

April 27, 2026

To: Glen Canyon Leadership Team for Implementation of Experiments under the Long Term Experimental and Management Plan (LTEMP)

From: Glen Canyon Dam Planning and Implementation Technical Team

Re: Technical Recommendation Regarding a High-Flow Experiment (HFE) at Glen Canyon Dam, Spring 2026

I. Recommendation Summary

Based on the 2016 LTEMP Record of Decision (ROD) and 2024 LTEMP Supplemental Environmental Impact Statement ROD, the Glen Canyon Dam Planning and Implementation (PI) Technical Team has worked over the past several weeks to evaluate existing information and data in determining this recommendation regarding an HFE at Glen Canyon Dam.

The Planning and Implementation (PI) Technical Team recommends the PI Leadership Team consider recommending the implementation of a spring High-Flow Experiment (HFE) at 32,400 CFS for 12 hours as described in the attached Tech Team Report.

Key discussion topics of the Planning and Implementation Technical Team summarized by Reclamation:

The PI Technical Team understood the importance of conducting an HFE to rebuild sandbars as well as support several other LTEMP resources. The short-duration HFE proposed would also be a great learning experience for potential future HFEs at Glen Canyon Dam as it would be the shortest duration HFE since the protocol was developed. Finally, it was important that Reclamation made it clear that any water volume adjustments for an HFE be made within the month of June and that no water be taken outside of the current proposed DROA/6e adjustments.

The PI Technical Team's recommendation regarding implementation of a spring 2026 HFE is based on a careful assessment of resources and best available science.

Background and Purpose of the Recommendation

The purpose of this memorandum is for the PI Technical Team to transmit a recommendation to the Glen Canyon Dam PI Leadership Team. Once the PI Leadership Team has provided a recommendation, this memo will be forwarded to the Department of the Interior (Department) in accordance with the LTEMP ROD (DOI 2016a). The PI Technical Team includes technical representatives from the National Park Service (NPS), U.S. Fish and Wildlife Service (FWS), Bureau of Indian Affairs (BIA), U.S. Geological Survey (USGS) Grand Canyon Monitoring and Research Center (GCMRC), Bureau of Reclamation (Reclamation), Western Area Power Administration (WAPA), Arizona Game and Fish Department (AZGFD), seven Colorado River Basin States (Basin States), and the Upper Colorado River Commission (UCRC).

In the fall of 2024, after evaluating the LTEMP resources using the best available science and

discussions within the PI Leadership Team, most PI Leadership Team members recommended deferring to a spring 2025 HFE. One member recommended a fall 2024 HFE. In the spring of 2025, the PI Technical Team reevaluated the Sand Budget Model and determined that there was sufficient sediment to conduct a spring 2025 HFE. Due to the risks of disrupting -12 Mile Slough modifications, the Technical Team ultimately recommended not to implement in the spring of 2025. Accumulated sediment was rolled over to the next accounting period for possible consideration of a fall 2025 HFE. In the fall of 2025, the PI Technical team reevaluated the Sand Budget Model and determined that there was sufficient sediment to conduct a fall 2025 HFE. However, due to the lapse in appropriations and the uncertainty concerning the necessary resources for monitoring, the Department of Interior decided to forgo the fall HFE. Accumulated sediment was rolled over to the next accounting period for possible consideration of a spring 2026 HFE. The PI Technical Team incorporated the most current science and data and considered multiple issues with agency experts, as summarized below, in making this recommendation.

In the fall of 2025, critical elevations were predicted for water year 2026 (Most Probable 24-Month Study: September 2025). The Upper Basin Drought Response Operations Agreement (DROA) planning trigger (projections of Lake Powell Elevations less than 3525 ft. within 12 months under most probable hydrology) was met. The projected likelihood of hitting the Interim Guidelines (IG) Supplemental Environmental Impact Statement (SEIS) 6(e) trigger (DOI 2024a) increased in the winter months due to low snowpack in the Upper Colorado basin. The LTEMP SEIS 6(e) requires operational adjustments in the Upper Colorado River basin when Lake Powell is projected to drop below elevation 3525 ft within 12 months, triggering modified monthly release volumes rather than changes to the annual release. In April, IG LTEMP 6e triggers were met based on the latest April Colorado River Mid-term Modeling System (CRMMS) results presented on April 17, 2026. Based on the monthly volume adjustments in December 2025 and proposed volume adjustments in April 2026, Reclamation recommends consideration of a HFE in June 2026, using the current proposed release (~ 460 kaf) anticipated from June 2026 and not re-allocating water from other months. Any HFEs proposed in the spring of 2026 do not change annual flow releases.

The PI Leadership team will consider the PI Technical Team's recommendation and develop a PI Leadership Team recommendation to be submitted to the Secretary of the Interior. The Secretary of the Interior or his Designee retains sole discretion to decide how best to accomplish operations and experiments in any given year pursuant to the LTEMP ROD and other binding obligations for Glen Canyon Dam.

Spring HFE and No HFE

Over the past several weeks the PI Technical Team considered two primary options: conducting a spring HFE or not conducting an HFE and reconvening the PI Team in fall 2026 to review and provide a recommendation for a fall HFE using the sediment accounting window from July 1, 2024 - November 30, 2026.

The spring HFE under consideration has a duration of 12 hours at a peak magnitude of 32,400 cfs. The duration of the spring HFE is subject to adjustments as more information is gained. Department of Interior will make the final decision on parameters surrounding the

HFE if one is to be implemented.

If the PI Team recommends opposing the spring HFE or an HFE cannot be conducted, the PI Team would like the sediment to roll over into the fall accounting period to be considered for a fall HFE.

The PI Technical Team's recommendation to conduct/not conduct a spring HFE was by a consensus/majority vote (Table 1). The PI Team identified the following resource concern as a significant reason to implement/not implement a spring HFE flow:

Table 1. Technical position of Planning and Implementation Technical Team members for consideration of a spring 2026 High-Flow Experiment.

Entity	Recommendation/Position
DOI-BOR	Support
DOI-NPS	Support
DOI-FWS	Support
DOI-USGS	Abstain
DOI-BIA	No Vote
DOE-WAPA	Support
Arizona	Support
California	Abstain
Colorado	Support
Nevada	Abstain
New Mexico	Support
Utah	Support
Wyoming	Oppose
AZGFD	Support
UCRC	Oppose

High-Flow Experiment (HFE) Sand Budget Model

The Sand Budget Model of Wright et al. (2010) was used to project instream sand mass balance in upper and lower Marble Canyon under multiple flow scenarios. Reclamation analyzed the resulting mass balance to estimate how a potential HFE would transport sand delivered from the Paria River to the Colorado River for the entire accounting period on July 1, 2024-June 30, 2026. Only HFE durations and magnitudes that resulted in a positive sand mass balance were considered (Figure 1-2). An HFE duration was considered to have a positive sand mass balance if the lower uncertainty bound of the sand mass balance was positive at the end of the HFE.

Two scenarios were analyzed:

1. A spring HFE with a magnitude of 32,400 cfs and duration range up to 12 hours (Figure 1) with a total of 460 kaf (Figure 3) available in the month of June that was presented during

the April 24-Month Study Webinar on April 17, 2026.

2. A no spring HFE scenario (Figure 2), where the PI Team would reconvene in fall 2026

Both scenarios are consistent with the new revised HFE protocols associated with the 2024 LTEMP SEIS ROD (DOI 2024a). A few HFE duration scenarios were modeled by WAPA to estimate volumes used by different HFE durations and also a range of costs (Table 2). Modeling results presented below serve as the initial recommendation for the duration of the spring HFE, based on the magnitudes constrained by dam release parameters (Figures 1-3). The following assumptions were made for the Sand Budget Model for all options and are subject to change:

- Estimated Available Powerplant: ~ 19,800 cfs (6 units)
- Estimated Available Bypass: ~ 12,600 cfs (4 River Outlet Works, ROW)
- Total Volume Bypassed: 0-94,330 af (Dependent on available volume of water and includes both ramp up and ramp down)
- Estimated Peak Release = ~ 32,400 cfs (adjusted for uncertainties)
- Potential Ramp Rate (Experimental Design):
 - Ramp-up from base releases at 4,000 cfs/hr at approximately 7:00 am on Tuesday, June 23, 2026 (all times Mountain Standard Time) until reaching powerplant capacity (~19,800 cfs)
 - Open first bypass tube at 10:00 am on June 23
 - Ramp-up from powerplant capacity to full bypass (~32,400 cfs) at one full bypass tube (~3,500 cfs) per hour in 4 hrs
 - Stay at peak release (~32,400 cfs) for up to 96 hrs
 - Ramp-down from peak release to base releases beginning at half bypass of 1,750 cfs/hr until reaching powerplant capacity and then decreasing at 2,500 cfs/hr

The above ramp rate recommendation results in the following release schedule at Glen Canyon Dam:

- Begin ramp-up from 6,500 cfs at 7:00 am on June 23 (Tuesday)
- Reach powerplant capacity at approximately 10:00 am on June 23
- Open bypass tubes at approximately 10:00 am on June 23
- Reach full bypass at 2:00 pm on June 23
- Begin ramp-down from bypass at 2:00am on June 24 (Wednesday)
- Complete HFE by 9:00 am on June 24

Sand Mass Balance

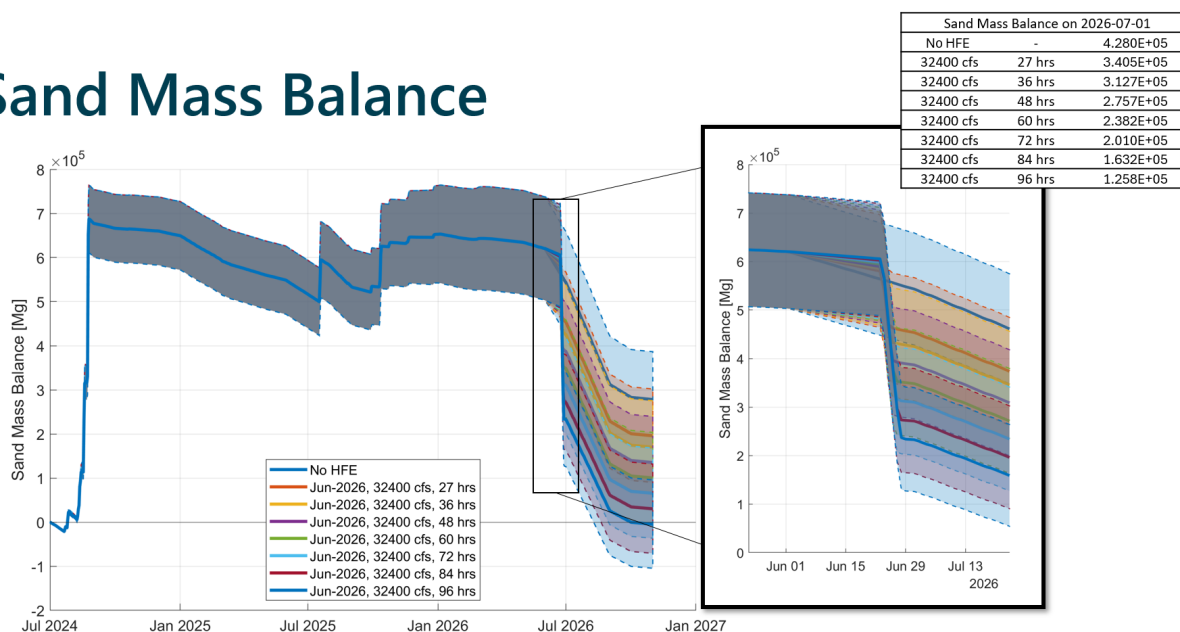


Figure 1. Hydrograph and modeled sand mass balance for proposed spring 2026 High-Flow Experiment (Option 1-3) Subject to minor revision.

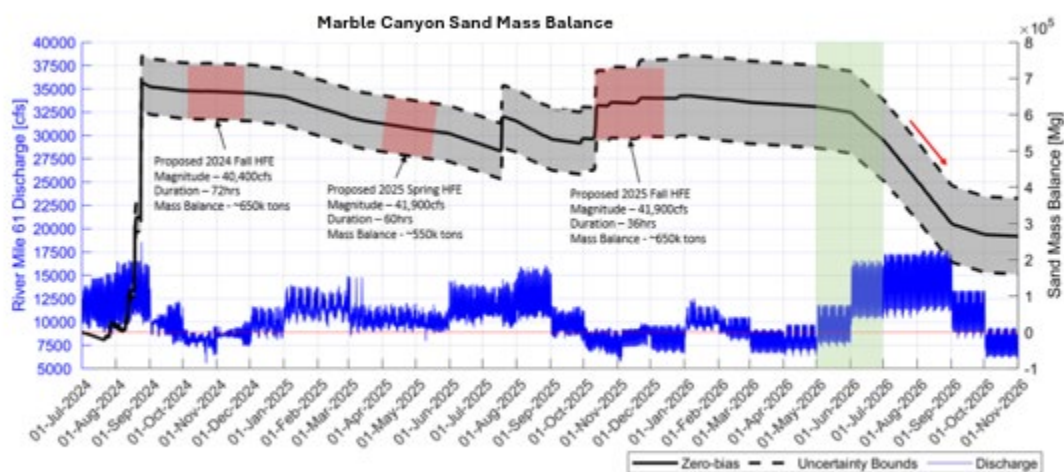


Figure 2. Hydrograph and modeled sand mass balance under a potential deferring to a fall 2026 HFE (Option 2). Red shaded areas on Option 2 indicate where previous HFEs were triggered but not implemented. The green shaded area on Option 2 indicates where a potential spring HFE would be implemented in May and June if triggered. Subject to minor revision.

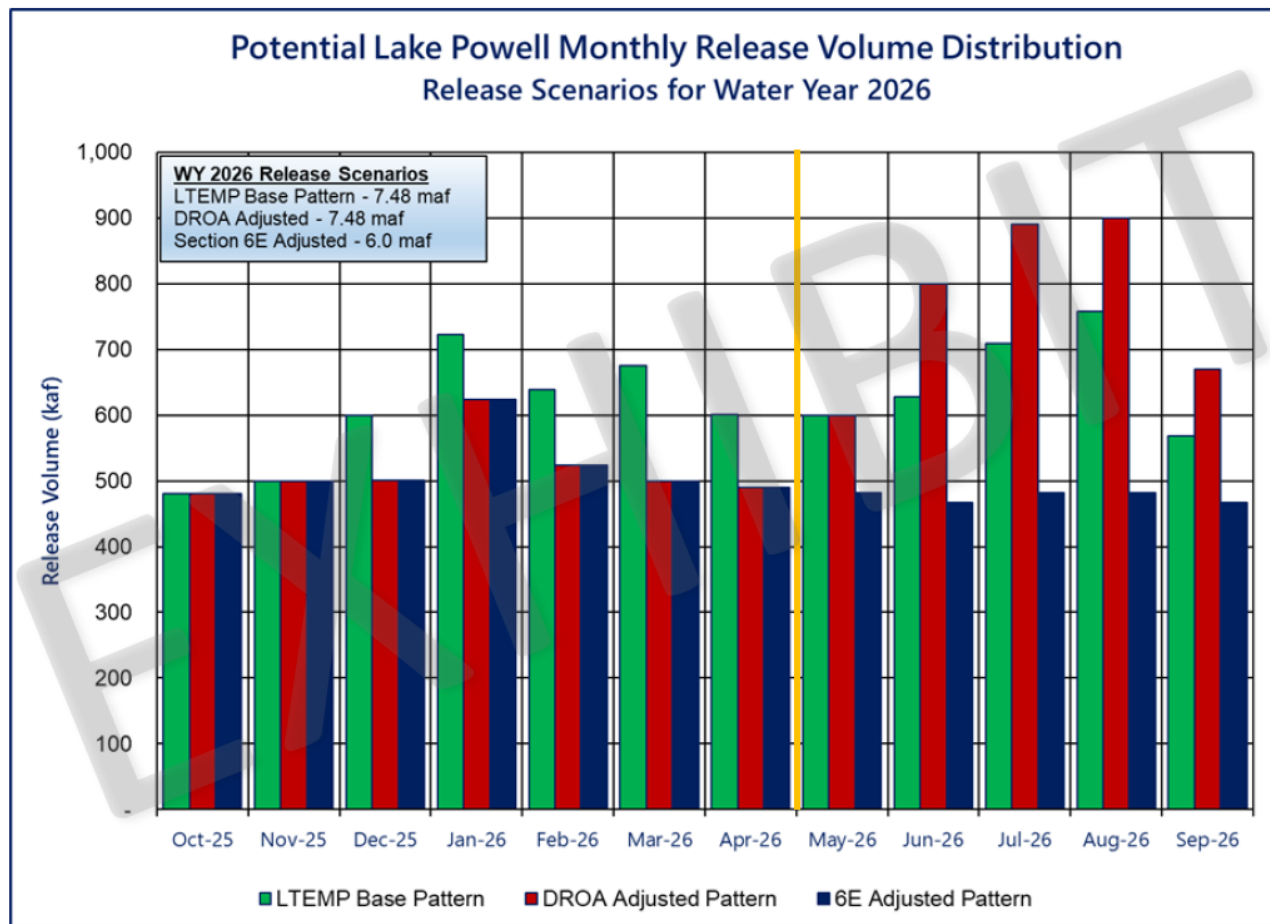


Figure 3. Estimated June Monthly release volume scenarios for a spring High-Flow Experiment based on the 24-month study in April of 2026.

The purpose of HFEs conducted in the context of the LTEMP ROD is to determine if sandbar building during HFEs exceeds sandbar erosion during periods between HFEs, such that sandbar size can be increased or maintained over the 20-year period of the LTEMP. In addition to reviewing the sand budget model output, the PI Technical Team assessed the status of the LTEMP resources and potential effects of an HFE on these resources in making the recommendation described in this document.

In coordination with GCMRC, WAPA, and Reclamation, the PI Technical Team completed an assessment of key resources impacted or affected by an HFE. This assessment is based on current resource conditions and findings from fall HFEs conducted in 2012, 2013, 2014, 2016, 2018 and a spring HFE conducted in 2023. Key resources were evaluated relative to the timing, duration, and magnitude of a potential spring 2026 HFE using the best available science. This section summarizes the assessment of resources and expected effects of a potential HFE.

II. Monitoring Plan

GCMRC developed a science plan for the LTEMP that describes a program of monitoring and

research activities that support ongoing information needs associated with implementation of the LTEMP and associated experiments like HFEs (Vanderkooi et al. 2017). This approach relies on water quality, sediment, aquatic biology, and other resource monitoring and research projects funded in the GCDAMP Fiscal Year (FY) 2025-2027 Triennial Budget and Work Plan (DOI 2024b). These projects inform the effect of future HFEs on the downstream resources of Glen, Marble, and Grand Canyons. Projects from the Triennial Work Plan (TWP) specific to monitoring HFEs are further discussed below.

Project A, *Streamflow, Water Quality, and Sediment Transport and Budgeting in the Colorado River Ecosystem*, and Project B, *Sandbar and Sediment Storage Monitoring and Research*, are essential components to implementation of the HFE Protocol under LTEMP because the protocol calls for high flow releases from Glen Canyon Dam whenever a specified minimum amount of fine sediment delivered from the Paria River is exceeded. Under Project A, the sediment-transport measurements needed to trigger and evaluate HFEs are collected. Project B supports the direct measurements of the volume of fine sediment, especially sand, that is stored on the bed of the Colorado River, in its eddies, or at higher elevation along the river's banks; these measurements allow assessment of the effectiveness of the HFE Protocol. A substantial accomplishment of these programs in previous work plans was the development of web-based interfaces to serve sediment transport and water quality data, calculate fine sediment mass balances (see https://www.gcmrc.gov/discharge_qw_sediment/), and to serve photographs of approximately 50 sandbars located from Lees Ferry to Diamond Creek (see <https://www.usgs.gov/apps/sandbar/>). The latter data allow stakeholders to evaluate the effects of controlled floods implemented under the HFE Protocol.

As described in the HFE Protocol Environmental Assessment (EA; DOI 2011) and the LTEMP FEIS (DOI 2016a), the potential HFE planned for spring 2026 would not be an isolated event, but a component of a longer-term experiment to restore and maintain sandbars with multiple high flows over a period of several years. The monitoring data that are needed to assess the outcome of this multi-year experiment include annual sandbar monitoring at selected long-term monitoring sites, periodic monitoring of changes in sand storage in the river channel, and measurements of sandbar size at more than 1,000 sites based on aerial photographs that are collected periodically. These activities are described in detail in the TWP (DOI 2024b). It is also important, however, to evaluate the sandbar building response of each HFE to assess whether the sandbar building objectives are being achieved incrementally. This evaluation will be based on sites that are monitored by remotely deployed digital cameras and repeat topographic surveys of sites that will occur in fall and spring 2026 if needed.

GCMRC scientists have installed digital cameras that capture 5 images every day at 43 sandbar monitoring sites throughout Marble and Grand Canyons between Lees Ferry and Diamond Creek. The images acquired by these cameras will be used to evaluate both the magnitude and spatial distribution of sandbar building caused by the HFE (Grams et al. 2018). They will also be used to assess the rate of post-HFE sandbar erosion. Because the remote cameras are monitoring the same sites that are monitored by the annual surveys and the same sites that were monitored during the previous high flows, it will be possible to evaluate sandbar-building effectiveness of the planned HFE relative to the previous HFEs.

Project D, *Effects of Dam Operations and Experimental Vegetation Management for Archaeological Sites*, will continue monitoring for changes in sediment storage in dunefields covering archaeological sites. An HFE implemented in 2026 would provide GCMRC and NPS the opportunity under their collaborative LTEMP vegetation management project to address a critical uncertainty about the potential combined effects of HFEs and riparian vegetation management.

GCMRC will also collect data on water quality (including nutrients), native and nonnative fishes, aquatic invertebrates, riparian plants, and other resources, as described in the TWP (DOI 2024). Project G, *Humpback Chub Population Dynamics throughout the Colorado River ecosystem*, continues long-term monitoring in Grand Canyon and will provide information about potential response of humpback chub (*Gila cypha*) to a spring HFE.

III. Assessment of Resources consistent with the 2016 LTEMP ROD and 2024 LTEMP SEIS ROD (all resources were evaluated for a spring HFE)

In coordination with the GCMRC, the PI Team completed an assessment of key resources that may be impacted or affected by an HFE. This assessment is based on the current condition of resources and on findings and observations from fall HFEs conducted in 2012, 2013, 2014, 2016, 2018, and spring of 2023. Key resources were evaluated relative to the timing, duration, and magnitude of the potential spring 2026 HFE using the best available scientific monitoring and research. This section summarizes the assessment of resources and expected effects of the potential spring HFE in 2026.

Sediment

Sand Supply for Spring High-Flow Experiment (HFE)

The HFE Protocol that was originally implemented in the HFE Protocol EA (DOI, 2011), incorporated in the LTEMP EIS (U.S. Department of the Interior, 2016a), and revised in the LTEMP SEIS (U.S. Department of the Interior, 2024a) specifies the procedures for designing HFEs based on recent sediment inputs from the Paria River. This approach, originally described by Wright and Kennedy (2011), has two main purposes. The first objective is to ensure that the mass of sand that is exported from Marble Canyon during the HFE does not exceed the mass of sand input by the Paria River to maintain a long-term neutral to positive sand mass balance. A long-term negative sand mass balance would cause a decline in sand availability, progressive erosion of the limited sand supply, and diminished capacity for rebuilding sandbars in the future. The second objective for utilizing the recent sand inputs is to conduct the HFE when the grain size of the sand is relatively fine. The sand grain size is finest immediately following the tributary sand inputs and coarsens as normal dam operations winnow the finest sand from the bed. Finer grain sizes result in higher concentrations of suspended sand during HFEs and greater rates of sandbar deposition. For these reasons, the sand mass balance for the current sediment accounting period is the most important consideration when designing the HFE. However, the sand mass balance over longer periods provides important and useful context to support the implementation decision.

The sand mass balance for the current accounting period, beginning July 1, 2024, and ending with the most recent available data on June 30, 2026, is positive in Marble Canyon and indeterminate in

Grand Canyon. Expanding the computation window to include sand inputs and erosion since the end of the April 2023 HFE shows net erosion of roughly 1 million metric tons of sand from Marble and Grand canyons. Most of this erosion occurred in the Eastern Grand Canyon. The negative sand mass balances are the result of erosion that occurred during sustained high releases in spring and summer 2023. Expanding the computation window yet further, to either the period of LTEMP (beginning July 1, 2017) or the entire HFE Protocol (beginning July 1, 2012), shows that the sand mass balances are either positive or indeterminate for these longer periods. Lower Marble Canyon and East Central Grand Canyon are both positive within uncertainty bounds. Upper Marble Canyon and West Central Grand Canyon are both positive, but with uncertainty that is greater than the positive value. The mass balance for the Eastern Grand Canyon is negative, with uncertainty greater than the negative value. These longer-term sand budgets show that despite the substantial amount of erosion that occurred in spring and summer 2023, the overall sand budget for the LTEMP period is likely positive. This indicates that a potential spring 2026 HFE that is designed according to the HFE Protocol to use only the sand accumulated in the accounting period is unlikely to create a higher risk of a long-term negative sand mass balance.

Sandbar resource context

Six HFEs have been conducted under sand-enriched conditions since the HFE Protocol was initiated in 2012. Those HFEs occurred in November of 2012 2013, 2014, 2016, and 2018 and April 2023. In each case, sandbar building results were consistent with the results from previous sand-enriched HFEs as described by Schmidt and Grams (2011). All prior HFEs resulted in substantial deposition at all sandbar types (see Mueller et al. 2018 for description of sandbar types) followed by erosion of about half the new deposits within six months. Response immediately after the 2023 HFE based on digital camera images of sandbars from Lees Ferry to Diamond Creek indicated that there was substantial gain (deposition) for 41 out of 43 sites monitored by camera (Grams et al., 2024). The HFE deposits typically begin eroding immediately following each HFE and the bulk of the newly deposited sand persists for approximately six to 12 months. Annual topographic surveys of sandbars were conducted in October 2025. Data from these surveys indicate there was net deposition over the period including the 2023 HFE and post-HFE erosion (October 2022 to October 2023) at 28 out of 44 sites. Between October 2023 and October 2025 (the most recent sandbar surveys), sandbars continued to erode and there was a net decrease in sand volume at all sandbar types. Net erosion occurred between October 2023 and October 2025 at 24 of the 28 sites that increased in volume between 2022 and 2023. The erosion from October 2023 to October 2025 was, on average, 1.7 times greater than the deposition that occurred between October 2022 and October 2023. Thus, losses have now exceeded the gains produced by the most recent HFE. Sandbars have also been impacted by gullying caused by hillslope runoff and tributary floods from summer rainstorms in 2023, 2024, and 2025. These eroded sandbars will not rebuild without an HFE.

Since 2012, repeated HFEs under the protocol have caused some cumulative increases in sandbar volume when HFEs are conducted regularly. During periods when HFEs are not implemented, such as occurred from 2019 to 2022, sandbar volume decreased (Grams et al., 2024). Deposition of sand during HFEs resulted in temporary increases in campsite area; however, there has been a net long-term decline in campsite area caused mostly by vegetation encroachment (Hadley et al. 2018a, Hadley et al. 2018b). All sandbar types decreased in size between fall 2023 and fall 2024. Further

deferments of HFEs will continue to decrease sandbar size and having a negative effect on the sediment resource and other resources discussed below.

Sandbars provide sand to resupply dunefields via aeolian transport throughout Marble and Grand Canyons (Sankey et al. 2018). Aeolian dunefields were resupplied with sand from HFE deposits in half of the instances monitored after the 2012, 2013, 2014, and 2016 HFEs (Sankey et al. 2018). There is also evidence for cumulative effects of sediment resupply of dunefields when annual HFEs are conducted consistently in consecutive years (Sankey et al. 2018). In 2019, under the LTEMP vegetation management project, NPS began experimentally removing riparian vegetation on six sandbar campsites; the riparian vegetation creates a barrier for aeolian transport of sand from sandbar campsites to dunefield archaeological sites. In April 2019, all vegetation was removed within the experimental management area on each sandbar. Vegetation removal within each Vegetation Management Area (VMA) was repeated annually in September 2020, 2021, and 2022. The vegetation management was then repeated biannually in April and September of 2023 and 2024. An HFE occurred in spring 2023. From 2019 through 2024, there was an increase in river-sourced sediment transported by wind from the sandbars and through dunefield archaeological sites downwind of experimental vegetation management treatments. The increase was especially pronounced following the 2023 HFE.

Spring HFE

Based on the above discussion and published peer-reviewed sediment science, a spring 2026 HFE would be beneficial for sediment resource management and sandbar building in the Grand Canyon. A spring HFE using sand supplied by the Paria River during the prior two summers would result in coarser bed sand, reducing sand concentrations during the HFE and therefore reducing sandbar growth (Topping et al., 2019) due to fine sand being eroded during dam operations over the winter. The original modeling in the 2016 LTEMP did not account for carry-over sediment. There is uncertainty in how long the system can continue to carry-over sediment and still trigger an HFE. Further deferments of and HFE will result in further erosion of sandbars and find sand sediment with no guarantee that conditions will improve. However, even with that erosion, the amount of carried-forward sand predicted to be available for an HFE in June 2026 is sufficient for up to a 96-hour HFE with a peak of 32,400 cfs. Based on previous HFEs, the proposed June 2026 HFE is predicted to result in general sandbar gains in Marble and Grand canyons above the stages associated with both 8,000 cfs and 25,000 cfs.

A spring HFE does not pose direct additional risks to the sediment conditions that were not previously analyzed in the LTEMP (e.g. carried-forward sediment) and will benefit most sediment resources. The amount of carried-forward sand from the previous HFE evaluation in June 2026 is sufficient for up to a 96-hour HFE with a peak of 32,400 cfs. Based on previous HFEs, the proposed June 2026 HFE is predicted to result in general sandbar gains in Marble and Grand canyons above the stages associated with both 8,000 cfs and 25,000 cfs (after U.S. Geological Survey, 2025).

Archaeological and Cultural Resources

Reclamation and NPS (DOI 2016b) determined that the majority of archaeological and cultural sites would benefit from HFEs through deposition and transport of sediment that keeps them

protected, however a limited number of sites may experience adverse effects per 36 CFR 800.5(2)(iv). The agencies also found that adverse effects to sacred sites could result from the HFEs, primarily from limitation of access of tribes to sacred sites during the period of HFE releases. Reclamation, as lead federal agency for National Historic Preservation Act section 106 compliance, completed the process outlined in the LTEMP Programmatic Agreement (PA; Reclamation 2017) with affected tribes and other parties to address these potential effects.

Effects of HFEs on cultural resources are primarily associated with deposition, erosion, or redistribution of river-sourced sediment. Inundation by the river during an HFE can adversely affect sites through erosion, but deposition of sediment by an HFE may help protect sites by providing sources of sand that can bury historic properties via aeolian transport (DOI 2011, DOI 2016b, East et al. 2016, Sankey et al., 2018, Sankey et al., 2023). Sand deposited in sandbars by HFEs can resupply dunefields via aeolian (wind) transport throughout Marble and Grand Canyons (Sankey et al. 2018) providing a protective cover to archaeological sites that are otherwise prone to erosion via processes like rainfall-runoff and human impacts (Sankey et al., 2023). HFEs also may affect access of tribes to historic properties and alter visitation patterns to historic properties (Reclamation 2011, DOI 2016b).

The PA incorporates, by reference and specified in Appendix D, a commitment to the stipulations identified in previous compliance agreements, most notably the Memorandum of Agreement for the 2012 High Flow Experiment. Reclamation, as lead federal agency, notified Tribes and consulting parties on September 11, identifying the potential for a spring HFE in 2026, in conformance with the stipulations in the PA (and previous MOA).

Spring HFE

A spring HFE would not be expected to cause unacceptable adverse impacts to Archaeological and Cultural Resources. Previous research has documented that sandbars are important sand sources that resupply sediment via aeolian transport to dunefields and terraces along the Colorado River containing archaeological sites (Sankey et al. 2018, Sankey et al., 2023). High-Flow Experiments of sufficient magnitude under sediment-enriched conditions can replenish these sand sources, and through subsequent wind transport of HFE sediment, can help to minimize and offset erosion at archaeological sites caused by rainfall-runoff and wind deflation. In Glen Canyon, upstream of the Paria River, an HFE with a magnitude of 32,400 cfs and up to 96 hours is likely to erode terrace scarps located immediately adjacent to the river margins, which could potentially impact archaeological sites embedded within those terraces. In Marble Canyon and Grand Canyon, however, where sediment is resupplied via the Paria River and other tributaries, an HFE with a magnitude of 32,400 cfs with up to a 96 hours is likely to rebuild and expand many sandbars that serve as source areas for wind-blown sand (see sediment section above), increasing the potential for the bars to resupply sediment to archaeological sites and thereby reducing erosion and increasing protection for archaeological and cultural resources within the Grand Canyon.

Natural Processes (Flow Regime)

Spring HFE

A spring HFE would not pose any direct additional risks to Natural Resources (Flow Regime). A more natural flow regime could benefit ecological resources within the river system. A

spring HFE could mimic a more natural flow disturbance (pre-dam peak flow) and more closely align with the goals for this resource (Palmquist et al. 2024). Larger, longer peak flows during the period of predam flooding (April-June) push the Natural Processes metric 2.1 in the direction of ‘more natural.’ It would not pose any direct additional risks to Natural Resources (Flow Regime).

Aquatic Food Base

Flood disturbance is a critical natural process in streams and rivers (Poff et al. 1997). By disrupting ecosystem structure and altering the availability of substrates and resources, flood disturbance can help maintain native biological diversity (Carlisle et al. 2017). Disturbance magnitude, for example the extent of drying at low flow or the proportion of the bed that is mobilized at high flows, can influence ecosystem outcomes by determining the extent of biomass loss and the quantity of newly scoured habitat patches available for recolonization by fast-growing algae and aquatic insects. Disturbance frequency and timing (e.g., spring vs. fall) can also influence the rate and trajectory of ecosystem recovery from disturbance. The life cycles of many species of native algae, insects and fish are directly tied to flood disturbances, and alterations to river flood regimes can adversely affect ecosystem health. In fact, a national synthesis of flow and biological data from over 700 streams and rivers in the lower 48 states found that intact and healthy communities of native aquatic invertebrates and fish were most often present where flood disturbance still occurred, and where flood timing was seasonally appropriate (i.e., similar to the natural condition; Carlisle et al. 2017). Although the Colorado River in Grand Canyon could not be included in this 2017 synthesis owing to the absence of pre-dam ecological data, the mechanisms linking periodic flow disturbance to stream ecosystem health were evaluated in a wide variety of streams and regions. It is therefore reasonable to predict that similar mechanisms linking appropriately timed flow disturbance to ecosystem health also operate in the Colorado River.

The pre-dam Colorado River was characterized by spring snow-melt floods that often exceeded 100,000 cfs and typically peaked in late June, followed by flash flood flows during the summer monsoon season, and extensive low base flows from the fall through early spring (Topping et al. 2003). This seasonally variable flow regime was an important driver of natural processes in the Colorado River, and the unique fish species that evolved here were adapted to frequent flow disturbances. For example, the small eyes and tiny embedded scales that are common to several native fish are thought to be adaptations to the sediment-laden floods that scoured the Grand Canyon annually. In the pre-dam river, turbidity was always high (Voichick et al. 2016), suggesting that algae growth was likely restricted to the river’s edge or shallow cobble habitats; detritus and leaf litter are thought to have been primary sources of energy fueling food webs (Blinn and Cole 1991). Regulation of the Colorado River by Glen Canyon Dam in 1963 eliminated the annual spring high flow disturbances. It also substantially increased base flow, thereby eliminating periods of low flows, and hourly variation in discharge increased substantially owing to hydropower production (Topping et al. 2003, Kennedy et al. 2016). In addition to changing the river’s flow regime, Glen Canyon Dam also changed other aspects of the physical template, particularly temperature, sediment, and nutrient regimes (Dibble et al. 2021, Topping et al. 2000, Yackulic et al. 2018). These changes to the physical template led to dramatic changes in the natural processes that sustain river food webs. For example, Colorado River food webs are now primarily built upon algae production owing to clear water (Stevens et al. 1997,

Cross et al. 2013). Many types of aquatic insects have been extirpated from Grand Canyon owing to multiple stressors including cold water temperatures and hourly fluctuations in discharge that leads to acute mortality of aquatic insect eggs laid along constantly changing shorelines (Kennedy et al. 2016). Three species of native fish have also been extirpated from Grand Canyon owing to cold water, predation by non-native fish, and dams that block migration routes (Minckley 1991).

Meanwhile, many species of non-native invertebrates (e.g., *Gammarus lacustris*, New Zealand mud snails (*Potamopyrgus antipodarum*), quagga mussels (*Dreissena bugensis*)) and fish (e.g., rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*)) have become established throughout the Grand Canyon segment because they are well-suited to this new physical template and altered flow regimes. Predation by non-native fish species is a constant and potentially growing threat to many native fish species that remain in Grand Canyon.

Additionally, simplified food webs that are inherently unstable and overall low food base production arising from nutrient limitation have been shown to limit native and desired non-native fish populations in some reaches and years (Cross et al. 2013, Korman et al. 2021). Despite these changes to the ecosystem and the natural processes that support food webs, native fish populations in Grand Canyon have been relatively stable over the past two decades compared to other segments of the Colorado River (Yackulic et al. 2014, Healy et al. 2020, Dibble et al. 2021).

Spring HFE

A spring 2026 HFE would not pose any direct additional risks to the Aquatic Food Base and may benefit the aquatic food base. Flood disturbance can help maintain native biological diversity in rivers including that of aquatic invertebrates, which represent the food base for fish and other wildlife. For example, a national synthesis of flow and biological data from over 700 streams and rivers in the lower 48 states found that intact and healthy communities of native aquatic invertebrates were most often present where flood disturbance still occurred, and where flood timing was seasonally appropriate (i.e., similar to the natural condition; Carlisle et al. 2017).

Humpback Chub (Gila cypha) and Native Fish

Past HFEs have had no measurable direct effects, positive or negative, on humpback chub or other native fish. Their populations in the Little Colorado River aggregation remained relatively stable over the decade from 2009-2019, a period that included fall-timed HFEs in 2012, 2013, 2014, 2016 and 2018 and increased water temperatures (Kennedy and Ralston 2011, USFWS 2018). In 2024, FWS conducted two spring and two fall monitoring trips on the Little Colorado River (LCR) to generate population estimates for humpback chub and to monitor trends of other native fishes. Since 2006, the LCR population of humpback chub has significantly increased in size. In the LCR during spring monitoring, adult population estimates representing resident and migrant fish in spring 2025 were similar to those of 2024, which marked the highest abundance recorded since standardized monitoring began in 2000. Adult population estimates representing resident humpback chub in fall 2025 were similar to recent years. FWS monitored the success of upstream translocations of humpback chub within the Little Colorado River and successfully translocated 455 new fish to this area in 2024.

Concerns about dispersal of nonnative fish indirectly impacting humpback chub were brought up by PI Technical Team members. The probability of nonnative fish dispersal is unlikely (see information on Nonnative Fish) and previous HFEs have not led to any direct or indirect effects to the humpback chub population. Based on provisional unpublished data, humpback chub were not directly affected by the fall 2012, 2013, 2014, 2016, 2018, or spring 2023 HFEs with adult populations appearing stable over the period of these HFEs and juvenile populations fluctuating in response to variable recruitment in the Little Colorado River (USFWS 2018).

In collaboration with the GCMRC and NPS, FWS continues to develop and refine a monitoring program to effectively sample mainstem aggregations of humpback chub in the Colorado River in Grand Canyon. In 2025, FWS and GCMRC conducted structured sampling to assess population size of humpback chub in and outside these aggregations. Since 2014, humpback chub populations in western Grand Canyon have increased in size. Large numbers of juvenile and adult humpback chub provide evidence of a continued expanding population comprised largely of in-situ spawning and recruitment in western Grand Canyon.

A small reproducing population of endangered razorback sucker resides downstream in Lake Mead, and past monitoring data indicate that razorback sucker occupy and spawn in the western Grand Canyon (Kegerries et al. 2017). In 2012, a single adult was captured near Spencer Canyon (Bunch et al. 2012) and several other sonic-tagged individuals were detected in the same relative area (Kegerries et al. 2017). Razorback suckers have been captured in small numbers in this same area in subsequent years including two adults, one untagged and one sonic tagged, in 2013, one sonic-tagged adult in 2016, and one untagged adult in 2018 (AZGFD unpublished data). Razorback sucker larvae were captured as far upstream as river mile 127.3 in 2019; however, numbers of larvae found during standardized monitoring have steadily declined since 2014 from 462 to 0 in 2020, 2021 and 2022 (Kegerries et al. 2021, S. Platania, ASIR, Inc., personal communication).

Changes in flows due to a spring HFE are unlikely to have a substantial effect on razorback suckers due to the limited recent evidence of the presence of early life stages within the Grand Canyon. In contrast to razorback sucker, in recent years, other native fishes have increased (or remained stable) in abundance and distribution in western Grand Canyon, with large numbers of juvenile humpback chub and flannelmouth sucker (*Catostomus latipinnis*) present (Kegerries et al. 2021, Van Haverbeke et al. 2017, Rogowski et al. 2018).

Spring HFE

A spring 2026 HFE is not expected to pose any direct additional risks to humpback chub or other Native Fish. There is no evidence past HFEs have had an influence on the humpback chub populations, and it is expected that any dispersal of nonnative fish will be minimal and not have negative effects to the humpback chub population. In the PI Technical Team discussions in the spring of 2024, it was suggested that a spring HFE may have more aquatic ecosystem benefits due to historic peak timing. Humpback chub recruitment in Western Grand Canyon was high in 2023, but there have been other high recruitment events in years without spring HFEs (evidence is needed to further test this hypothesis).

Hydropower and Energy

The recent financial impacts of the LTEMP Experiments are changing how WAPA and Reclamation are utilizing the Basin Fund. These experiments have created a funding shortfall for the capital replacements program for the Colorado River Storage Project (CRSP) system. These cuts resulted in many capital replacement projects being deferred to a later date. Continued pressure on the Basin Fund due to these experiments could result in further deferral of replacements and maintenance increasing the risk of failures in the CRSP power system.

*Table 2. Median cost estimate of a 23hr spring HFE in 2026 at a magnitude of 32,400 cfs. **Min and max cost estimates represent extremes and likely the actual cost will be within that range.** HFE duration represents how hours (hrs) the HFE will be conducted, Turbine Releases is the amount of water in Acre-Feet (AF) that will flow through the penstocks during the proposed HFE, Bypass Releases is the amount of water in AF that will flow through the river outlet works during the proposed HFE, Total Volume is the combined Turbine and Bypass Release, and min and max cost represents the range estimated costs for implementing an HFE at that duration. These are estimates and uncertainty still exists around hydrology, monthly volumes, power costs, and other factors. Due to time constraints a 12hr HFE was not able to be modeled for replacement costs.*

HFE Duration (hrs)	Turbine Release (AF)	Bypass Release (AF)	Total Volume (AF)	Median Cost Estimate	Min Cost Estimate	Max Cost Estimate
23	64,884	29,446	94,330	\$612,000	\$189,000	\$1,098,000

Spring HFE

The financial impact of a 32,400 cfs up to 23-hour HFE release in the spring of 2026 would likely be between \$189,000 - \$1,098,000. A spring HFE for 2026 with a magnitude of 32,400cfs would have a replacement median cost of \$612,000 with a range of \$189,000-\$1,098,000. The team changed the proposed High-Flow Experiment (HFE) duration from 23 hours to 12 hours as more information was learned on available flow volumes. However, because this change happened late in the process, they did not have time to run the cost modeling for a 12-hour event. Since a shorter HFE uses less water and bypass time, the replacement costs should cost less than the 23-hour scenario previously modeled. But the exact amount of savings is unknown because the cost analysis wasn't completed. The cost impact of an HFE in the spring of 2026 alone is not of a scale that would change how WAPA and Reclamation are currently utilizing the Basin Fund. However, HFE's coupled with continuing more costly experiments such as the Cool Mix experiment in 2026 and in future years will lead to WAPA returning funds to the Treasury sooner than scheduled, the depletion of the Basin Fund of cash needed for CRSP operations and maintenance, additional deferment of capital replacement projects needed to maintain the critical water and power infrastructure associated with the CRSP system, and higher regional greenhouse gas emissions. WAPA remains concerned that continuing experimental releases that bypass generation at Glen Canyon Dam such as HFEs and Cool Mix, and the increasing likelihood of falling below power pool, may result in unsustainable impacts to critical infrastructure, grid stability, and the operations and maintenance programs the Basin Fund supports.

Recreational Experience

In Grand Canyon National Park (GRCA), impacts to recreational experiences associated with the HFE would be both short- and long-term. Some private trips may choose to cancel rather than be on the water during the high flows. Both commercial and private trips may alter their itineraries to avoid rafting if they are near rapids, which becomes more dangerous at high flows. The stage elevation changes at the start and end of the flows may create problems in camp and make some campable areas unusable. Medium- to long-term impacts to recreational experience would be expected to be minimal as flows of this magnitude are unlikely to alter the rapids. The HFE should benefit recreational users through improvements to campable area and vegetation reduction in the near shore habitat.

Both commercial and private angling trips for rainbow trout also occur on all days of the week. During the peak flow of the HFE, there would be a direct impact to fishing as it would produce flows large enough to impede fishing activity and may also affect foraging behavior of trout immediately following the HFE, reducing catch rates. If an HFE were to occur a redistribution of water in June would be needed. That redistribution would lead to lower daily flows both pre- and post-HFE. Those lower daily flows could make the river more difficult to navigate and public communication with anglers would be needed.

Conducting an HFE in June would provide recreation users with immediate access to restored beaches and reduce erosion resulting from dam operations, compared to an HFE held earlier in the year. Additionally, if the 6e adjustment is implemented, the lower flows during summer will result in less erosion of newly built beaches, and the reduced river stage will facilitate greater aeolian transport and expand available camping areas due to the lower water levels. Finally, rehabilitation of gullies that have formed on some beaches may be filled in with the implementation of an HFE.

Spring HFE

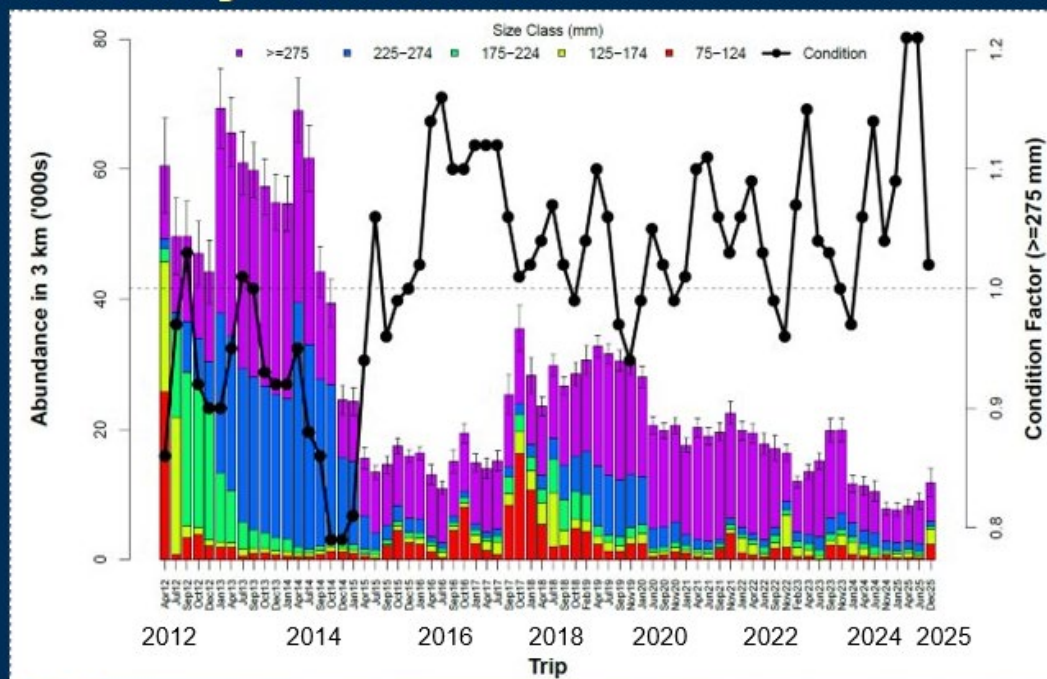
A spring HFE should benefit recreational users long-term through improvements to campable area and vegetation reduction in the near shore habitat. There is potential for short-term disruptions to commercial and private angling trips but those impacts would be short and temporary. Additionally, lower minimum flows may make it more difficult to navigate the river for a short-period in June, however, those minimum flows would try to maintain above 6,500cfs to ease navigational concerns. Public communication will be crucial to mitigate any concerns during those short-term disruptions could be limited. The majority of recreational users along the river in both Glen Canyon Recreation Area (GLCA) and GRCA access the river by boat. Recreational use occurs throughout the week. If an HFE is implemented, press, website, and social media posts as well as direct contacts with the commercial operators will need to occur to inform potential recreationists. Day use visitors also use Paria Beach for picnicking and shoreline recreation. Since the HFE will be a short duration, it will likely have minimal impact and can be mitigated with public communication. Therefore, little to no impact to shoreline users would be anticipated from the HFE. The longer the HFE, the greater the disruption to angling and guiding on the Colorado River. White-water boating in the Grand Canyon is a year-round recreational experience, and all

Grand Canyon river users with permits for use of the river during the HFE could be affected by changing flow patterns.

*Rainbow Trout (*Oncorhynchus mykiss*) Fishery*

The NPS Comprehensive Fisheries Management Plan completed in cooperation and coordination with AZGFD (NPS 2013), and the AZGFD Management Plan (AZGFD 2015) establish objectives for the rainbow trout fishery at Lees Ferry. Two of those objectives are to maintain angler catch rates of ≥ 1 rainbow trout per hour, and fish condition ≥ 1 in the summer. In addition, metrics have been established to monitor trends in LTEMP goals (Fairly et al. 2025), including angler catch rates and age-1+ abundance of rainbow trout (i.e., spring abundance). After a population crash of rainbow trout in the winter of 2015-2016, the population started rebounding with increased young of the year production in 2017-2018, however that did not result in an increase of catchable fish, and overall abundance has been decreasing since 2018 (Figure 4). Currently, angler catch rates are well below the 1 fish/hour threshold, and abundance of age-1+ rainbow trout is the lowest on record, indicating LTEMP goals are not currently being met for the rainbow trout fishery (Healy et al. 2025).

Rainbow Trout Abundance – Glen Canyon Site 1C



USGS

Preliminary unpublished data, do not cite

Figure 4. Rainbow trout abundance over time at site 1C during the TRGD trips (USGS 2025).

The natal origins and trout recruitment and growth dynamics projects led by GCMRC to more closely examine relations between dam operations and rainbow trout have provided data to assess the effect of fall HFEs on rainbow trout abundance and vital rates in Lees Ferry and at the LCR. Analysis of data from fall HFEs conducted in 2004, 2012, 2013, 2014, 2016, and 2018 indicates a weak and uncertain negative effect of fall HFEs on the rainbow trout growth in Lees Ferry (Korman et al. 2023). However, this effect is smaller than the expected impacts of current high temperature and low dissolved oxygen, which are likely negatively impacting the fishery. Rainbow trout growth has been high in years both with and without HFEs. Additionally, modeling indicates other factors besides HFEs, including fish density/competition and reservoir effects on nutrient dynamics and food base production are more important determinants of the health and abundance of the rainbow trout population in Lees Ferry (Korman et al. 2021). Further, there is no evidence of a direct link between fall or spring HFEs and emigration of rainbow trout out of Lees Ferry.

Drift data from 2008 (Rosi-Marshall et al. 2010) showed that the drift of trout food (midges, black flies, and scuds) initially declined after the 2008 spring HFE but then recovered 4-6 weeks later to much higher levels than pre-HFE abundance. Even if HFE velocities are not large enough to directly impact recently emerged fry, a spring HFE in May and June could reduce food availability during a critical time for feeding (trout and salmon fry only have a few weeks to feed on their own after the yolk sac is absorbed).

Spring HFE

If a spring HFE were implemented, it remains unknown how the overall rainbow trout population will react. A spring HFE would likely disrupt angling (see above recreation section) but it remains unknown how the rainbow trout fishery would be affected. Previous fall-timed HFEs may have a weak negative impact on rainbow trout growth, however, it is believed that other factors (e.g., temperature, soluble reactive phosphorous and prey production) have a larger influence on the demographics of the rainbow trout fishery (Yard et al. 2023). A spring HFE could benefit the rainbow trout fishery long-term if implemented early in the spring when rainbow trout are reaching spawning conditions; however, a recent spring HFE seemed to have no measurable effects to the population. Rainbow trout are most vulnerable during the egg stage and for a couple of weeks after emergence when they are transitioning to exogenous feeding. Peak hatch and emergence dates are likely linked to temperature during incubation, but hatch may occur in early May (Korman et al. 2011), making early June peak timing for emergence. The foodbase may be temporarily disrupted by an HFE, and displacement of fry would also be likely to occur based on emergence timing.

Nonnative Invasive Species

Green Sunfish (*Lepomis cyanellus*) -Spring HFE

A spring HFE is not expected to pose any direct additional risks from green sunfish dispersal. Green sunfish abundance in 2025 appeared lower than in 2024 and previous years (Dibble et al. 2026 GCDAMP Annual Reporting Meeting). Since the slough has been modified (see -12 mile slough section) there has been an observed reduction in green sunfish presence. Additionally, green sunfish are still abundant above Badger Rapid (RM 8.0) and have become more common and widely distributed in the Grand Canyon. Although the probability of dispersal increasing green

sunfish distribution could happen, it is likely any increased negative risks to native fishes is minimal since green sunfish are widely distributed and an HFE isn't likely to increase their abundance or distribution.

Brown Trout (*Salmo trutta*) -Spring HFE

A spring HFE would not pose any direct additional risks from brown trout. Brown trout are a highly piscivorous species known to prey on humpback chub and other native species (Yard et al. 2011; Whiting et al. 2011). Monitoring of juvenile humpback chub suggests that increased rainbow trout abundances (and perhaps brown trout abundances) are associated with lower juvenile chub survival rates (Yackulic et al. 2018); however, this effect is context specific may be weak relative to other drivers of humpback chub dynamics (e.g., temperature, juvenile recruitment, food availability), under current river conditions (e.g. warmer temperatures). Nonetheless, brown trout can have a population-level impact on native fish in the Grand Canyon (Healy et al. 2020). Coinciding with suppression of brown trout in a primary area for reproduction (Bright Angel Creek; Akland et al. 2025) and subsequent suppressed abundance (Healy et al. 2020), brown trout catches at the Little Colorado River confluence have generally been low since implementation of the HFE protocol in 2012 (GCMRC unpublished data). In contrast to observations near the Little Colorado River, brown trout abundance increased in Glen Canyon through 2022 and then declined precipitously with recent warming river temperatures and low dissolved oxygen (GCMRC unpublished data). Nonetheless, if river conditions change (i.e., temperatures remain cool), brown trout may again become a cause for concern (Healy et al. 2023). This species is known to be a fall-spawner that has successfully spawned and recruited in Glen Canyon since implementation of the HFE protocol in 2012 (Runge et al. 2018). During a fall HFE, evidence suggests high flows could trigger additional immigration of adult brown trout into Lees Ferry tailwaters area (Healy et al. 2022; Healy et al. 2023). This is likely due to fall-timed seasonal spawning triggers for brown trout. A spring HFE would not be expected to trigger similar spawning behaviors as in fall, and thus increases in brown trout reproductive behaviors or changes in distribution would not be expected. Due to the low abundances of brown trout downstream of Lees Ferry and lack of a known humpback chub population above Lees Ferry, the probability of negative impacts to the humpback chub population is minimal.

Smallmouth Bass (*Micropterus dolomieu*) -Spring HFE

A spring HFE is not expected to pose any direct additional risks from smallmouth bass. Smallmouth bass are a high-risk invasive species within the Colorado River basin that is established in both Lake Powell following stocking in the 1980s, and in Lake Mead (as well as throughout many river sections in the Upper Basin of the Colorado River). Smallmouth bass are a highly valued sport fish that have been introduced across the globe and have often spread extensively beyond their initial point of introduction (Loppnow et al. 2013). Smallmouth bass' invasion into rivers throughout the globe have been associated with substantial population declines, and in many instances, extirpations of native fish species (Brown et al. 2009; Loppnow et al. 2013). In the Upper Basin, smallmouth bass are considered the greatest threat to the persistence of threatened and endangered fish species (Johnson et al. 2008). Smallmouth bass are highly fecund, adaptable to a substantial range of environmental conditions, and extremely capable predators able to consume many size classes of the federally listed humpback chub and razorback sucker (*Xyrauchen texanus*) (Edwards et al. 1983; Johnson et al. 2008; Ward and

Vaage, 2019). These traits have allowed smallmouth bass to quickly increase in abundance and exert population level impacts on species that did not co-evolve with them.

Smallmouth bass are already in the Lees Ferry reach and are unlikely to be further distributed downstream owing to a high flow release. Smallmouth bass are accustomed to high flows in the spring and are capable of remaining stationary in the face of high seasonal floods. Fish “flushing” from this proposed experiment would pose no further risk to distribution than expected from normal high monthly volume operations. Additionally, surveys from 2024 and 2025 indicate no spawning events likely occurred (USGS-GCMRC public communication). The fall 2022 HFE Technical Memo acknowledges the uncertainty and potential for an HFE to cause downstream dispersal of smallmouth bass, particularly < 25 mm TL (Harvey 1987). All smallmouth bass observed in 2025 have been above that size, further limiting the potential for downstream dispersal. Smallmouth bass prefer water velocities of < 0.2 meters per second (m/s) (Todd and Rabeni 1989) and during an HFE one could assume that they would be actively searching for areas of low water velocity. It should be noted that if a smallmouth bass spawn were to occur in the summer or fall of 2025, an assessment of whether a spring HFE could disperse those small fish (< 25 mm TL) downstream should be evaluated. However, currently no spawn or small smallmouth bass have been observed in 2025 or 2026 likely reducing the probability of smallmouth bass distribution downstream (Shollenberger et al 2026).

Entrainment of fish, including smallmouth bass, through Glen Canyon Dam is dependent on Lake Powell elevations. As of April 17, 2026, Lake Powell is near 3,528 feet and predicted to be near 3,515 feet by June according to the April CRMMS projection. Friesen (2024) found that fish occupy the forebay near when Lake Powell is stratified and smallmouth bass are likely to inhabit the upper 65 feet of the water column in the forebay. Fish entrainment is thought to increase when elevations go below 3,540 feet (Eppehimer et al. 2025). Current elevations and predicted elevations for June would put entrainment at a higher probability than if elevations were greater in Lake Powell. Therefore, entrainment may increase resulting in increased capture of smallmouth bass of all sizes below the Glen Canyon Dam. However, smallmouth bass catches in 2025 below the Glen Canyon Dam have remained lower than any year since 2023 (Shollenberger et al 2026; Kim Dibble, Adaptive Management Work Group Annual Reporting Meeting, February 2026) even during these lower Lake Powell elevations and higher probabilities for entrainment at the dam. This is likely due to the combination of cool-mix flows and mechanical removal efforts in the Lees Ferry reach below Glen Canyon Dam. Elevations at 3,525 feet do pose a relatively higher risk of smallmouth bass and nonnative fish entrainment. An April HFE in 2023 had similar risks and there has been no significant connection between higher smallmouth bass catches and the April HFE in 2023. It should be recognized that there is a lot of uncertainty at this time of whether a HFE in June would result in higher entrainment and intensive monitoring would be needed both before and after to get a better understanding of this risk. Currently, monitoring is planned for 2026 and will continue to provide data to better understand entrainment risks of nonnative fish species.

Some literature suggests that a flood prior to spawning may improve smallmouth bass reproductive success by clearing spawning gravel (Brown et al. 2009). This presents some concern that an HFE prior to smallmouth bass spawning in the Glen Canyon Dam tailwater could

remove fine particulates from gravel and cobble substrates and increase the suitability of smallmouth bass spawning substrate, especially upstream of the Paria River in the Lees Ferry reach. Smallmouth bass likely found spawning suitable in 2022 without any recent HFE occurring, however, this may not be a limiting factor and further gravel bed condition improvement may not affect their reproductive potential. Additionally, the slough at -12 river mile has been modified to reduce smallmouth bass spawning, eliminating one known spawning location for smallmouth bass. There has been concern that if river flow drops to low the slough potentially could become disconnected from the river posing a risk to nonnative fish spawning. The exact flows that would disconnect the slough from the river has not been identified but is suspected to be around 6,800cfs. High flows expected from a spring HFE are likely to also remove fine particles from spawning gravels, so the effect of a spring HFE is not expected to increase the probability of smallmouth bass spawning compared to a fall HFE.

Other Nonnative Invasive Fishes-Spring HFE

A spring HFE is not expected to pose any direct additional risks from other Nonnative Invasive Species. In addition to those noted above, other nonnative fish species observed in recent years in Glen Canyon that could threaten humpback chub and other native fishes if they became more abundant and widespread in the Colorado River downstream of Glen Canyon Dam include striped bass (*Morone saxatilis*) and walleye (*Sander vitreus*). Striped bass have been periodically captured in Glen Canyon since the early 1980s. More recent captures of striped bass by GCMRC in Glen Canyon include one caught in each 2020 and 2016; two in 2019; and three in 2015. In August of 2018, five striped bass were observed in the slough (GCMRC unpublished data). Approximately 40 were reported between Lees Ferry and the Little Colorado River by the September 2022 FWS/GCMRC seining trip (GCMRC unpublished data). Approximately 50 young-of-year striped bass of uncertain origin have been reported in Marble and Grand Canyons in 2022. No striped bass were captured in 2025 during NPS sampling between the dam and Badger Rapid (Shollenberger et al. 2026) and only a few were reported by other agencies (NPS personal communication).

Small numbers of walleye have been captured annually in Glen Canyon, from 2006 to 2019. AZGFD has captured an average of three (range 0 to 8) each year (AZGFD unpublished data, GCMRC unpublished data), primarily downstream of Glen Canyon Dam, with none captured in 2020 or in 2021. In 2024, a total of 38 walleye were captured above Lees Ferry (Shollenberger et al. 2025). Two walleye were captured during NPS sampling between the dam and Badger Rapid (Shollenberger et al. 2026) in 2025.

There is no evidence that detection of these non-native species in recent years is related to past HFEs. With low lake elevations, increased probability of fish entrainment through Glen Canyon Dam and increased river temperatures conducive to warm water invasive fishes exists. At reservoir elevations below ~3,540 ft above sea level, surface levels are less than 20 m away from the penstock centerline and fish entrainment probability increases, as recent monitoring has revealed that the majority of pelagic fish are located in the top 20 m of the water column (Eppehimer et al. 2024 in review). A survey of the forebay with gill nets in early March 2023 captured only one walleye in the vicinity of the penstocks. Catch per unit effort (CPUE) was low compared to fall of 2022, perhaps due to cold temperatures in early March (water temp 7.4 C). Minnow traps set near

the dam capture small numbers of juvenile green sunfish and bluegill down to almost the penstock depths (Friesen 2024). Reclamation reported very few fish targets on hydroacoustic surveys in the forebay at the same time, compared with surveys conducted in March 2022 and fall 2022 (Friesen 2024).

Native Riparian Vegetation

Spring HFE

A spring HFE is not expected to pose any direct additional risks to native riparian vegetation, however a June-timed HFE followed by relatively steady flows could lead to germination of tamarisk in addition to native species. Spring HFEs (March – May) have the greater potential to benefit regeneration of native species from seed, as they correspond closely with the natural flow regime and germination period of some native species, such as cottonwoods and willows. Maintenance of sandbars and sediment resources maintains unique habitats for native riparian plant species, and therefore also promotes unique native riparian plant communities (Palmquist et al. 2025). Higher annual peak flows that inundate the floodplain accompanied by sand deposition may maintain more non-vegetated surfaces, which is desirable for maintaining natural river processes and recreation. Spring HFEs may also be increasing native species richness and contributing to maintaining more native plant species cover than nonnative cover (Palmquist and others, 2026). Tamarisk seed throughout the summer and could germinate with a June HFE. Historically, higher summer daily fluctuating flows eroded seedlings from the shoreline. If fairly stable flows follow a June HFE, it is possible that tamarisk seedlings could establish in addition to native species. No unacceptable risks are anticipated, however, and there are opportunities for promoting desirable riparian vegetation conditions.

IV. Other Considerations

Water Delivery - Monthly, Daily, and Hourly Releases

Spring HFE

The spring HFE considered by the PI Team would occur in June without changing planned monthly release volumes near 460kaf according to the April 24-Month Study Webinar on April 17, 2026. In the fall of 2025, critical elevations were predicted for water year 2026 (Most Probable 24-Month Study: September 2025). The Upper Basin Drought Response Operations Agreement (DROA) planning trigger (projections of Lake Powell Elevations less than 3525 ft. within 12 months under most probable hydrology) was met. The projected likelihood of hitting the Interim Guidelines (IG) Supplemental Environmental Impact Statement (SEIS) 6(e) trigger (DOI 2024a) increased in the winter months due to low snowpack in the Upper Colorado basin. The LTEMP SEIS 6(e) requires operational adjustments in the Upper Colorado River basin when Lake Powell is projected to drop below elevation 3525 ft within 12 months, triggering modified monthly release volumes rather than changes to the annual release. In April, IG LTEMP 6e triggers were met based on the latest April Colorado River Mid-term Modeling System (CRMMS) results presented on April 17, 2026. Based on the monthly volume adjustments in December 2025 and proposed volume adjustments in April 2026, Reclamation recommends consideration of a HFE in June 2026, using the current proposed release (~ 460 kaf) anticipated from June 2026 and not re-allocating water from other months. Any HFEs proposed in the spring of 2026 do not change annual flow releases.

A spring HFE is expected to change elevation on a daily/hourly basis since required movement of water is restricted to the month of June. The End-of-Month elevation would remain the same as estimated without an HFE. If there is a reduction it will be temporary and will equalize by the end of June.

Water Quality

Spring HFE

A spring HFE is not expected to pose any direct adverse effects to water quality either in Lake Powell or in the Colorado River. Glen Canyon Dam River Outlet Works (ROWs) withdraw water from deeper in the reservoir than the penstocks. As such, releasing water from the ROWs during an HFE temporarily reduces water temperatures, increases dissolved oxygen concentrations, and increases concentrations of dissolved nutrients. During an HFE, water temperatures in the Glen Canyon reach can be around 1-2°C cooler compared to normal operations when the bypass tubes are not in use. Dissolved oxygen concentrations in the Glen Canyon reach during an HFE increase because the bypass tubes effectively aerate the water. Biologically available phosphorus concentrations have been increasing in the last year and are currently ~0.003 to 0.008 mg/L; this represents a moderate value relative to historical values. By releasing water from lower in the reservoir using the bypass tubes, an HFE would temporarily increase phosphorus concentrations; phosphorus concentrations are higher near the bypass tube elevation compared to the penstock elevation. For example, the 2018 HFE increased Glen Canyon's biologically available phosphorus concentration by ~ 0.001 mg/L from 0.003 to 0.004 mg/L. However, this effect of elevated phosphorus would be during the duration of the HFE, and an HFE is unlikely to cause any long-term changes in phosphorus concentrations or loading to the Colorado River. Effects to downstream resources of an HFE arising from changes in phosphorus would therefore be negligible.

-12 Mile Slough

Spring HFE

A spring HFE would not pose any adverse effect to the slough modification. Construction of the slough channelization by the NPS and Reclamation finished June 2, 2025. This project channelized the slough at river mile -12, and vegetation restoration and monitoring will be done in following years. The project reduced suitable habitat for reproduction of smallmouth bass and other warm water high-risk species at this location and reduced the likelihood of downstream expansion and establishment in Glen, Marble, and Grand Canyons. Details of the slough modification efforts can be found here: [ParkPlanning - Warmwater Nonnative Fish Management at the -12-Mile Slough](#). An evaluation of the modified cobble bar and channel was conducted in May 2025 and confirmed that it should withstand an HFE. Glen Canyon National Recreation Area considers an HFE to be the final contour shaping event prior to active restoration of vegetation (Personal Communication Bud Fazio). Some vegetation growth is returning to the slough site naturally, but further vegetation restoration of the slough has been postponed in anticipation of a potential spring HFE. In order to maintain a cool flow through the modified slough a minimum flow of 6,800cfs has been suggested by National Park Service. This would allow the slough modification to

maintain its goal of cooler, flowing water to help limit nonnative spawning and refuge. Current projects of would put maintaining that flow at risk.

Dam Maintenance and Operations

Spring HFE

A spring HFE is not expected to pose any direct adverse effects to dam maintenance or operations at Glen Canyon Dam as long as bypass releases are adjusted to avoid cavitation.

The April 2023 HFE resulted in cavitation to the bypass tubes and provided guidance for future releases under low reservoir conditions (DOI 2024d). In 2024-2025 the bypass tubes were recoated to protect the bypass tube for future operations. The bypass tubes have been used since that recoating and evaluation has shown they have maintained operational. Furthermore, an electrical outage occurred on units 3 and 4 at the Glen Canyon Dam on September 25, 2025. It is unlikely that units 3 and 4 will be available for use during the HFE implementation window. Due to the maintenance issue, the PI Technical Team considered an updated magnitude for a spring HFE that reflected the decreased release capacity. The new conditions considered were a magnitude of 32,400 cfs and up to a 96-hour duration. After Glen Canyon ROW operating restrictions (DOI 2024d), the estimated maximum available flow for each bypass is 3,150 cfs (total maximum bypass = 12,600 cfs). Further investigations of dam maintenance are ongoing, but a spring HFE is not expected to have any significant effects to dam maintenance or dam operations.

Other LTEMP Experimental Flows (i.e., Smallmouth Bass Flows)

A spring HFE is not expected to pose any direct impacts on the ability to conduct Smallmouth Bass Flows in the summer of 2026. The LTEMP SEIS modeled for the possibility of both an HFE and Smallmouth Bass Flow occurring in the same Water Year. Impacts to post-HFE sandbars would depend on the Smallmouth Bass Flows implemented and therefore would be further analyzed dependent on the HFE recommendation, and which Smallmouth Bass Flow may be considered. In 2024 and 2025, cool-mix flows did not appear to impact sandbar building since volumes of water released was the same as normal operations. It has been suggested that other Smallmouth Bass Flows (e.g., nonbypass flows) could have an impact to the sandbars but uncertainty remains. In Planning and Implementation Team discussions there were concerns that a spring HFE could influence the availability of daily flows both before and after the spring HFE within the month of June. An HFE would result in redistribution of the daily releases to accommodate an HFE. These adjustments will depend on the duration of the HFE. The flows before and after the HFE would be lower with an HFE compared to without an HFE. This may influence potential SMB flow operations but this was not explored in detail at this time. Further discussion on this may occur in the Planning and Implementation meeting as the team gathers more information.

V. GCDAMP and LTEMP PA Consultation

On March 3, 2026, the required 30-day advance notification and offer for consultation were sent electronically to the Tribes and Parties to the LTEMP Programmatic Agreement regarding the potential for a High-Flow Experiment. A follow-up notification will be sent electronically to the Programmatic Agreement signatories, including Tribes, following the Department's decision regarding the potential High-Flow Experiment. As of March 6, 2026, no tribes have asked for a

consultation.

Notification of the potential for a LTEMP sediment-triggered spring HFE was communicated to Glen Canyon Dam Adaptive Management Program (GCDAMP) stakeholders on April 9, 2026, through the GCDAMP AMWG/TWG webinar (See Appendix I). A follow-up email will be distributed to the GCDAMP stakeholders informing them of the final recommendation.

VI. Conclusion

Determining whether to recommend an HFE required coordination and effective communication among the technical staff of multiple agencies. The PI Technical Team relied heavily on and would like to acknowledge the contributions of staff from GCMRC, Reclamation, and WAPA in making this recommendation. The PI Technical Team has thoroughly evaluated the issues discussed above and has taken into consideration the information and analyses included in the 2016 LTEMP FEIS, and ROD and the 2024 LTEMP SEIS ROD. The PI Technical Team's recommendation regarding implementation of a spring 2026 HFE is based on a careful assessment of resources and best available science. **By a consensus/majority vote, the PI technical Team does/does not recommend the Department of the Interior conduct a High-Flow Experiment in the spring of 2026.**

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VIII. Appendices

Appendix I. Summarized Stakeholders comments using Artificial Intelligence so errors may exist.

1. Operational Context and Constraints

- The group discussed the potential for a spring HFE, with a proposed flow of 32,400 CFS. The duration is to be determined, but sediment modeling indicates sufficient sediment for up to a 96-hour HFE. However, monthly volume constraints due to drought response operations (DROA) and Section 6E guidelines may limit the actual duration and feasibility of the experiment
- There is uncertainty about water availability, with projections showing that even minimum legal releases may drop Lake Powell below minimum power pool by next year. This urgency was highlighted by public commenters and technical staff, emphasizing that this year may be the last opportunity for a meaningful HFE for some time

2. Stakeholder Support and Recommendations

- **Strong support for conducting an HFE this year:** Multiple stakeholders, including American Whitewater and Grand Canyon River Guides, emphasized the importance of conducting an HFE in 2026, even if it must be shorter in duration. They noted that sediment conditions are optimal and that HFEs are the only tool available for sediment management in the system. Delaying further could risk losing critical ecological and recreational benefits
- **Flexibility in experiment design:** Suggestions included considering shorter HFEs (24–36 hours) with slower down-ramping rates, especially if full power plant capacity is not available. Even reduced-volume HFEs may provide some benefit, though the group acknowledged the need for sediment experts to assess the value of lower-volume events
- **Economic and recreational impacts:** Outfitters and recreation advocates stressed that HFEs have direct benefits for riparian restoration and recreational experiences. For example, the 2023 HFE led to cottonwood germination at Paria, a previously unobserved outcome

3. Technical and Scientific Considerations

- **Modeling and decision timelines:** The technical team is developing screening tools to model population growth, costs, and operational scenarios for both HFE and smallmouth bass flows. Recommendations are expected soon, but there is concern that decisions may need to be made quickly as temperature thresholds are likely to be reached earlier than usual
- **Monitoring and research:** There is consensus that any experimental flow should be accompanied by robust monitoring to assess ecological, sediment, and recreational outcomes. Stakeholders requested updates on long-term actions and feasibility studies for dam infrastructure improvements, such as thermal curtains

4. Process and Inclusion

- **Stakeholder engagement:** Several comments addressed the need for broader stakeholder and tribal involvement in the decision-making process for experiments. There is ongoing concern about disenfranchisement from the PNI team and a desire for more inclusive, consensus-driven recommendations

Key Takeaways

- There is strong, multi-sector support for conducting an HFE in 2026, even if constrained by water availability.
- Stakeholders urge flexibility in experiment design and emphasize the need for robust monitoring and adaptive management.
- Concerns about water supply, operational feasibility, and the urgency of action were repeatedly raised.
- Calls for improved stakeholder and tribal engagement in experiment planning and decision-making were prominent.

Appendix II. Summarized TWG/AMWG comments for the High-Flow Experiment being considered for the spring of 2026. Summarized TWG/AMWG comments were summarized through Artificial Intelligence and may contain errors.

1. Operational Context and Constraints

- The group discussed the potential for a spring HFE, with a proposed flow of 32,400 CFS. The duration is to be determined, but sediment modeling indicates sufficient sediment for up to a 96-hour HFE. However, monthly volume constraints due to drought response operations (DROA) and Section 6E guidelines may limit the actual duration and feasibility of the experiment
- There is uncertainty about water availability, with projections showing that even minimum legal releases may drop Lake Powell below minimum power pool by next year. This urgency was highlighted by public commenters and technical staff, emphasizing that this year may be the last opportunity for a meaningful HFE for some time

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- Flexibility in experiment design: Suggestions included considering shorter HFEs (24–36 hours) with slower down-ramping rates, especially if full power plant capacity is not available. Even reduced-volume HFEs may provide some benefit, though the group acknowledged the need for sediment experts to assess the value of lower-volume events
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3. Technical and Scientific Considerations

- Modeling and decision timelines: The technical team is developing screening tools to model population growth, costs, and operational scenarios for both HFE and smallmouth bass flows. Recommendations are expected soon, but there is concern that decisions may need to be made quickly as temperature thresholds are likely to be reached earlier than usual
- Monitoring and research: There is consensus that any experimental flow should be accompanied by robust monitoring to assess ecological, sediment, and recreational outcomes. Stakeholders requested updates on long-term actions and feasibility studies for dam infrastructure improvements, such as thermal curtains

4. Process and Inclusion

- Stakeholder engagement: Several comments addressed the need for broader stakeholder and tribal involvement in the decision-making process for experiments. There is ongoing concern about disenfranchisement from the PNI team and a desire for more inclusive, consensus-driven recommendations

Key Takeaways

- There is strong, multi-sector support for conducting an HFE in 2026, even if constrained by water availability.
- Stakeholders urge flexibility in experiment design and emphasize the need for robust monitoring and adaptive management.
- Concerns about water supply, operational feasibility, and the urgency of action were repeatedly raised.
- Calls for improved stakeholder and tribal engagement in experiment planning and decision-making were prominent.