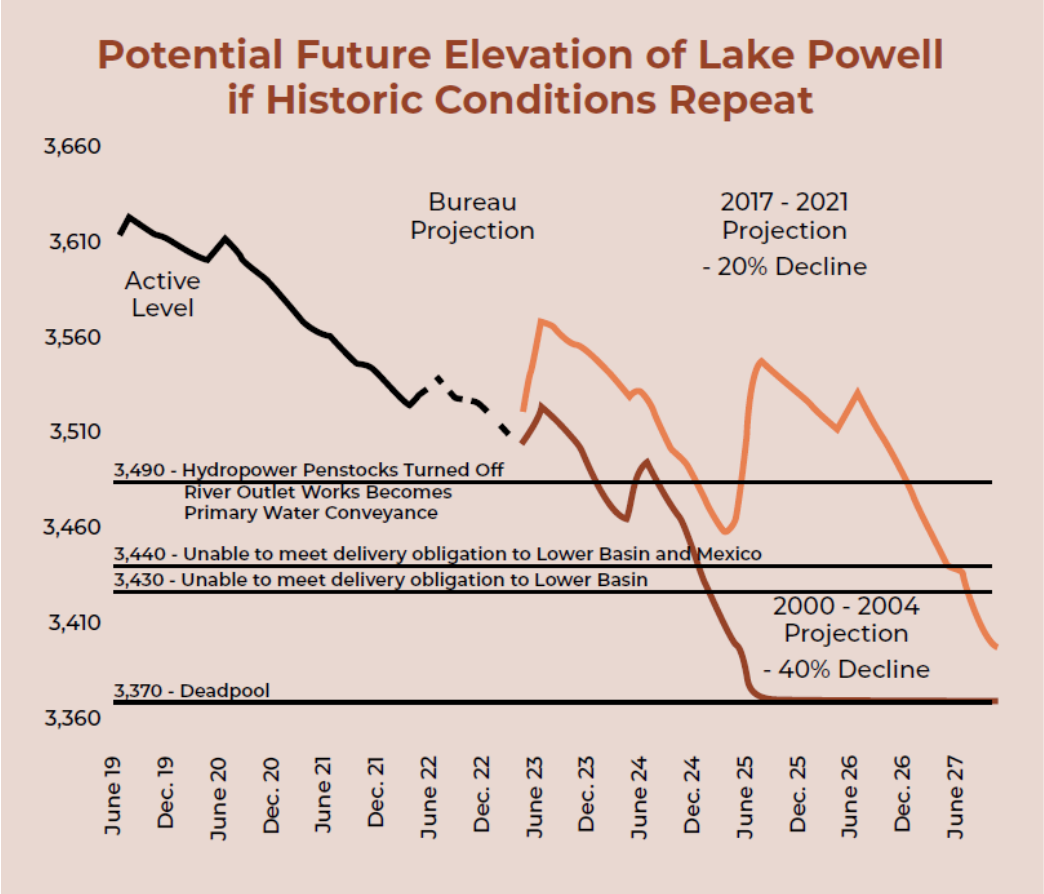
	Average unregulated inflow to Lake Powell	Change in Lake Powell Storage	Change in Lake Powell Storage	Average Natural Flow at Lees Ferry	Decline in Natural flow from 20th Century Average
2000-2004	5.8 million ac-ft	-120 feet	-13.8 million ac-ft	9.4 million ac-ft	38%
2017-2021	7.8 million ac-ft	-65 feet	-5.5 million ac-ft	12.2 million ac-ft	20%

Summary statistics for two historical time periods used in analysis.

These two periods were chosen because they represent good 'new normal' and 'low end' projections for the Colorado River System. The 2000-04 period roughly lines up with the low end projection of a 40% decline in Colorado River flows predicted by the current scientific literature[23]. The 2017-21 is similar to the 21st century average Colorado River flow of 12.3 million acre-feet and could be thought of as the recent new normal. The figure below shows Lake Powell's projected elevation level using these two historical periods.

When forecasted into the future using these two historic periods, Lake Powell quickly drops to levels well below the critical elevation thresholds of 3,440 and 3,430 feet above sea level. This exercise is not meant to be a prediction that Lake Powell will follow either of these paths over this time frame. Projecting Lake Powell's actual water levels over the next five years with a high degree of certainty is very difficult, especially without incorporating potential future curtailments. This exercise merely demonstrates it is plausible that Powell could drop to critical elevation thresholds in the near future, and reflects similar outcomes to the charts shared by Reclamation at its December SEIS webinar.

[23] Milly, P. C., & Dunne, K. A. (2020). Colorado River flow dwindles as warming-driven loss of reflective snow energizes evaporation. Science, 367(6483), 1252-1255. Bradley Udall & Jonathan Overpeck, The Twenty-first Century Colorado River Hot Drought and Implications for the Future, 53 WATER RESOURCES RES. 2404 (2017).



Projected elevation of Lake Powell reservoir levels into the future from March 2023 forward, given observed historical hydrologic periods of both 2000 – 2004 and 2017 – 2021.

4. The need to study modifications at Glen Canyon Dam and model operations with low and no reservoir scenarios

As demonstrated by the charts above and Reclamation's own charts presented at it's SEIS webinars, there is a significant enough likelihood of Powell dropping below power pool and near dead pool that Reclamation should have every tool available to operate the system in such scenarios. Currently those tools are unavailable, because of plumbing limitations at Glen Canyon Dam, and the lack of modeling done around alternative scenarios where Lake Powell is drawn down to low levels or run-of-river level.

In an announcement on August 16th, 2022[24], and at in its SEIS webinars, Reclamation outlined a number of actions it could take to address falling levels at Lake Powell. One of these actions states Reclamation will, "Take administrative actions needed to authorize a reduction of Glen Canyon Dam releases below 7 million acre-feet per year, if needed, to protect critical infrastructure at Glen Canyon Dam."

[24] https://www.usbr.gov/newsroom/news-release/4294?filterBy=year&year=2022

These actions highlight some of the structural limitations at Glen Canyon Dam, including its ability to operate solely through use of the river outlet works for months or years at a time. Tanya Trujillo, Assistant Secretary for Water and Science, in an April announcement stated, "Glen Canyon Dam was not envisioned to operate solely through the outlet works for an extended period of time and operating at this low lake level increases risks to water delivery and potential adverse impacts to downstream resources and infrastructure." In other words, it's unclear that the physical structure of the river outlet works are capable of operating at full capacity for long periods of time.

Current planning from Reclamation[25] is centered around propping up Lake Powell through increased releases from upstream reservoirs, and reduction of releases downstream. These efforts are short term and don't address the important problem of Glen Canyon Dam's inability to operate at low levels.

Even with the significant efforts to prop up Lake Powell, the Drought Response Operations Agreement (DROA) itself acknowledges that these efforts may not be enough to avoid dropping below minimum power pool. Line 453[26] of the DROA document states that "if dry conditions persist or worsen, available storage volumes for potential adjustments or releases may be insufficient to protect the Target Elevation at Lake Powell. As such, Drought Response Operations may be ineffective and therefore futile."

Another action from Reclamation's August announcement[27] is that the agency will "support technical studies to ascertain if physical modifications can be made to Glen Canyon Dam to allow water to be pumped or released from below currently identified critical and dead pool elevations." Based on these statements from Reclamation, is it clear that any planning for future management paradigms must include modifying Glen Canyon Dam to operate at low or run-of-river levels.

a. Plumbing limitations of Glen Canyon Dam

When the Reclamation designed and engineered Glen Canyon Dam, it prioritized two things: water storage to help the Upper Basin store its unused apportionment of Colorado River water and meet its delivery requirements, while hydropower generation was intended to be a second priority[28]. It was not designed to run at the low levels we face in the era of aridification.

The eight hydropower penstocks at elevation 3,470 feet above sea level are the primary means of moving water downstream. Once the reservoir dips below minimum power pool, elevation 3,490 feet above sea level, the only way for the dam to release water is through the river outlet

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[25] https://www.usbr.gov/dcp/droa.html

[26] https://www.usbr.gov/uc/DocLibrary/Plans/20220103-Draft-2022DroughtResponseOperationsPlan-508-UCRO.pdf?ct=t(October_Lowdown10_20_2016_COPY_01)

[27] https://www.usbr.gov/newsroom/news-release/4294?filterBy=year&year=2022

[28] Bureau of Reclamation. Technical Record of Design and Construction: Glen Canyon Dam and Powerplant. (1966). http://www.riversimulator.org/Resources/USBR/GCDtechnicalData.pdf

works at elevation 3,374. The outlet works have a much more limited ability to release water, with diminishing capacity as the reservoir drops closer to them, a function of reduced head pressure[29]. The figure below, from Futures of the Colorado White Paper #1, breaks down the maximum release capacity of the outlet works, assuming they are run at full capacity.

Maximum rate of discharge through the river outlets as a function of Lake Powell elevation[20]

Reservoir elevation, in feet above sea level	Maximum discharge through river outlets, in cubic feet per second	Maximum discharge rates through bypass tubes, in acre feet per year
3,500	15,000	10,900,000
3,490	14,650	10,600,000
3,450	12,600	9,090,000
3,440	11,400	8,280,000
3,430	10,200	7,410,000
3,420	8,800	6,370,000
3,400	4,800	3,470,000

Table from White Paper #1 demonstrating limited release capacity of river outlet works

b. Glen Canyon Dam is incapable of meeting delivery obligations at low levels

At elevation 3,430, the dam is physically incapable of releasing enough water to meet Upper Basin delivery obligations, based on current interpretations of the Law of the River[30]. Failure to deliver these agreed upon amounts could result in technical, legal, engineering, and environmental problems for all members of the Basin.

While the Upper Basin Delivery obligation of 7.5 Million acre feet per year (or 75 million acre feet over ten years), is a cornerstone of the Law of the River, it should be noted that ongoing policy discussions around the Law of the River argue that this interpretation should be updated and that it is unrealistic for the “75 in 10” policy to continue as is[31]. Nevertheless, it is unclear what changes the Law of the River may undergo in the future, and it’s likely that Glen Canyon Dam’s structural limitations are hindering the system’s ability to adapt to those changes.

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[29] Bureau of Reclamation. Technical Record of Design and Construction: Glen Canyon Dam and Powerplant. (1966). http://www.riversimulator.org/Resources/USBR/GCDtechnicalData.pdf

[30] Schmidt, John. White Paper #1: Fill Mead First – A Technical Assessment. (2016). https://qcnr.usu.edu/coloradoriver/files/CCRS_White_Paper_1.pdf

[31] http://www.inkstain.net/fleck/2021/07/reverence-or-pragmatism-the-upper-colorado-river-basins-compact-dilemma/

c. Additional problems with operation of Lake Powell at or near dead pool

The river outlet works intakes sit nearly 240 above the bottom of the dam, meaning that a large pool of approximately 1.7 million acre-feet of water is effectively 'stranded' behind the dam[32]. This large pool of water, commonly referred to as deadpool, could become a common occurrence in the near future at Lake Powell without significant changes at Glen Canyon Dam. In addition to the inability to access to 1.7 million acre-feet of water, operating near deadpool at Lake Powell would create a number of problems for the reservoir's managers, Colorado River Basin water users, and a range of other constituencies. Not the least would be a stagnant body of water sitting in a desert environment that would be conducive to harmful algal blooms and other water quality problems.

At deadpool, the reservoir is subject to rapid changes in elevation, due to the martini glass-like shape of Lake Powell's vertical cross section. Nearly half of the reservoir's capacity resides above 3,600 fasl[33], meaning that when water levels drop to deadpool elevation ranges, even moderate inflows can cause water levels to rise over 100 feet in one season[34]. This could create numerous problems for both reservoir visitors and the National Park Service – the federal agency tasked with managing the recreational facilities at Lake Powell.

These rapid elevation changes would force the Park Service to move marinas and extend boat ramps, which can be extremely costly. Already, the majority of Park Service and Tribal supported launch ramps are unusable. Current plans to adapt to declining reservoir levels include abandoning the current Bullfrog Marina site and moving marina facilities into the main channel at an estimated cost of $25 million dollars[35]. With the significant cost of extending boat ramps, walking ramps and marina utility infrastructure, there will come a point of diminishing returns on increasingly large and frequent taxpayer investments. After such investments are made to adapt to deadpool elevations, a subsequent medium or large water runoff year could lead to significant damage to this new infrastructure. This could create infrastructure challenges for the National Park Service, which is already suffering from a large backlog of maintenance projects.

In a scenario where the reservoir nears deadpool without subsequent engineering modifications to Glen Canyon Dam, its lifespan would dramatically decrease due to its storage volume being displaced with sediment. The Colorado River has the second largest natural sediment load of any large river in North America, moving an estimated 54-60 million metric tons of sediment per year into Lake Powell[36]. When the reservoir is full, this amount of sediment displaces a relatively

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[32] Bureau of Reclamation. Technical Record of Design and Construction: Glen Canyon Dam and Powerplant. (1966). http://www.riversimulator.org/Resources/USBR/GCDtechnicalData.pdf

[33] Root, J. C., & Jones, D. K. (2022). Elevation-area-capacity relationships of Lake Powell in 2018 and estimated loss of storage capacity since 1963 (No. 2022-5017). US Geological Survey

[34] Root, J. C., & Jones, D. K. (2022). Elevation-area-capacity relationships of Lake Powell in 2018 and estimated loss of storage capacity since 1963 (No. 2022-5017). US Geological Survey

[35] Returning Rapids Project. Field Binder: The River Persists. (2022). https://www.glencanyon.org/product/2022-returning-rapids-field-binder-the-river-persists/

[36] Schmidt, John. White Paper #1: Fill Mead First – A Technical Assessment. (2016). https://qcnr.usu.edu/coloradoriver/files/CCRS_White_Paper_1.pdf

small portion of the reservoir. But when the reservoir is low, that proportion of sediment displacement will more quickly diminish the reservoir's smaller storage volume as sediment moves closer to the dam. According to the findings of Schmidt et al. (2016), if the reservoir were to remain at levels between power pool and deadpool, sedimentation will eventually affect flow into the River Outlet Works[37].

Sediment has been accumulating in the upper reaches of the reservoir for nearly 60 years, totaling a loss of 6.8% reservoir storage capacity since 1963[38]. As the reservoir and its volume of stored water has declined, the rate of siltation has already increased relative to its overall size.

As Lake Powell water levels drop down to deadpool, the maximum water flow release capacity out of Glen Canyon Dam drops from 15,000 cfs to below 5,000 cfs. The reduction in water release capacity will have adverse effects on the Grand Canyon ecosystem. Below elevation 3,440 fasl, downstream releases would likely need to be maximized to meet delivery obligations, meaning flows in the Grand Canyon would be constant over long periods of time. Once water levels in the reservoir are reduced below the intakes for the generators, there will be no ability to conduct High Flow Experiments downstream and aggravate restoration efforts to improve sediment deficits in Grand Canyon National Park. Under these flow conditions, the fate of the Grand Canyon's ecosystem will be in jeopardy, and would likely violate key provisions of the Grand Canyon Protection Act[39].

Climate projections for the American Southwest all show a trend to smaller snowpacks and increased loss of water due to evaporation, sublimation and runoff lost to soil infiltration. To believe that somehow snowpacks will rebound to pre-2000 levels or that large influxes of "new" water will appear in the next 20 years is unlikely. To not plan for a future where the landscape of the Colorado River Basin is aridified is a misuse of the science and common sense.

d. The need to model alternative scenarios including Lake Powell operating at low or run-of-river levels

In addition to considering physical modifications at Glen Canyon Dam to allow water releases from low or run-of river levels, there is a need to use CRSS or similar modeling tools to test how the entire Colorado River system would operate under such scenarios. The primary method of modeling Colorado River reservoirs is the Colorado River Simulation System (CRSS) system, which by design, only models reservoir storage scenarios conceptualized under existing operating criteria of the 2007 Interim Guidelines, 2019 Drought Contingency Plans, and DROA operations. As stakeholders of the Basin develop future operational strategies for Lake Powell

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[37] Schmidt, John. White Paper #1: Fill Mead First – A Technical Assessment. (2016). https://qcnr.usu.edu/coloradoriver/files/CCRS_White_Paper_1.pdf

[38] Root, J. C., & Jones, D. K. (2022). Elevation-area-capacity relationships of Lake Powell in 2018 and estimated loss of storage capacity since 1963 (No. 2022-5017). US Geological Survey

[39] Grand Canyon Protection Act of 1992, P.L. 102-575, Sec. 1802(a).

and Lake Mead, it's imperative that Reclamation model a wide range of scenarios, including ones in which Lake Powell is at low or run-of-river levels.

The Futures of the Colorado Group has taken steps in this direction by modeling an array of scenarios[40] outside the limitations of existing operating criteria, but even this selection of scenarios do not represent a wide enough range to explore every storage regime available on the Colorado River. Using the CRSS tool to model alternatives outside of the current reservoir operating criteria, White paper #6 models and analyzed several different scenarios including variations of prioritizing storage Lake Mead vs Lake Powell and vice versa. These analyses were an important step in the right direction building the data around informed discussions of new alternatives, but they didn't go far enough, as they don't model the full drawdown of Lake Powell - a scenario which was once incomprehensible, but now possible within a scale of years as a function of supply/demand deficit. The focus of White Paper #6 was stabilization of the broader system, not averting the impending problems at Glen Canyon Dam.

In order to have an informed discussion among Basin stakeholders, it's imperative to understand the tradeoffs of potentially phasing out Lake Powell entirely. As such, discussions around updated operating guidelines must entail CRSS modeling of scenarios that includes Glen Canyon Dam being operated at levels below what the dam is physically capable of currently.

5. The need to include an assessment of emerging ecological, cultural, and recreational resources in Glen Canyon, Cataract Canyon, and Narrow Canyon.

Since the 2007 interim shortage guidelines, new resources have emerged in Glen Canyon that were not accounted for in the previous NEPA analysis. Given the significance of these resources under NPS responsibilities and the mandates of the Grand Canyon Protection Act, the SEIS NEPA analysis must recognize and include an analysis of the importance of the emerging recreational resources in the tributary rivers and canyons, including rafting and hiking in Glen Canyon, and recognize the impact that operational strategies will impact environmental resources including vegetation, wildlife, and archeological/cultural sites in Glen Canyon.

a. NPS Mandates, Grand Canyon Protection Act, and Endangered Species Act

Similar to the 2007 Interim Shortage Guidelines, the SEIS guidelines will require extensive cooperation with the National Park Service (NPS). With ten national park sites directly affected by Colorado River operations, NPS should be an official cooperating agency in developing operational strategies. The decisions made around how Glen Canyon Dam is operated will have widespread effects on areas and resources that fall under the jurisdiction of NPS. As NPS is responsible for "conservation of natural and cultural resources and administers visitor use"[41], it is essential that decisions around how to manage Lake Powell, Glen Canyon, and Grand

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41 https://www.usbr.gov/lc/region/programs/strategies/RecordofDecision.pdf, page 3

Canyon incorporate up-to-date information on changing and emerging resources in those park units.

Additionally, Public Law 102-575, which includes the Grand Canyon Protection Act requires that Glen Canyon Dam be managed “in such a way as to protect, mitigate adverse impacts to and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use[42]."

Reclamation must also plan and manage for Endangered Species Act compliance not just in Grand Canyon national park, but for Glen Canyon National Recreation Area. With thus far minimal species monitoring in the restoration zone of GCNRA (above reservoir level and below 3,700), the extensive emerging ecosystems could provide habitat for threatened and endangered species. Last year, a Mexican Spotted Owl (threatened species) was seen in a emerged side canyon in GCNRA.[43]

b. Emerging Resources in Glen Canyon

Glen Canyon National Recreation Area has experienced extreme changes in the past 20 years as Lake Powell has receded. More than 100,000 acres of land that were once inundated under Lake Powell have now emerged[44]. Unique geologic and natural features like Cathedral in the Desert, Gregory Bridge, La Gorce arch, and countless waterfalls, grottos, alcoves, and other natural wonders are now seeing the light of day. These one-of-a-kind features are what inspired former Interior Secretary Harold Ickes to propose making Glen Canyon the central part of a larger Escalante National Monument in the 1930’s, and what inspired countless western writers like Wallace Stegner, who said Glen Canyon would have made a “superb national park”. The emergence of these emerging treasures have garnered attention from national[45] and international media outlets, and have even been used for tourism promotions by GCNRA concessionaires[46].

There is also large-scale ecological succession taking place in Glen Canyon and its tributary rivers and streams. With over 40 new miles of the Colorado River flowing once again in what used to be the northern reach of Lake Powell, 40 miles on the San Juan River, 13 miles flowing on the Escalante River, 10 Miles on the DIrty Devil River, and hundreds of miles of creeks and stream flowing in the 100-plus side canyons of Glen Canyon, the ecosystems surrounding Glen Canyon are rebounding[47].

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[42] Grand Canyon Protection Act of 1992, P.L. 102-575, Sec. 1802(a).

[43] https://www.sltrib.com/news/environment/2022/08/28/glen-canyons-side-canyons-spring/

[44] Root, J. C., & Jones, D. K. (2022). Elevation-area-capacity relationships of Lake Powell in 2018 and estimated loss of storage capacity since 1963 (No. 2022-5017). US Geological Survey.

[45] https://www.newyorker.com/magazine/2021/08/16/the-lost-canyon-under-lake-powell

[46] https://marketing.revinate.com/public/promotion/view-in-browser/message-log/97e341cc-9266-4408-9b84-e434c4f437c8

[47] https://www.sltrib.com/news/environment/2022/08/28/glen-canyons-side-canyons-spring/

In many tributary canyons to Glen Canyon, well-established groves of Goodings Willow, Coyote Willow, and Fremont Cottonwoods are thriving[48]. These riparian forests are of great significance in many places throughout the Colorado River Basin, with resource managers going to great lengths to restore and protect them. Recent research led by GCI has documented the return of plant life in the emerged canyons, which is many places has an abundance of native plant species such as globemallow, wirelettuce, scorpion weed, sacred datura, four wing salt bush, matted crinkle mat, wooly plantain, Jone's blue star, woody aster, desert trumpet, milkvetch, sticky brittle bush, purple three awn, common pepperweed, threadleaf sunflower, Indian rice grass, sand sage, and prickly pear cactus[49].

Abundant wildlife has also been documented in emerged canyons of Glen Canyon including bighorn sheep, mule deer, coyote, bobcat, beaver, river otter, numerous birds, lizards and snakes[50]. Dozens of invertebrate species such as bees, beetles, and dragonflies have also been documented in the emerged areas[51]. These emerging landscapes provide native species the ability to compete with non-native species and to add to the ecological integrity of the Colorado River system.

Glen Canyon is home to thousands of archeological sites that were inundated by the water behind Glen Canyon Dam. Many of these culturally significant archaeological sites, including structures and rock art, have emerged along with other resources[5253]. The SEIS analysis should recognize impacts of reservoir operations on these social and culturally important resources. The Glen Canyon landscape has cultural and social significance to multiple Colorado River Basin indigenous tribes, early Mormon settlers, and to many early explorers. The future management of these resources should include a different approach than was used in the late 1950's and early 1960's when the Department of the Interior only focused on 'recovery of artifacts". Future operational scenarios need to include indigenous people in the management of reservoir operations to protect all resources, not just the water.

c. Emerging Recreational Resources in Cataract and Narrow Canyons

Cataract Canyon, located below the confluence of the Green and Colorado RIvers, is home to some of the most prolific whitewater in North America. It is known by many river rafters and guide companies as "Utah's Grand Canyon". When Lake Powell was full, the flowing river and whitewater rapids of Cataract Canyon ended below Big Drop 3 Rapid, which is also the boundary between Canyonlands and Glen Canyon National Recreation Area. Since Lake Powell's decline from its most recent peak storage in 1999, the Colorado River in Cataract Canyon has reestablished itself in what used to be a reservoir.

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[48] https://content.jwplatform.com/previews/6H3H1RhH

[49] Babtiz, Kendra, MPP. The Botanical Recovery of 50-Mile Canyon, *Hidden Passage: The Journal of Glen Canyon Institute*, issue XXV, Fall 2019 https://www.glencanyon.org/wp-content/uploads/2020/02/Hidden-Passage-25.pdf

[50] McGivney, Annette, *Resurrection: Glen Canyon and a New Vision for the American West,* 2009, Braided River Publishing

[51] https://www.glencanyon.org/13220-2/

[52] https://www.sltrib.com/news/2022/10/24/cultural-sites-are-being/

[53]https://www.knau.org/knau-and-arizona-news/2022-05-12/archaeological-sites-once-thought-lost-under-lake-powell-reappear-as-water-drops

What was left behind from Lake Powell's retreat was massive sediment deposits in the Cataract, Narrow Canyon (just downstream), and upper Glen Canyon. Over the years, much of this sediment has been eroded, and the natural characteristics of the Colorado have once again reestablished themselves. This transformation has been documented extensively by The Returning Rapids Project[54], which has conducted numerous research trips in the reemergence area with coordination from NPS, USGS, GCMRC, and multiple researchers from the University of Utah and Utah State University.

In Cataract Canyon, the return of the river and its whitewater rapids have created a recreational experience that hasn't been available since the reservoir first drowned the canyon. The prospect of a returning river rafting economy to Glen Canyon has been discussed publicly by former GCNRA superintendent Billy Shott[55]. The rapids that have returned in lower Cataract Canyon add a significant value to a Cataract Canyon trip — one of Utah's most popular rafting destinations and most popular expeditions from outfitting companies around the region. Since there is now flowing river current all the way to the Hite area and beyond, parties can run Cataract without the use of motors — which reduces the overall carbon footprint of this recreation possibility. This unique and changing resource will be affected by reservoir operations and should be included in the SEIS NEPA analysis.

6. The need to consult tribes on impacts to Glen Canyon Resources

According to the Park Service, 19 American Indian tribes and bands have an association with Glen Canyon — including contemporary descendants of the people who left behind the thousands of archeological sites in the canyon[56]. The Navajo, Hopi, Ute, Southern Paiute, Zuni and Puebloan tribes all have deep connections to Glen Canyon, and consider it to be part of their ancestral homelands. When the canyon was flooded, hundreds of tribal members were displaced[57] — their homes, farms and sacred sites drowned[58]. As more ancestral lands emerge from the reservoir, cooperative tribal management with the Federal Government should be a central piece of any management strategy. Recent agreements on the management of Bears Ears National Monument, upstream from Glen Canyon, should be the template for cultural resources management. Additional recreational economic opportunities for guiding, like the Hualapai tribe does in the Grand Canyon, or the Navajo Nation does in Antelope Canyon should be considered and analyzed.

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[54] https://www.returningrapids.com/

[55] https://lakepowellchronicle.com/article/the-future-of-gcnra-lake-powell

[56] https://www.nps.gov/glca/learn/management/foundation-document.htm

[57] https://digitalrepository.unm.edu/hist_etds/21/

[58] Graham, Taylor. Oral Histories: Charley Bulletts on Glen and Grand Canyon, *Hidden Passage: The Journal of Glen Canyon Institute*, issue XXVI, Fall 2020 https://www.glencanyon.org/wp-content/uploads/2021/02/Hidden-Passage-Final-Version-2021.pdf

7. The need to manage for sediment accumulating in Glen Canyon

With the combination of Lake Powell's retreat and the massive amounts of sediment accumulating in Glen Canyon every year, sediment deltas are emerging in every tributary and the mainstem Glen Canyon. These sediment deposits deserve careful consideration in operational strategies under the SEIS.

These deltas are moving down through the mainstem river canyons. In the coming 20-50 years these mud glaciers[59] will greatly affect the viability of the reservoir's storage capacity. In areas where the reservoir once was, mitigation efforts need to be taken where the sediment is damaging resources.

On the San Juan River, the original river channel has been displaced causing a waterfall at Paiute Farms, which may create challenges for future rafting recreation and ecological challenges. The lack of riverine ecosystem connectivity at the falls has impacts on native fish populations. The waterfall has blocked upstream sediment from the San Juan, impacting not just the newly flowing sections of river below Lake Powell's full pool level, but even causing river sediment to back up farther upstream[60]. A sediment management plan should include some monitoring of the Paiute falls waterfall and how it is impacting resources above the 3700 elevation level.

It's believed a similar waterfall may soon develop near Hite at the end of Narrow Canyon[61]. The emergence of such a waterfall would create a significant safety hazard and impact the recreation opportunities for private boaters and outfitters who utilize that section of river. If a reservoir-caused waterfall forms near Hite marina, reclamation should assess the feasibility of dredging the river back in its original channel.

Any updated operations of Lakes Powell and Mead must include development of a comprehensive sediment plan in Glen Canyon. This plan should address issues related to waterway access (river or reservoir), resource impacts, ongoing monitoring of sediment accumulation and resource remediation above areas exposed as the reservoir has diminished in capacity.

8. The need to assist NPS in planning for a Glen Canyon in the 21st century

With conditions changing so rapidly on the ground in Glen Canyon National Recreation Area, it will be vital for this SEIS process to assist NPS in planning for adapting to new physical realities at the park. GCNRA develops its facilities planning based on projections and guidance from Reclamation[62] The recreation landscape at the park is changing at speeds that are almost

[59]https://www.kunc.org/environment/2022-08-04/a-mud-caked-terra-incognita-emerges-in-glen-canyon-as-lake-powell-declines-to-historic-low

[60] Gene Stevenson, March 2000

[61] https://www.sltrib.com/news/2022/04/03/waterfall-could-soon-form/

[62] https://www.nps.gov/glca/learn/changing-lake-levels.htm

impossible for the park to keep up with. This year, there was a two month period where nearly every boat ramp at the reservoir was non-operational, with boat ramps being extended and marinas being moved as quickly as possible. Hite and Dangling rope marinas have closed indefinitely. With reservoir levels projected to drop below 3,525 feet over the next ~4 months, it's likely that most boat ramps will again remain closed for a significant amount of time.

GCNRA has stated recreational use on the emerged Colorado River in Cataract Canyon/North Glen Canyon has increased dramatically, as has land based recreation around the park[63]. Yet the takeout ramp for Cataract Canyon rafting trips near Hite, UT has repeatedly degraded in recent years, creating a safety hazard as well as deterring recreational visitation to the area.

If Lake Powell is to be managed at low levels moving forward, NEPA analyses must include planning plans for a permanent solution for the Hite boat ramp and the broader recreation area. Without a more comprehensive approach to the evolving recreation characteristics in the park, GCNRA will be forced to simply react to problems as they come. While the disappearance of Lake Powell creates big challenges for many stakeholders, it has nonetheless created significant recreation opportunities in the park. NEPA analyses and resource planning need to optimize management for this reality, pursuant to the mission of the NPS and Grand Canyon Protection Act.

9. The need to assess Upper Basin Storage in Lake Mead

Many leading scientists and policy experts along the Colorado River have advocated for a management approach where Lake Powell and Mead are viewed as one unit of water storage, rather than two separate storage facilities[64]. Some experts have even made the point that since Upper Basin users don't actually pull from the reservoir, it is effectively a Lower Basin reservoir. Given the reality that Lake Powell could dip below minimum power pool in the next few years, and Reclamation has announced plans to assess re-engineering the dam to operate below deadpool, it is conceivable to imagine a situation where the reservoir is entirely phased out based on its physical limitations.

As such, it's crucial that the SEIS analysis assess options for Upper Basin states to store water in Lake Mead in the form of an ICS. Similar ICS tools were essential in the 2007 Interim guidelines and provided a framework and incentive for water users to conserve[65]. A 2013 legal analysis by Larry McDonnel explored the concept, stating "There may be opportunities to put in place measures that would reduce the likelihood of a 75/10 shortfall such as using an accounting system to smooth out the annual variability of flows and even a relaxation of the requirement under certain circumstances[66]."

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[63] Glen Canyon Gazzette,volume 2, issue 1, August 5th, 2022

[64] https://qcnr.usu.edu/coloradoriver/files/news/fs-white-paper-6.pdf

[65] https://www.usbr.gov/lc/region/programs/strategies/RecordofDecision.pdf

[66] McDonnell, Larry, Potential Legal Issues under the Law of the River Associated with the Fill Mead First Proposal, *The Water Report*, Issue 112: June 15, 2013

This accounting approach could offer flexibility to the system, encourage conservation in the Upper Basin, and may save some water avoiding higher ground-seepage rates in Glen Canyon[67]. Though such an idea was considered outside the scope of previous NEPA analyses, it is clearly worthy of exploration in the current hydrology of the Colorado River. Analyzing options for Upper Basin storage in Lake Mead in the SEIS process will provide all stakeholders in the Basin the information needed to assess the best approach to water storage in the decades ahead.

Thank you for taking the time to consider our comments.

Sincerely,

Eric Balken, Glen Canyon Institute
Mike DeHoff, Returning Rapids Project
Kyle Roerink, Great Basin Water Network
John Weisheit, Living Rivers
Zach Frankel, Utah Rivers Council
Gary Wockner, Save the Colorado
Erika Pollard, National Parks Conservation Association

[67] https://qcnr.usu.edu/coloradoriver/news/wp1