October 15, 2018

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

From: Glen Canyon Dam technical implementation / planning team

Re: Final Recommendation to Implement a Fall 2018 High Flow Experiment at Glen Canyon Dam, November 5-8, 2018

I. Introduction

Based on the LTEMP Record of Decision (ROD), the Glen Canyon Dam technical implementation/ planning team (Technical Team) has worked over the past several months to evaluate existing information and data in determining this recommendation regarding a high flow experiment (HFE) at Glen Canyon Dam. Based on this technical evaluation, the Team recommends, with the qualifications explained below, that DOI implement an HFE November 5-8, 2018.

The purpose of this memorandum is to transmit a recommendation to the Glen Canyon Leadership Team and to the Department of the Interior (Department) in accordance with the LTEMP ROD. The Technical Team includes technical representatives from the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), the Bureau of Indian Affairs (BIA), the U.S. Geological Survey (USGS) Grand Canyon Monitoring and Research Center (GCMRC), the Bureau of Reclamation (Reclamation), Western Area Power Administration (WAPA), the Arizona Game and Fish Department (AGFD), the seven Colorado River Basin States (States), and the Upper Colorado River Commission (UCRC).The Technical Team has worked over the past several months to evaluate the existing data and coordinate the potential implementation of an HFE experiment. The Technical Team incorporated the most current science and data and considered multiple issues with agency experts, as summarized below, in making this final recommendation.

The majority of representatives on the Technical Team are in favor of recommending that DOI implement an HFE this fall, several members do not support recommending an HFE this fall, and several members have abstained from making a recommendation. The Technical Team arrived at this recommendation after several months of weekly Technical Team conference calls, subgroup meetings (brown trout subgroup), and after feedback from Adaptive Management Program stakeholders and the Adaptive Management Working Group's Technical Work Group. Technical Team representatives in favor of implementing an HFE this fall include all five DOI agencies, WAPA, and several representatives from the States. Among the States and UCRC, technical representatives were divided, with some in favor of recommending the HFE, some recommending against it, and others choosing to abstain from making a recommendation. Some Technical Team members in favor of an HFE cited the resource benefits gained from a fall HFE given the current conditions and the lack of evidence that there would be undue adverse impacts or unacceptable risks to other resources as identified by the subject matter experts using the best available current science. Some in favor were cautiously supportive given current baseline risk of nonnative fishes and the uncertainty in the science but stated there was much to learn by conducting the experiment to help resolve these uncertainties and that the risk to other resources was acceptably low. Notably, the FWS determined that given current conditions of humpback chub and nonnative fishes, the risk to endangered and native fishes in the canyon is not anticipated to increase above the baseline risk during an HFE this fall. Those opposed to recommending an HFE this fall expressed concern about the risks associated with a hypothesis that fall HFEs may be linked to the 2014-2016 increase in brown trout in Glen Canyon and impacted food base and determined that this uncertainty was too high to recommend an HFE in fall 2018.

A subgroup met on two occasions to discuss specific concerns related to the potential risk of a fall HFE benefitting brown trout. This team reached a consensus determination that this risk was not great enough to recommend that a fall HFE not be implemented this year given current conditions; however, there was disagreement regarding the overall level of risk. The subgroup agreed that monitoring should be increased or more specifically focused to provide more information about the possible effects of fall HFEs on brown trout, especially related to reproduction and movement.

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) 2018-20 Triennial Budget and Work Plan (Reclamation and GCMRC TWP; U.S. Department of the Interior, 2017). These projects will inform the effect of HFEs on the downstream resources of Glen, Marble, and Grand Canyons, including the questions raised about the response of brown trout and the aquatic food base to fall HFEs. Currently, brown trout in the Glen Canyon reach are represent approximately 1% of the fish captures and brown trout are rarely detected downstream. GCMRC and NPS have existing monitoring projects in place designed to provide information about reproduction and movement of brown trout relative to a fall HFE if adequate numbers are detected. NPS has also initiated internal discussions related to permitting increased tagging of brown trout in Glen and Grand Canyons to increase potential for data collection related to movement, including during HFEs. Monitoring projects are in place to increase our understanding of the impacts and help resolve uncertainties of fall HFEs on downstream resources.

If implemented, this will be the first HFE conducted under the LTEMP HFE Protocol. It will demonstrate the utility of the LTEMP to allow for high flow experiments when sediment conditions are adequate, and an evaluation of downstream resources indicate there will not be unacceptable adverse impacts. The recommended HFE is expected to provide resource benefits in the near term and will also provide scientific information to be used in future decision making.

II. LTEMP Process for Implementing Experiments

The LTEMP ROD provides the framework for implementing flow-based experiments at Glen Canyon Dam when resource conditions warrant. The purpose of LTEMP experiments is to learn, through adaptive management, how to better protect, mitigate adverse effects to, and improve resources downstream of Glen Canyon Dam, while complying with relevant laws. Ongoing research and monitoring through the Glen Canyon Dam Adaptive Management Program ensures the best science and data are available for making decisions related to experimental releases.

Under the LTEMP, the Department may conduct flow-based experiments (HFEs, Bug Flows, Trout Management Flows, and Low Summer Flows) at Glen Canyon Dam when resource conditions warrant and if it is determined that there will not be unacceptable adverse impacts on other resources. 2018 is the first year of implementing flow-based experiments under the LTEMP, and Reclamation has been following a process similar to that established for HFEs under prior operational decisions. This process entails outreach to Glen Canyon Dam Adaptive Management Program (GCDAMP) partners through regular meetings and additional notification to Tribes inviting consultation. The process also entails coordination with the Technical Team to plan for the possible experiment, evaluate the status of resources, and make a technical recommendation regarding whether to conduct an experiment. The Technical Team presents its recommendation to the Glen Canyon Leadership Team, which makes a recommendation to the Department. The technical and leadership teams are made up of representatives from Reclamation, FWS, NPS, BIA, USGS, WAPA, AGFD, and one liaison from each Colorado River Basin State and one from the UCRC. The Assistant Secretary for Water and Science is the chair of the Leadership Team and makes the decision for the Department regarding the experimental release. The recommendation process used this year is consistent with the process that the Department has used in the past for making decisions about HFEs as well as the Experimental Macroinvertebrate Production Flows ("Bug Flows") implemented earlier in 2018; the Department may choose to retain or modify this recommendation process to more efficiently coordinate with stakeholders.

LTEMP HFE Protocol

As described in the LTEMP ROD, HFEs are experimental in nature and are designed to achieve a better understanding of whether, how, and when to incorporate high releases into future dam operations in a manner that maintains or improves beaches, sandbars, and associated habitat. The LTEMP HFE Protocol establishes a decision-making framework consisting of three components: (1) planning and budgeting, (2) modeling, and (3) decision and implementation.

Under the LTEMP, HFE releases are restricted to limited periods of the year when the highest volumes of sediment are most likely available for building sandbars. Sediment-triggered HFEs may be made in spring (March or April) or fall (October or November; Figure 1). Fall extended-duration HFEs range from greater than 96 hr to 250 hr. Spring and fall HFEs that are not extended-duration range from less than 1 hr to 96 hr. Proactive HFEs may be implemented in spring or early summer (April, May or June), and have a duration range up to 24 hr. HFE magnitudes range from 31,500 cubic feet per second (cfs) to 45,000 cfs. The frequency of HFEs is determined by tributary sediment inputs, annual release volumes, resource conditions, and decisions of the Department. Extended-duration fall HFEs are limited to a frequency of 4 times total in the 20-year LTEMP period.

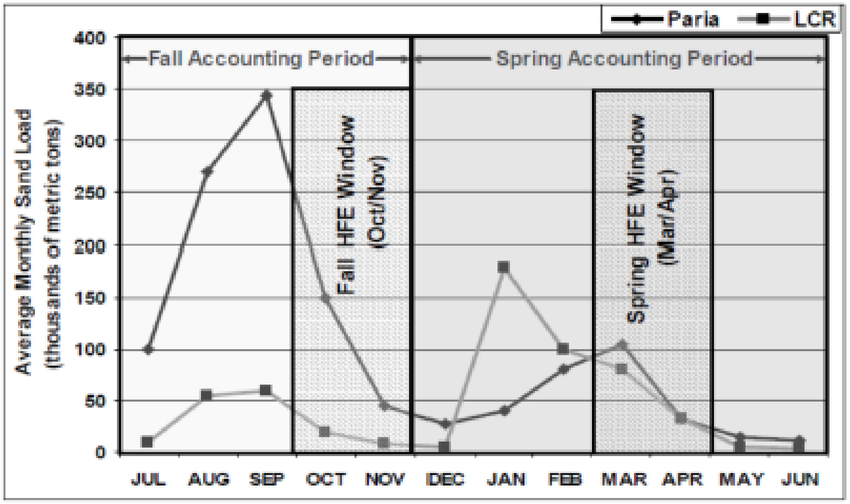

Figure 1. Average monthly sand load from the Paria River (1923-2010) and Little Colorado River (1987-2010) showing the fall and spring HFE accounting periods and implementation windows (DOI 2016a).

HFE Sand Budget Model

The LTEMP HFE Protocol uses predictive models to make recommendations for the magnitude and duration of potential HFEs using real-time measurements and models of sand inflow from the Paria River and forecasted hydrologic data to determine whether suitable sediment and hydrology conditions exist for a high-flow experimental release.

A sand transport/budget model (Wright et al. 2010) was used to predict the mass of sand that would be transported by an HFE and to estimate if a proposed HFE would transport more or less sand than had been delivered from the Paria River to the Colorado River during the fall accounting period (July 1 to November 30). Only HFE durations that resulted in a “positive sand balance” were considered. Output of the modeling runs provides the initial recommendation for the magnitude and duration of the HFE. However, because modeling only considers a simple range of possible HFE peak magnitudes and durations, the Protocol includes a review of the model output that may modify the recommended HFE to benefit relevant resources.

In addition to reviewing the sand budget model output, the Team assessed the status of the LTEMP resources and the potential effect of an HFE on these resources in making the recommendation described here.

III. Recommended Experiment: Fall High Flow Experiment

Purpose and Goal

The purpose of HFEs 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 several years.

HFE Sand Budget Model Results

Throughout the summer and fall, and in accordance with the Protocol, Reclamation regularly updated its modeling estimates based on cumulative sediment inputs to determine the largest HFE that resulted in a positive sand balance in Marble Canyon. The modeled HFE shape was based on past years' input from scientists at GCMRC and designed to meet the twin objectives of providing the greatest resource benefit and developing scientific information that will help better inform future decision making. Hydrology inputs were provided as hourly Glen Canyon Dam releases (historic and future) for the accounting period (July 1 – November 30).

The final October 9, 2018 model results predicted there was sufficient sediment for implementation of a 60-hr HFE under the LTEMP HFE Protocol. The final cumulative sand load estimates for the lower and upper bounds were, respectively, 567,726 and 783,178 metric tons. This model run used the conservative lower bound estimate for Paria River sand input (543,712 metric tons of sand supply in Marble Canyon) and estimated 39,100 metric tons would remain on November 30, 2018 following the potential HFE and at the end of the accounting period.

Experimental Design and Description

GRMRC and Reclamation recommend that the 60-hour HFE:

- Ramp-up from base releases at 4,000 cubic feet per second (cfs)/hr at approximately 6:00 am on Monday, November 5, 2018 (all times Mountain Standard Time) until reaching powerplant capacity (~23,700 cfs)
- Open first bypass tube at 10:00 am on November 5
- Ramp-up from powerplant capacity to full bypass (~38,700 cfs) at one full bypass tube (~3,750 cfs) per hour in 4 hrs
- Stay at peak release (~38,700 cfs) for 60 hrs
- Ramp-down from peak release to base releases at beginning at half bypass of 1,875 cfs/hr until reaching powerplant capacity and then decreasing at 2,500 cfs/hr

These recommendations result in the following release schedule at Glen Canyon Dam (also, Figure 2):

- Begin ramp-up from 6,500 cfs at 6:00 am on November 5 (Monday)
- Reach powerplant capacity at approximately 10:00 am on November 5
- Open bypass tubes at approximately 10:00 am on November 5
- Reach full bypass at 2:00 pm on November 5
- Begin ramp-down from bypass at 2:00 am on November 8 (Thursday)
- Complete HFE (back to 9,000 cfs) at 3:00 pm on November 8 (Thursday)

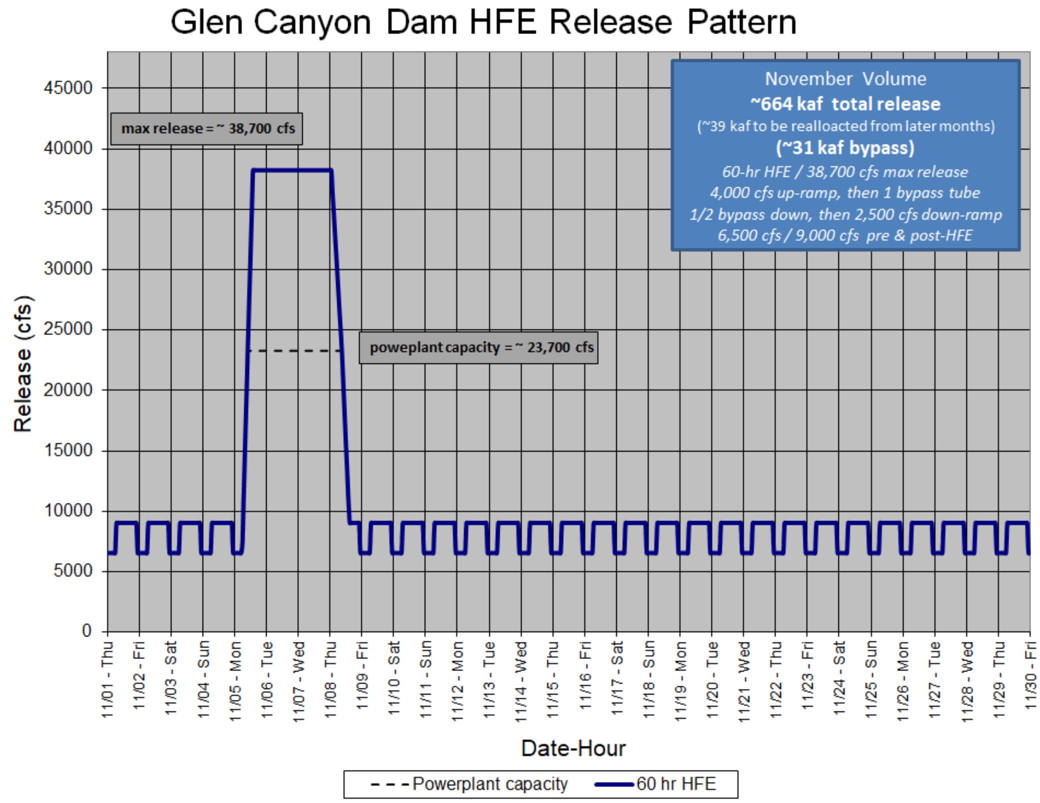

Figure 2. November 2018 Glen Canyon Dam hourly releases for proposed 60-hr HFE

This recommendation ensures that monitoring to increase scientific knowledge is a priority and places a high priority on GCMRC's field collection of samples at RM 87. Automated pump samplers would collect at least 2 samples during hydrograph rise. Based on the assumed travel time of the HFE release wave, and to ensure the safety of sampling crews as discussed further below, sampling at all sites will only be performed during daylight conditions.

IV. 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) 2018-20 Triennial Budget and Work Plan (Reclamation and GCMRC TWP, U.S. Department of the Interior, 2017). These projects will inform the effect of future HFEs on the downstream resources of Glen, Marble, and Grand Canyons. Projects from the Reclamation and GCMRC 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 measurements needed to trigger 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 EA (U.S. Department of the Interior 2011) and the LTEMP EIS (U.S. Department of the Interior 2016a), the HFE planned for fall 2018 would not be an isolated event, but as 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 Reclamation and GCMRC TWP (U.S. Department of the Interior 2017). It is also important, however, to evaluate the sandbar building response of each high flow 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 spring and fall 2019.

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.

Some Technical Team members' concerns regarded uncertainties about potential negative impacts of a fall 2018 HFE on food base and an increase in brown trout. Project F, Aquatic Invertebrate Ecology, continues a long-term monitoring in Glen and Grand Canyons, and will provide information about potential food base response to a fall HFE. Project H, Salmonid Research and Monitoring, is focused on evaluating how experimental flows such as a fall HFE influence rainbow trout recruitment, growth, survival, and movement. In addition, this project seeks to examine the brown trout response to such experiments. NPS, with Reclamation and BIO-WEST, has surgically implanted 39 brown trout in the Lees Ferry area with radio and acoustic tags and installed Submersible Ultrasonic Receivers (SURs) in the Lees Ferry area and every 10 miles downstream to Pearce Ferry (RM 280). This project will also be positioned to inform about potential brown trout movements during and following a fall HFE event, should they occur.

V. Assessment of Resources

In accordance with the LTEMP ROD, the Technical Team completed an assessment of key resources that may be impacted or affected by an HFE in making this recommendation, based on the most recent information, especially regarding fall 2012, 2013, 2014 and 2016 HFEs. This assessment focuses on recent findings and key resources and an evaluation of these resources relative to the proposed timing, duration, and magnitude of the potential fall 2018 HFE using the best available science. Consistent with the LTEMP modeling, the Technical Team did not find any information in the resource assessment that would indicate a fall HFE conducted November 5-8, 2018 would have sufficient potential adverse effects to other resources that would lead to a decision of not conducting the experiment. This section summarizes the assessment of resources and expected effects of the proposed HFE.

Archaeological and Cultural Resources

Reclamation and NPS (DOI 2016b) determined that the HFEs, as identified in the LTEMP, could, through multiple experiments, potentially affect historic properties and the effect would be adverse 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 LTEMP Programmatic Agreement (PA, Reclamation 2017) with affected tribes and other parties to address these effects. Effects of HFEs to cultural resources are primarily from erosion and redistribution of sediment. Inundation can adversely affect sites through erosion, but deposition may help protect sites by providing sources of sand that can bury historic properties via aeolian transport (Reclamation 2011, DOI 2016b, East et al. 2016). 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, initiated consultation with Tribes and consulting parties on September 6, 2018 identifying the potential for a fall HFE in 2018, in conformance with the stipulations in the PA (and previous MOA).

GCMRC monitoring has shown that recent HFEs have eroded terraces that contain archaeological sites in Glen Canyon National Recreation Area (GLCA; East et al. 2016). HFEs also rebuild or maintain sandbars that provide sand to resupply aeolian dunefields containing archaeological sites 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). No adverse effects to historic properties were identified from the 2012, 2013, or 2014 HFEs. Results from monitoring conducted during 2016 show that several archaeological sites have recently transitioned from net-erosion to net-deposition dominated topographic changes in association with the higher frequency of HFEs during the time period of the current HFE protocol. A fall HFE this year does not pose risks to archaeological and cultural resources that were not previously analyzed in the LTEMP.

Natural Processes (Aquatic Food Base)
HFEs can affect aquatic biological resources in Glen, Marble, and Grand Canyons as well as Lake Mead by changing the physical template of the ecosystem. HFEs scour the river bed, primarily in Glen Canyon, removing algae and aquatic plants and animals, which alters the distribution and abundance of aquatic animals, particularly in benthic habitats, and can result in changes to the aquatic food base for fish (Kennedy and Ralston 2011).

Controlled floods have been released from Glen Canyon Dam on the Colorado River seven times since 1996. Research conducted in Glen Canyon around the March 2008 flood demonstrated that this pulse disturbance reduced biomass and cover of aquatic macrophytes and restructured invertebrate assemblages by favoring fast-growing insect taxa (midges and blackflies) that prefer bare substrates and disadvantaging nonnative and non-insect taxa such as mud snails that prefer macrophyte beds (Cross et al. 2011). These shifts in the invertebrate assemblage and increases in drift concentrations contributed to dramatic increases in rainbow trout biomass. In the years after this controlled flood (2009-2012), aquatic macrophytes returned, large bodied mud snails came to dominate, and fast-growing midges and blackflies declined (GCMRC unpublished data).

Controlled floods were again conducted in November 2012, 2013, 2014, and 2016, but long-term drift monitoring in Glen Canyon indicates these fall-timed floods did not restructure invertebrate assemblages except possibly to facilitate increased dominance by mud snails, likely due to the seasonal scouring potential of aquatic macrophytes (GCMRC unpublished data). Specifically, primary production monitoring in Glen Canyon indicates that although these fall-timed floods temporarily reduce macrophyte cover (i.e., lower primary production) these negative effects are not persistent, and macrophyte biomass and production recovers the following spring, thereby providing low-velocity macrophyte beds that favor mud snail production. The 2008 spring-timed flood appeared to have a persistent and long-term effect (i.e., >1 yr) on macrophyte production in Glen Canyon, because this disturbance occurred at the onset of the growing season. Fall-timed floods occur at the end of the growing season at a time when macrophytes are already in the process of shunting biomass and preparing to overwinter, so the effect of fall floods on macrophytes are relatively short-lived compared to spring floods. Experimental studies in other systems have also shown that disturbances that happen early in the growing season (i.e., spring) have stronger effects on macrophyte communities compared to disturbances that happen at the end of the growing season (i.e., fall; see Torn et al. 2010). Thus, both the timing and the magnitude of controlled floods on the Colorado River appears to determine food web response via differential effects on macrophyte communities. This fall HFE does not pose risks to the food base that were not previously analyzed in the LTEMP.

Humpback chub
The adult humpback chub population in the Little Colorado River aggregation is stable and above the Tier-1 threshold of 9,000 adults identified in the Biological Opinion for the LTEMP (GCMRC unpublished data, USFWS unpublished data). HFEs have had no measurable direct effects, positive or negative, on humpback chub or other native fish, although their populations

have increased significantly over the last decade, a period that included HFEs in 2004, 2008, 2012, 2013, 2014, and 2016 and increased water temperatures (Kennedy and Ralston 2011, GCMRC unpublished data). HFEs may indirectly affect humpback chub through increases in rainbow trout or brown trout populations, which are discussed below. Based on provisional unpublished data, humpback chub were not directly affected by the 2012, 2013, 2014, or 2016 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. For example, there was poor production of juveniles this year in the Little Colorado River (catch during June was less than 10% of typical juvenile catch), in agreement with past findings that in years lacking winter/spring runoff, humpback chub recruitment is depressed (Van Haverbeke et al. 2013). The spring spawner abundance estimate for adult (> 200 mm) humpback chub in the Little Colorado River was lower in 2015 and 2016 relative to 2014 values, but higher in 2017 and 2018 (USFWS unpublished data). There is evidence that the relative condition (a ratio of length to weight and general indicator of fish health) of humpback chub in the Colorado River near the confluence of the Little Colorado River dropped in 2014 and has since slowly recovered (GCMRC unpublished data). This is important because it is possible that low spring catches in the Little Colorado River in 2015 and 2016 were due to adults with low condition values choosing to forego spawning as a result of less energy available for fish to devote to reproduction. This is not particularly surprising since humpback chub are known to skip spawn (Yackulic et al. 2014). Based on the current population status of humpback chub and the unclear relationship of fall HFEs to humpback chub, at this time there are no issues of concern relative to a fall 2018 HFE.

Hydropower and Energy

WAPA has firm electric power contracts and must meet these contract obligations either with generation from Colorado River Storage Project powerplants or from purchases from the wholesale electrical market. During the HFE, low-volume releases from Glen Canyon Dam (GCD) pre- and post-HFE will require extra electrical purchases to meet WAPA's contract obligations. Conversely, during the HFE, high volume releases from GCD will require the energy be sold to the open market. The estimated financial costs to WAPA as a result of implementing the 2018 Fall HFE is $923,963. The financial implications of the HFE occurs over several months. In comparison with past years HFEs, WAPA estimated that the 2016 HFE would cost approximately $1.4 million; the final calculated cost was $1.1 million for 2012, $2.6 million for 2013, and $2.1 million for 2014.

Water releases from GCD during the HFE may be affected by electrical disturbances of the electrical system. Electrical system operations for these disturbances are required by Reclamation and WAPA under law, contracts, and other agreements. Changes in water releases at GCD to assist in recovery from electrical system disturbances are of two types, regulation and contingency reserves; both are managed by WAPA's Western Area Colorado-Missouri (WACM) Balancing Authority. Regulation is used to respond to frequency deviations on the electrical system. Glen Canyon Dam is the only CRSP powerplant capable of the immediate responses required for regulation. These responses can either slightly increase or decrease GCD water releases and can be as much as ±1,100 cfs (40 mw) for up to 1 hour and 59 minutes. Due to maintenance on other CRSP units, Glen Canyon Dam will continue to hold contingency reserves (reserves) during the Fall 2018 HFE. When reserves are called upon to assist in an electrical emergency, the response is only in the upward direction (increased release) and would result in an increase in GCD water release up to 800 cfs (28 mw). A change in GCD water release for both regulation and reserves at the same time, in the same direction, and up to the allowed limits would be extremely rare. However, the two potential responses combined in the upward direction could ramp GCD releases up by 1,900 cfs (68 mw) for up to 1 hour and 59 minutes.

WAPA estimates that the Colorado River Basin Fund will end the 2018 fiscal year with a balance of $118 million. This is below WAPA's target for an end of year balance which puts WAPA at an increased level of financial risk. However, WAPA's evaluation of all factors and projected cost of this HFE does not indicate a level of risk preventing an HFE in water year 2019.

Other Native Fishes

A small reproducing population of endangered razorback sucker occurs downstream in Lake Mead, and recent monitoring data indicate that razorback sucker occupy and spawn in western Grand Canyon (Kegerries et al. 2017a). 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. 2017a). 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 (AGFD unpublished data). Sonic-tagged adults have also been remotely detected as far upstream as Pipe Creek (River Mile 90). Razorback sucker larvae were captured just upstream of Lava Falls in 2014 and 2015. In 2016, the study was expanded upstream, and larvae were collected as far upstream as below Havasu Creek in 2016 and 2017 (Kegerries et al. 2016). Changes in flows due to a fall HFE are unlikely to have a substantial effect to razorback suckers since life stages that might be sensitive to higher flows (e.g., spawning adults, larval fish) are not present in the fall months. In recent years, native fish have increased in abundance and distribution in western Grand Canyon with large numbers of juvenile humpback chub and flannelmouth sucker present (Kegerries et al. 2017b, Van Haverbeke et al. 2017, Rogowski et al. 2018). There is no negative response expected among native fishes to a fall HFE this year, based on current monitoring results and previous HFEs.

Recreational Experience

The majority of recreational users along the river in both GLCA and GRCA access the river by boat. Upriver trips from Lees Ferry are primarily related to day use angling, boating, and camping with decreased use during the fall months. Most use is on the weekends and we anticipate little if any impact to day or overnight users during the high flow experiment. Day use visitors also use Paria beach for picnicking and shoreline recreation. Most use in this area is during the summer and early fall, with limited use in the colder, late fall into winter months. Little to no impact to shoreline users would be anticipated from the HFE. White-water boating in 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. Effects would primarily be related to safety considerations, covered in Section VI of this report.

Day raft trips from Glen Canyon Dam to Lees Ferry, conducted under contract by Wilderness River Adventures (WRA), cannot operate during HFEs because flow into the Colorado River uses the bypass tubes at Glen Canyon Dam near the launch point for these trips. 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 a HFE, reducing catch rates.

Any impact to recreational experience associated with the HFE will be short term, with long term impacts to recreational experience and participation uncertain, and the biophysical results should benefit recreational users through improvements to the near shore habitat and beaches as identified in the LTEMP related to HFEs.

Sediment
See discussion in Section III for current sediment conditions relative to the HFE Protocol. Four 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, and 2016. In each case, sandbar building results were generally consistent with the results from previous sand-enriched HFEs as described by Schmidt and Grams (2011). All 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 6 months. Response immediately after the 2016 HFE based on digital camera images of sandbars from Lees Ferry to Diamond Creek indicated that there was a substantial gain (deposition) for 24 sandbars (56% of sites), no substantial change for 14 sandbars (33% of sites), and substantial loss (erosion) for 5 sandbars (11% of sites) (Grams et al. 2018). The HFE deposits typically begin eroding immediately following each HFE and the bulk of the newly deposited sand persists for approximately 6 to 12 months. Annual topographic surveys of sandbars were conducted between September 29 and October 16, 2017. Data from these surveys indicate that there has been some net increase in the size of reattachment sandbars since the beginning of the HFE protocol in 2012. The size of other types (Mueller et al. 2018) of sandbars has fluctuated, with no significant net increase or decrease. Thus, repeated HFEs under the protocol have caused cumulative increases in the size of some sandbars. Deposition of sand during HFEs has caused 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). Anecdotal reports from river guides indicate that hillslope runoff from summer rainstorms has caused substantial erosion at many sandbars during summer 2018. These eroded sandbars will not rebuild without an HFE.

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).

The aggregate sand mass-balance conditions since inception of the HFE Protocol (i.e., for the period between July 1, 2012, and September 1, 2018) for the different segments of the Colorado River (from https://www.gcmrc.gov/discharge_qw_sediment/reaches/GCDAMP) are:

- *Upper Marble Canyon:* +1.70 million metric tons (the range of this measurement is between -0.51 and +3.90 million metric tons)

- *Lower Marble Canyon:* +1.00 million metric tons (the range of this measurement is between +0.32 and +1.70 million metric tons)

Thus, there was likely more sand in the Colorado River corridor in Marble Canyon on September 1, 2018, than there was on July 1, 2012 when the HFE Protocol was first implemented. The proposed fall HFE does not pose risks to the sediment conditions that were not previously analyzed in the LTEMP and will benefit most sediment resources.

Tribal Resources

All resources in the canyon are of importance to Tribes, thus all resources are tribal resources. As such, careful consideration of the potential effects of an HFE on all resources has been considered. In addition, the taking of life in the canyon is a serious concern expressed by Tribal partners. The proposed HFE is not expected to directly or indirectly result in increased taking of life in the canyon, either during the experiment or in the future as a result of the experiment. The careful analysis indicates that the implementation of the proposed fall 2018 HFE does not pose an increase in the risk of taking of life. The proposed experiment is not expected to cause unacceptable adverse impacts to tribal resources.

Rainbow Trout Fishery

The AGFD Management Plan identifies targets for angler catch quality of 10 rainbow trout ≥ 14 inches (355 mm) caught in a 10-hour day, with at least one ≥ 20 inches (508 mm). Overall, rainbow trout catch rates have increased from 10-year lows observed in 2016. Preliminary results from 2018 creel surveys estimate that through September 16, boat angler catch rates are 0.89 fish/hr (CI 0.82-0.96, AGFD unpublished data), which is below the targeted minimum catch rate of one fish/hr identified within AGFD’s Lees Ferry Fishery Management Plan; however, catch rates were above the target for the months of May, June, and August (AGFD unpublished data). Catch rates at the walk-in fishery section have also increased from 2016 lows but are highly variable by month and on average are still well below management target catch rates of one fish/hr. Patterns in angler satisfaction mirror catch rates with an increase from 2016 lows. Rainbow trout condition factor is averaging over one indicating healthy individuals within the population accessible to anglers (AGFD unpublished data). Although catch rates are increasing, the rainbow trout population still consists of a majority of fish less than 200 mm, which are less desirable to anglers than larger fish (AGFD unpublished data). Successful cohorts from 2016 and 2017 are recruiting into the larger size classes sought by catch-and-release anglers but it may take multiple years of continued high recruitment to return to size structures matching those observed in 2012-2013 when catch rates and satisfaction were highest. This time also represents the highest densities and catch rates of rainbow trout ever observed in Glen Canyon (GCMRC 2013).

The angling community’s TWG representatives submitted a request to defer the HFE in 2018. There is sentiment among the angler community that fall HFEs are linked to the population decline observed beginning in 2013, culminating in the lowest average condition factor observed in many decades in the fall of 2015. The mechanism is believed to be a result from concentrating fish within the lower volumes of water leading up to and following the HFE; the effect being amplified in the fall when condition factors and food availability are both naturally low. It should be noted that the GCMRC trout projects have observed high growth in years both with and without HFEs, and growth appears to be confounded by nutrients and competition, which may have greater effects on growth (GCMRC unpublished data). Fall-timed floods have been shown to have neutral to possibly negative effects on the food base. Long-term monitoring of invertebrate drift in Glen Canyon indicated fall-timed floods do not restructure invertebrate assemblages as was observed following the 2008 spring HFE except possibly to facilitate increased dominance by mud snails (GCMRC unpublished data). No negative response is expected to the rainbow trout fishery resulting from a fall 2018 HFE, based on current monitoring results and previous HFEs.

Nonnative Invasive Species- Green Sunfish
In June 2018, nonnative green sunfish were again discovered in the small isolated pool at the upstream end of the backwater slough on river left at RM -12 in Glen Canyon (NPS unpublished data). The pool is about 1/3 acre in size and is located just upstream of the larger backwater slough. Agency biologists agreed that elimination of this invasive species from the isolated pool is necessary and urgent due to the risk of negative interactions with native fish, particularly the humpback chub. Efforts to eliminate the green sunfish from this isolated pool using electrofishing were ineffective in 2016 (Trammell 2016, GCMRC unpublished data) so mechanical removal using electrofishing was not attempted this year. In September 2018, NPS used 3 gasoline powered pumps to attempt to dewater the isolated pool. The pool was greatly reduced in volume, but inflow rates from several small springs was higher than anticipated, so the pond could not be dried sufficiently to eliminate green sunfish larvae or eggs. As outlined in a risk assessment completed in 2015, chemical treatments provide the greatest likelihood of success (Ward 2015) and reducing the size of the wetted area was thought to decrease the amount of chemical required. Permitting a rotenone treatment as was implemented in 2015 was not possible within the necessary time frame, consequently other chemical treatments options were used. Initially, soda ash was added to raise the pH to levels lethal to fish and fish eggs (Ward, personal communication), but again inflow rates diluted the treatment and provided fresh water refuges. Subsequently, ammonium chloride was added to the water that remained following dewatering with pumps at dosage rate of 0.5 ml ammonia hydroxide per 3.78 L of water, following protocols outlined in Ward et al. 2013. No green sunfish were found in the pool during post-ammonia-treatment monitoring, and very few green sunfish have been found in the main slough in 2018 (NPS unpublished data, AGFD unpublished data) indicating that treatment of the main slough is unnecessary this year. Based on these findings, green sunfish do not represent a resource concern that would prevent a fall 2018 HFE.

Nonnative Invasive Species- Brown Trout
Brown trout are a highly piscivorous species known to eat humpback chub and other native species (Yard 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 uncertain and may be weak relative to other drivers of humpback chub dynamics (e.g., temperature, juvenile recruitment, food availability). Brown trout catches at the Little Colorado River confluence have generally been low since implementation of the HFE protocol in 2012 (GCMRC unpublished data). Catches increased in 2013 with 43 brown trout captured over four trips, but catches declined to 23 fish in 2014 and have continued to drop with none observed during the most

recent trip in July 2018 (GCMRC unpublished data). In contrast to observations near the Little Colorado River, brown trout abundance has increased in Glen Canyon in recent years and is a cause for concern. 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). The coincidence of these events led the GCDAMP's Adaptive Management Work Group to pass a motion recommending that the Secretary of Interior direct GCRMC and others to convene a workshop to investigate the brown trout increase, its causes, and what might be done about it. The workshop was held in September 2017 with a subsequent report (Runge et al. 2018) published in April 2018. The report concluded that brown trout increases in Glen Canyon since 2012 were likely due to a migratory event in 2014 and subsequent reproduction. The report further concluded that the underlying cause of these increases was unclear and could be due to a number factors including fall HFEs. More recent observations indicate that brown trout abundance in Glen Canyon peaked in 2016, and total abundance, reproduction, and survival of brown trout in 2017 and 2018 have been lower in comparison (GCMRC unpublished data, AGFD unpublished data). Thus, it remains uncertain whether the proposed 2018 HFE will have any effect on reproductive activities of brown trout or whether brown trout may be benefitting from fall HFEs. Continuation of the trout monitoring program now in place will provide an assessment of the effects from a 2018 HFE. The subgroup convened to discuss the potential increased risk from a fall 2018 HFE posed by brown trout reached a consensus decision recommending that that the risk from brown trout was not great enough to avoid a fall HFE this year given current conditions.

Nonnative Invasive Species- Other Fishes

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 smallmouth bass, striped bass, and walleye. One smallmouth bass was captured in 2018 and one in 2017. Prior to that two were caught in 2013 and one each in 2011 and 2010 (AGFD unpublished data). Five striped bass were observed in Glen Canyon in August 2018, but this species has been periodically captured in Glen Canyon since the early 1980s (GCMRC unpublished data). Small numbers of walleye have been captured annually in Glen Canyon since 2006 including three in 2018 (AGFD unpublished data, GCMRC unpublished data), primarily just downstream of Glen Canyon Dam. If the current drought continues and reservoir levels continue to decline, there may be an increased risk of fish entrainment through Glen Canyon Dam and increased river temperatures conducive to warm water nonnative invasive fishes; however, this baseline level of risk would be present whether an HFE is conducted or not. There is no evidence that the detection of these species in recent years is related to past HFEs or will be influenced by a HFE, were one to occur in 2018.

Riparian Vegetation

There is no evidence that the proposed HFE would significantly impact riparian vegetation resources. The primary impact will be to extend the active channel upslope, which is the zone of daily inundation, for the duration of the HFE. This may slightly extend the suitable habitat for obligate wetland herbaceous species that respond positively to inundation, though longer-lived perennial species are unlikely to respond significantly to this short-term increase in inundation (Butterfield et al. 2018). Nonetheless, possible impacts of HFEs will be assessed through statistical modeling of changes in riparian vegetation composition based on 2018 vegetation surveys and hydrological variables, specifically inundation duration and elevation above base flows, calculated from the hydrograph and sandbar exceedance equations. These results will be available for discussion at the upcoming Annual Reporting Meeting. Future work to assess physiological responses of plants to HFEs will be conducted in 2019 and 2020.

Monthly, Daily, and Hourly Releases

The recommended HFE will result in changes to the weekly release prior to and after the HFE and the monthly volume distribution during Water Year (WY) 2019. Neither the tier determination nor the annual release volume as outlined in the 2007 Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lakes Powell and Mead (Reclamation 2007) will be impacted by a potential HFE. Reclamation currently projects the annual release volume for water year 2019 will be 9.0 million acre feet (maf) under the maximum, and most probable inflow scenarios and 8.23 maf under the minimum probable scenario.

The best estimate for total release from Glen Canyon Dam for a HFE in November 2018 is 38,700 cfs (23,700 cfs through the powerplant and 15,000 cfs of bypass). This estimate is based on the most recent unit testing completed in September 2018, a maintenance assumption that seven of the eight units at Glen Canyon Powerplant would be available November 5-12, 2018, and an approximately 100% gate opening on the available seven units. In addition, this estimate assumes that 70 megawatts (MW) (approximately 1,893 cfs) of system regulation and spinning reserves will be maintained at Glen Canyon.

The release volume required in November for the proposed 60-hour HFE is 664,000 acre-feet. The September 24-Month Study projected 625,000 acre feet release volume in November, therefore it is necessary to reallocate 39,000 acre-feet from March, April and May later in WY2019 into November. The November total volume for a 60-hour HFE is 664,000 acre-feet and bypass volume is 81,000 acre-feet. WAPA and Reclamation will coordinate on the scheduled reallocation of monthly release volumes with the goal of protecting minimum monthly thresholds whenever practicable as described in the LTEMP as well as maximizing the economic value of hydropower. The September 24-Month Study most probable annual release for water year 2019 under Interim Guidelines is projected to be 9.0 maf, with all months projected to be above these thresholds regardless of the HFE release. If inflows in WY2019 are very low, the annual release could be as low as 8.23 maf, in which case monthly volumes would be lower than under the 9.0 maf monthly release pattern.

The LTEMP maximum ramp rates (4,000 cfs per hour when increasing and 2,500 cfs per hour when ramping down) will be adhered to throughout the experiment, as will the maximum daily fluctuations (9 times the monthly release volume in May and June; and 10 times the monthly release volume in July and August). Hourly releases for the days prior to and after the proposed HFE in November are anticipated to fluctuate between 6,500 to 9,000 cfs and complies with the daily fluctuating range not to exceed 8,000 cfs outlined in the LTEMP. In addition, minimum releases of 5,000 cfs during the nighttime and 8,000 cfs during the daytime will be maintained.

VI. Safety Considerations

As identified in the LTEMP HFE Protocol, potential effects on public health and safety could occur in conjunction with an HFE, primarily impacting recreational anglers and boaters. All daily fluctuations, minimum flows and maximum flows associated with any proposed HFE are within the range experienced by recreational users in the past. Reclamation and NPS continue to work together to ensure that safety measures are implemented, including restricting access to the river immediately below the dam during proposed HFEs, and as noted below, providing public notice about the timing of the HFE implementation. NPS Boating Safety Rules always apply to all boaters using the river.

Reclamation and NPS coordinate to address safety and security issues related to HFEs. Additionally, the three park service units affected, GLCA, Grand Canyon National Park (GRCA) and Lake Mead National Recreation Area (LAKE) will work together to collaboratively plan necessary actions for the HFE. NPS units work to maximize continuity of efforts and resources, particularly in those areas where responsibilities are shared, specifically Lees Ferry and Pearce Ferry. Each park has clearly designated responsible parties and staffing needs and actions that need to occur prior to and during an HFE. The parks have coordinated communications plans, medical plans and resource capabilities for search and rescue responses. The three park units maintain frequent communication and information sharing leading up to and during any implemented HFE.

In preparation for an HFE, GRCA, GLCA, and LAKE identify and communicate with permitted Colorado River trip permit holders that have the potential to be impacted by the HFE while rafting the Colorado River within each respective park unit. Planning is implemented to provide alternative trip dates for trips potentially affected by an HFE. All permit holders are directed to access up-to-date information provided by Reclamation, NPS, and the USGS/GCMRC websites. Additionally, all backcountry hikers who access the Colorado River as part of their backcountry hike are alerted to potential campsite inundation areas.

Prior to an HFE, GLCA communicates with the holders of commercial use authorizations for commercial services (primarily fishing guides) on the Colorado River within GLCA to provide information on the time and duration of the HFE. During past HFEs, relatively few recreational boaters traveled upstream from Lees Ferry. Information about a pending HFE and safety considerations are provided to recreational users at Lees Ferry in coordination with the Technical Team Communications group. Information is also provided via public media, the GLCA website and on-site NPS staff. A fact sheet explaining potential impacts to park visitors is distributed to potentially affected visitors. Notifications are provided at Lees Ferry and Phantom Ranch and the fact sheet is available at these locations, as well as the GRCA Backcountry Information Center and primary visitor center.

In addition, safety considerations regarding sampling efforts by GCMRC have been incorporated into planning to ensure that safety of field staff is an overarching priority. There is a lag between the time that water is released from the dam and the time that water arrives at a particular downstream location (often referred to as “travel time”). USGS crews are deployed to locations in the days before the high flow release and will be supported by motorized rafts, and boats and cableways. They take critical measurements of discharge, suspended sediment transport, and organic drift. At sites downstream from the Paria River (river mile [RM] 1), work can only be safely conducted during daylight hours. This is especially the case on the first day of the HFE when the water surface typically is covered with woody debris that potentially can clog props of outboard engines or snag equipment suspended from cableways. Likewise, large logs that float just below the water surface can pose a threat to the safety of sampling staff. To address these issues, all field measurements by USGS personnel will be done during daylight hours in order to maximize the safety of field personnel.

In addition, safety considerations regarding sampling efforts by GCMRC is incorporated into planning to ensure that safety of field staff is an overarching priority. USGS crews deployed during the experimental flows will be made aware of the timing of the experimental flows. The range of proposed minimum flows for the current HFE are within the range GCMRC and contracted boat operators have experienced in the past.

VII. Communications Plan

The proposed HFE presents an excellent opportunity to explain to the public the purpose of the LTEMP flow-based experiments and expected beneficial impacts. The communications/public affairs aspect of this HFE will not include a public/media event at Glen Canyon Dam but will include communications product development and media coordination.

Pending an HFE, Reclamation's Upper Colorado Region Public Affairs Office in coordination with NPS and USGS public affairs and the Department develop a communications product. An initial media advisory is sent to alert media representatives and the public of the HFE, including its summary purpose and expected start and finish dates. A more detailed news release, for publication on or near the HFE dates, may be prepared for distribution by the Secretary's office. Social media outlets are also used to communicate with the public leading up to and during the event--including to share imagery of the HFE.

VIII. Monitoring and Coordination During Experiment Implementation

Pending an HFE, members of the Technical Team will continue to meet regularly throughout the implementation of the experiment. This occurs through the regularly scheduled monthly Glen Canyon Dam operations coordination calls as well as additional coordination calls, as needed. Scientists conducting field surveys during the experiment and agency technical experts report on data collected and preliminary results to the Department and the GCDAMP at regularly scheduled meetings. Glen Canyon Dam operations are adjusted accordingly in the event of unexpected impacts from the HFE, and/or in the event of an emergency.

IX. Post Experiment-Reporting and Feedback

The Technical Team will coordinate to report initial findings at the 2018 GCDAMP Annual Reporting Meeting in February 2019 in Phoenix, AZ.

In addition, the Technical Team will report ongoing findings at meetings of the GCDAMP Technical Work Group (TWG) and Adaptive Management Work Group (AMWG). Reclamation has a commitment to provide an annual monitoring report to the FWS Arizona Ecological Services Office (AESO) in compliance with the 2016 Biological Opinion; this report will also include a summary of the effects of an HFE conducted under the LTEMP ROD. Reclamation will use the monitoring information and feedback from AESO and GCDAMP stakeholders to inform monitoring for future experiments, and to design and implement any measures necessary to address any adverse effects that may occur due to these flows.

At the conclusion of the experiment, the Technical Team will review the planning process, implementation, and monitoring activities and develop a list of "lessons learned" to inform potential future experiments and experimental planning.

X. Planning for Future Experiments

- Monitoring of sediment transport and sandbar responses to an HFE would include measuring sediment transport at several sites in Marble and Grand Canyons as well as 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 as described in section IV. 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 Reclamation and GCMRC TWP (DOI 2017). GCMRC will use the information from these studies to evaluate the effects of HFEs on downstream resources in Glen, Marble, and Grand Canyons and to help in the design of future experiments.

- The brown trout subgroup of the Technical Team recommended that monitoring efforts be conducted aimed at addressing uncertainty about the impact of fall HFEs on brown trout reproduction and movement in the system to inform future planning and discussion about fall and spring HFEs.

- At the August 2018 AMWG meeting, it was agreed that GCMRC would: conduct a scientific assessment of the effects of past experimental high flows (including powerplant capacity flows) at Glen Canyon Dam on high valued resources of concern to the GCDAMP (i.e., recreational beaches, aquatic food base, rainbow trout fishery, hydropower, humpback chub and other native fish, and cultural resources); and present initial findings in a written summary at the 2019 Annual Reporting Meeting and the March 2019 AMWG meeting for review and discussion. As a next step GCMRC would identify experimental flow options that would consider high valued resources of concern to the GCDAMP (defined above), fill critical data gaps, and reduce scientific uncertainties.

- Trout Management Flows were originally contemplated in early 2018 but were not recommended for this year. GCRMC has planned additional research to inform the design of any future Trout Management Flows including studies on flow optimization and the distribution and behavior of young trout in response to various flow scenarios in

Glen Canyon. GCMRC will use the information from these studies to help in the design of future experiments.

- The Technical Team will meet in early 2019 to review the implementation and results of all 2018 experimental activities, and to begin coordination on the evaluation of resources and potential experiments that may be conducted in 2019.

- In accordance with the LTEMP, the Department may make the decision to conduct future flow-based experiments (High Flow Experiments, Bug Flows, Trout Management Flows, and Low Summer Flows) at Glen Canyon Dam if it is determined that there are no unacceptable adverse impacts on other resource conditions. Information and data from this or other experiments will be considered in future recommendations and decisions.

XI. Consultation

Reclamation and GCMRC provided much of the information in this report that was available at the time in the GCMRC 2017 Annual Report. Newer not yet published information was reported on to the Adaptive Management Program Partners at the GCDAMP Annual Reporting Meeting on March 6-7, 2018 as well as to the AMWG at its August 22-23, 2018 meeting. Notification of the potential for a 2018 fall HFE was emailed to GCDAMP stakeholders on August 24, 2018, shortly after the sediment trigger was met. A follow-up informational webinar was held on September 27, 2018, with GCDAMP stakeholders as an opportunity to ask questions and provide feedback. Representatives from the Basin States participated in the development of this recommendation; some are in favor, some do not support, and some abstained from taking a formal position. Reclamation and GCMRC also presented the findings and draft recommendation of this report to the TWG on October 10, 2018. Based on feedback and discussion at the GCDAMP webinar and the TWG meeting, the recommendation and report were finalized without major changes.

On September 6, 2018, the required 30-day advance notification and offer for consultation was mailed to the Tribes and parties to the LTEMP cultural Programmatic Agreement of the potential for a High Flow Experiment beginning November 5, 2018. As of October 4, 2018, Reclamation has not received any requests for consultation on the potential experiment. A follow-up notification will be sent electronically to the Programmatic Agreement signatories, including Tribes, following the Department's decision regarding the proposed High Flow Experiment.

XII. Conclusion

Determining whether to recommend an HFE required coordination of many details and effective communication among technical staff of multiple agencies. The Team members relied heavily on the staff in each of the agencies in making this recommendation. The Team has thoroughly evaluated the issues discussed above and has taken into consideration the information and analysis included in the LTEMP EIS and ROD. The Team's recommendation to proceed with implementation of the HFE is based on the careful assessment of resources and best available science. The Team is recommending that HFE be conducted in fall 2018 because the sediment conditions are favorable and the risks relative to other resources are acceptable.

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