STATE OF COLORADO

Colorado Water Conservation Board
Department of Natural Resources
1313 Sherman Street, Room 721
Denver, Colorado 80203
Phone: (303) 866-3441
Fax: (303) 866-4474
www.cwcb.state.co.us

TO: Colorado Water Conservation Board Members

FROM: Ted Kowalski, Chief, Interstate, Federal & Water Information Section

DATE: November 13, 2013

SUBJECT: **Agenda Item 12b, November 19-20, 2013 Board Meeting**
Interstate, Federal & Water Information Section – Colorado River Issues
Current Colorado River Issues

Background

Current Hydrology

As of November 4, 2013, Lake Powell has risen to elevation 3991, which equates to approximately 10.91 million acre-feet (maf), or 45% of capacity. Lake Mead is at elevation 1106, which equates to approximately 12.104 million acre-feet (maf), or 46% of capacity. When considering the other storage amounts within the Colorado River basin, the system storage still sits at approximately 50% full. Under the 2007 Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Interim Guidelines), the Interim Guidelines call for an annual release of 7.48 maf from Lake Powell to Lake Mead, for Water Year 2014 (October 1, 2013-September 30, 2014). This is known as the Mid-Elevation Release Tier of the Interim Guidelines.

High Flow Experiment

In October, 2013, the Department of the Interior (DOI) notified the Colorado River Basin States (Basin States) that the sediment conditions are such that a High Flow Experiment from Glen Canyon Dam through the Grand Canyon (HFE) is warranted this fall, under the HFE Protocol. A further review of the other resource conditions suggested that the HFE could occur without negatively affecting those other resources. DOI consulted with the Basin States as required under the Protocol. Copies of the DOI decision memo and supporting information are attached to this memo.

Minute 319 Implementation

The Staff continues to work with Commissioner McClow, Director Eklund, the representatives of the Basin States, the federal agencies, Mexican representatives, and interested stakeholders regarding Minute 319 Implementation. Workgroup meetings occurred during September and October relating to environmental flows, water accounting and operations, and basin hydrology.

The environmental flows work group is continuing to develop a flow delivery plan for the base flows and pulse flows that Mexico will use for environmental purposes in the river corridor below Morelos Dam. The environmental flows workgroup conducted its third and final meeting with science experts from the U.S. and Mexico on September 24-25, 2013 in San Diego. The flow delivery plan is being designed to utilize the limited quantities of water available to Mexico under Minute 319 and to fit within the schedule established by the Minute and allowed by the treaty.

Staff Recommendation
This item is informational and there is no Board action required.

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

OCT 2 5 2013

MEMORANDUM

To: Regional Director
Upper Colorado Region, Bureau of Reclamation

From: Anne J. Castle
Chair, Glen Canyon Leadership Team
Assistant Secretary - Water and Science

Subject: Approval of Recommendation for High-Flow Experimental Release from Glen Canyon Dam, November 2013

On October 23, 2013, the Glen Canyon Technical Team (Technical Team) recommended a high-flow experimental (HFE) release from Glen Canyon Dam (Attachment 1, Technical Team Recommendation to Implement a Fall 2013 High Flow Experiment at Glen Canyon Dam) in accordance with the Development and Implementation of a Protocol for High-Flow Experimental Releases from Glen Canyon Dam, Arizona, 2011 through 2020 (HFE Protocol) Environmental Assessment (EA) and Finding of No Significant Impact (FONSI). The Glen Canyon Leadership Team (Leadership Team) has carefully reviewed and considered the Technical Committee's recommendation. After a thorough discussion on October 24, 2013, the Leadership Team has unanimously decided to proceed with the recommended HFE release. This HFE would be the second conducted under the HFE Protocol and effectuates the goal of the HFE Protocol to allow for HFEs whenever resource conditions warrant. The Leadership Team would like to thank the members of the Technical Team for their hard work to make this process more efficient and build on the knowledge and experience gained during the work prior to and following the 2012 HFE. Please take the appropriate actions to implement the HFE release as described in the Technical Team recommendation.

The Leadership Team would like to highlight several important aspects of the recommendation that have led to this decision.

First, this HFE recommendation incorporates the best scientific information concerning a variety of resource areas. The determination of the presence of the triggering conditions for an HFE and appropriate rate and duration of HFE release is based on modeling information that accounts for water and sediment resources. But because more than those two resources are implicated, the HFE Protocol decision process calls for resource experts to review the model output, consider

the potential effects on other resources, and adjust the model's HFE release recommendation to account for key resource areas.[1]

The model that the HFE Protocol uses to assess different duration and magnitude HFEs called for an HFE Release of 37,200 cubic feet per second (cfs) with a peak flow duration of 96 hours, based only on sediment and water resources (a flow of 37,200 cfs is the maximum rate available because of maintenance currently ongoing at Glen Canyon Dam). Having reviewed this model output and the status and trends of other key resources, the resource experts reached a consensus on the recommendation for this HFE Release (37,200 cfs with a peak flow duration of 96 hours) in order to maximize benefits to resources.

The 2013 HFE hydrograph is different than the 2012 HFE hydrograph in several notable ways. The recommendation for the 2013 HFE incorporates a faster up-ramp rate[2] of 4,000 cfs/hour up to power plant capacity, compared to 1,500 cfs/hour in the 2012 HFE hydrograph. The faster up-ramp rate is recommended to improve sandbar building in upper Marble Canyon, the portion of the system with the poorest sandbar condition at this time. The 2013 HFE recommendation also does not include the slower down-ramp rate of 200 cfs/hour from peak release to power plant release that was used in 2012, but instead uses 1,500 cfs/hour. The 2012 recommendation for a slower down-ramp rate was based on a much smaller amount of sediment available in the system, about 650 thousand metric tons, and the slower down-ramp rate and corresponding reduction in time at peak release was recommended to both better utilize the relatively small sediment supply, and provide for sandbars with a shallow bar angle. In contrast, there is currently a very large amount of sediment in the system, at least 1.5 million metric tons, and the 2013 HFE recommendation is therefore to conduct the largest and longest possible HFE under the HFE Protocol to fully utilize this tremendous available sediment resource to its greatest benefit.

The Team also worked to ensure that HFE effects to water delivery and hydropower were minimized. Although the HFE will increase the release of water in November to 700,000 acre feet (kaf) from 500 kaf, the additional 200 kaf needed can be reduced from March and May releases, and the annual volume of delivery for water year 2014, scheduled to be 7.48 maf, will not be affected by the HFE. Also, in response to input from the Western Area Power Administration (Western), the Technical Team was able to propose a schedule for the HFE that modifies the anticipated initiation of the HFE and instead starts on Monday, November 11, which resulted in better conditions for Western to market the additional hydropower generated by the HFE and resulted in a cost savings of $30,000 over the original proposal to begin the HFE on November 13.

Second, the HFE release approved in this decision is the result of thorough public and stakeholder involvement over the past year following the fall 2012 HFE. The HFE Protocol EA

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[1] Another important aspect of the review by resource experts is to ensure that the anticipated effects of the proposed HFE are within the range of impacts analyzed in the environmental documentation prepared for implementation of the HFE Protocol.

[2] Ramp rates are the rates at which the release rate through the Dam changes over time. Ramp rates are measured in cubic feet per second per hour.

and FONSI addressed involvement from the Glen Canyon Dam Adaptive Management Program (GCDAMP) Adaptive Management Work Group (HFE Protocol EA, page 41). This outreach was extended to include various meetings, conference calls, and webinars with the Indian Tribes, the Colorado River Basin States, and the Adaptive Management Work Group, including its Technical Work Group. This process was put in place in developing the 2012 HFE and was refined and streamlined in developing the 2013 HFE. While fewer meetings were needed this year, the meetings were more efficient thanks to the hard work of the Technical Team last year and the familiarity of the stakeholders with the HFE Protocol process now in place.

Third, this 2013 HFE release under the HFE Protocol will continue the adaptive management process of taking experimental actions that will inform future experiments and potential management decisions. This HFE includes a thorough monitoring and research process to collect data on various resource conditions. The 2013 HFE recommendation is based on thorough analysis of the available results of the 2012 HFE provided by this monitoring and research process. Information was analyzed by resource experts in the various agencies from the 2012 HFE and reported on in a number of meetings following the 2012 HFE (some as soon as December 2012 – just weeks after the 2012 HFE). Information developed during the 2013 HFE will be disseminated in a similar way, to inform stakeholders, and decision making for future HFE releases and potential future management actions. This information will also be valuable as the Department continues the ongoing NEPA process for the Long-Term Experimental and Management Plan EIS, as well as development of the FY2015-16 GCDAMP Budget and Work Plan, facilitating public participation and input and allowing the best available scientific information to inform future decision making for Glen Canyon Dam operations and research and monitoring efforts.

Overall, the Leadership Team's conclusion is that the recommended HFE release will provide resource benefits in the near term and scientific information that can be used in future decision making. The HFE release will satisfy the Department of the Interior's goal to ensure effective and coordinated implementation of important research that the Department is undertaking through the GCDAMP.

The Leadership Team would like to thank the Technical Team for the sustained hard work that has led to this recommendation, particularly given the difficult conditions resulting from the temporary federal government shutdown at the beginning of October 2013. The individual efforts of members of the Technical Team, most particularly the outstanding dedication of Glen Knowles of the Bureau of Reclamation, and coordination of the team as a whole has made this process a smooth one with clear support for the ultimate outcome. The HFE Protocol and the individual releases conducted under its umbrella will ensure continued benefits to the incomparable resources of Grand Canyon National Park and Glen Canyon National Recreation Area and effective and coordinated research to benefit river science and future operations.

Attachment

cc:

Glen Canyon Leadership Team

Lori Caramanian, Department of the Interior
Jane Lyder, Department of the Interior

Bob Snow, Office of the Solicitor
Fritz Holleman, Office of the Solicitor
Rod Smith, Office of the Solicitor

Ann Gold, Bureau of Reclamation
Larry Walkoviak, Bureau of Reclamation

Bert Frost, National Park Service
Dave Uberuaga, National Park Service

Dave Lytle, U.S. Geological Survey
Jack Schmidt, U.S. Geological Survey

Steve Spangle, U.S. Fish and Wildlife Service
Benjamin Tuggle, U.S. Fish and Wildlife Service

Bryan Bowker, Bureau of Indian Affairs
Chip Lewis, Bureau of Indian Affairs

Lynn Jeka, Western Area Power Administration
Mark Gabriel, Western Area Power Administration

Glen Canyon Technical Team

Lori Caramanian, Department of the Interior
Sarah Rinkevich, Department of the Interior
Bob Snow, Office of the Solicitor
Ron Anderson, Bureau of Reclamation
Mary Barger, Bureau of Reclamation
Jane Blair, Bureau of Reclamation
Rick Clayton, Bureau of Reclamation
Katrina Grantz, Bureau of Reclamation
Lisa Iams, Bureau of Reclamation
Glen Knowles, Bureau of Reclamation
Dennis Kubly, Bureau of Reclamation
Deborah Lawler, Bureau of Reclamation
Dave Trueman, Bureau of Reclamation
Jason Tucker, Bureau of Reclamation
Mike Ward, Bureau of Reclamation

Nick Williams, Bureau of Reclamation
Malcolm Wilson, Bureau of Reclamation
Jan Balsom, National Park Service
Brian Bloom, National Park Service
Rob Billerbeck, National Park Service
Todd Brindle, National Park Service
Brian Carey, National Park Service
Martha Hahn, National Park Service
Chris Hughes, National Park Service
Rosemary Sucec, National Park Service
Mark Wondzell, National Park Service
Jack Schmidt, U.S. Geological Survey
Scott Vanderkooi, U.S. Geological Survey
Lesley Fitzpatrick, U.S. Fish and Wildlife Service
Garry Cantley, Bureau of Indian Affairs
Shane Capron, Western Area Power Administration
Sam Loftin, Western Area Power Administration
Nancy Scheid, Western Area Power Administration

October 23, 2013

To: Department of the Interior (DOI) Glen Canyon Leadership Team for the High Flow Experimental Protocol (HFE Protocol) and Non-Native Fish Control (NNFC)

From: DOI Glen Canyon Technical Team

Re: Recommendation to Implement a Fall 2013 High Flow Experiment at Glen Canyon Dam

I. Introduction

The DOI Glen Canyon Dam Technical Team (Team) has worked during the past several months to evaluate existing data in determining this recommendation for a high flow experiment (HFE) to be conducted at Glen Canyon Dam in November 2013 and is recommending that the Leadership Team approve a fall 2013 HFE. This controlled high flow release would be the second HFE conducted under the HFE Protocol.

The purpose of this memorandum is to transmit this recommendation to the Glen Canyon Dam Leadership Team in accordance with the May 23, 2012, Secretarial Directive on the Implementation of Research to Improve Conditions in the Colorado River in Grand Canyon National Park and Glen Canyon National Recreation Area. The Team includes representatives from the National Park Service (NPS), the Fish and Wildlife Service (FWS), the Bureau of Indian Affairs (BIA), the United States Geological Survey (USGS) and its Grand Canyon Monitoring and Research Center (GCMRC), and the Bureau of Reclamation (Reclamation). Western Area Power Administration (Western) resource specialists also participated in the process and provided information for this recommendation. Western is fully supportive of this recommendation.

The Team has met several times over the past several weeks prior to the government shutdown. Resource and communications specialists who were not furloughed have been coordinating in small groups as necessary since the shutdown. Some key staff not furloughed because they were in exempted status during the shutdown were able to continue working on 2013 HFE planning. The Team incorporated the latest data from agency experts in making its final recommendation. In making this recommendation, the Team considered multiple issues, as summarized below, including the tasks addressed in the July 18, 2012 memorandum from Anne Castle, Assistant Secretary for Water and Science. The Team also considered additional technical information included in the project notebook for the 2012 (including the results of monitoring after the 2012 HFE) and 2013 HFEs.

The Team recommends that an HFE at Glen Canyon Dam be conducted in November 2013 with a maximum magnitude of approximately 37,200 cubic feet per second (cfs) for 96 hours, as explained below.

II. HFE Protocol

As explained in the Development and Implementation of a Protocol for High-Flow Experimental Releases from Glen Canyon Dam, Arizona, 2011 through 2020 Environmental Assessment (HFE EA; Reclamation 2011), the HFE Protocol is experimental in nature and is designed to achieve a better understanding of whether, how, and when to incorporate high releases into future dam operations in a manner that effectively conserves natural resources that are intimately connected to the distribution, size, and characteristics of fine-sediment deposits. Fine sediment is sand, silt, and clay; the deposits of the Colorado River in Grand Canyon are primarily composed of sand. The HFE Protocol establishes a decision-making framework consisting of three components: (1) planning and budgeting, (2) modeling, and (3) decision and implementation.

The Protocol uses predictive models for two purposes. First, predictive models were used to anticipate the magnitude, duration, and frequency of HFEs that might occur on a decadal time scale, based on historic sediment and hydrologic data for the Paria River. These models allow prediction of the maximum potential for sandbar building with the historic sand supply. Second, predictive models are used to make recommendations for specific HFEs using real-time measurements and models of the rate of fine sediment inflow from the Paria River and forecasted hydrologic data to determine whether suitable sediment and hydrology conditions exist for a high-flow experimental release. The two basic inputs for the modeling are the hydrology, based on forecasted monthly inflow volumes from the National Weather Service's Colorado Basin River Forecast Center and Reclamation's 24-month study storage and release projections, and the estimated mass of fine sediment that has been delivered to the Colorado River in Marble Canyon. Virtually all of this fine sediment comes from the Paria River, but other small tributaries contribute approximately 10% additional sediment supply.

A flow routing model was used to predict the rate at which the HFE release wave moves downstream. A sediment transport/budget model was used to predict the mass of fine sediment that would be transported by the HFE and to estimate if a proposed HFE would transport more or less fine sediment than had been delivered to the Colorado River during the fall accounting period (July 1 to November 30). Only HFEs that removed and/or redistributed slightly less fine sediment than had been delivered from the Paria River during the fall accounting period (a "positive sand balance") were considered. Sediment-inflow data are based on real-time measurements of the Paria River measured at the gage near Lees Ferry and a predictive model that allows the measurements of sediment transport to be extrapolated to entire HFE periods. Sediment inflow from lesser tributaries is estimated as a small proportion of the inflow rate from the Paria. Modeling of Colorado River sediment transport is used to predict if the duration and magnitude of an HFE release transports slightly less sand than was delivered to the Colorado River during the immediately preceding accounting period. Output of the modeling runs provides the initial recommendation for the magnitude and duration of the HFE. Because modeling only considers a simple range of possible HFE peak magnitudes and durations, the Protocol includes a review of the model output, so that other resources can be considered. Thus, the Team also considered the status of resources and consideration of HFE effects on key resources in making the recommendation described here.

Throughout the summer and fall, Reclamation regularly updated its modeling estimates based on ever increasing sediment inputs and worked with scientists at GCMRC to ensure that the HFE design has the greatest potential to produce the greatest likelihood of effective and efficient sandbar building and conservation. GCRMC research scientists provided input concerning how the HFE might best be shaped to meet the twin objectives of providing the greatest resource benefit and developing scientific information that will help better inform future decision making.

Sand Budget Model

Because sand transport can be reliably predicted, a sand transport/budget model was used to determine the largest and longest HFE that could be conducted that still yielded a positive sand balance in Marble Canyon for the accounting period, (given the mass of sand delivered by the Paria River since July 1 of any given year). Model runs iteratively cycled through the different HFE types until HFE types were identified that did not result in a negative sand balance. Beginning in September 2013, following several storm events on the Paria River, model results predicted there was sufficient sediment for an HFE.

The sediment modeling component uses the sand transport/budget numerical model developed by the USGS/GCMRC. Model results reliably matched measured conditions in upper Marble Canyon, which is the river segment between Lees Ferry and River Mile (RM) 30.

Model Inputs

Model predictions require estimation of the following:

- Antecedent conditions
- Hydrographs including of the potential HFE
- Sand input from the Paria River

Antecedent Conditions

The antecedent conditions required for the sand budget model are bed thickness, in meters, and median particle size, in millimeters. The most recent values represented May 2002 bed conditions. These values were updated to July 2013 by running the sand budget model for the period from 2002 to 2013 and using the results of that simulation as the antecedent conditions of the 2013 HFE model simulations.

Hydrology Input

Hydrology inputs were provided as hourly releases from Glen Canyon Dam in cubic feet per second (cfs). During the modeled period, a combination of historic hourly releases and forecasted releases were used as the hydrology inputs. Hourly GCD releases were routed using the one-dimensional unsteady flow model developed by the USGS/GCMRC to determine hourly hydrographs at the downstream end of various modeled reaches.

Sand Input

Sand inputs to the sand budget model were provided as hourly loads in kilograms per second (kg/sec). During the modeled period, observed sand loads were used as input up to the date of the simulation. From the simulation date forward zero future sand input was assumed through the end of the modeled period.

Sand inputs were measured and estimated by GCMRC. Data were made available in real-time to Reclamation through the Paria River USGS/GCMRC water quality website (www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09382000#). Estimates of sand inflow were regularly adjusted by GCMRC as field samples were processed in the USGS/GCMRC laboratory.

Paria River sand inputs were increased to account for inputs from other tributaries in Upper Marble Canyon. Inputs from these tributaries are monitored and measured but estimates are not available in real-time. The historic average of these inputs is equal to approximately 10% of the Paria River loads, and is always a very small proportion of the amount delivered by the Paria River. Thus, Paria River sand inputs were increased by 10% to account for these contributions from the lesser tributaries as was done for the HFE EA.

In the final run of the sand budget model, the lower bound of the Paria River sand estimate was used for tributary inputs. Such an approach is prudent, because there is an equal probability that the actual amount of sand delivered from the Paria River could be any value between the upper and lower bound. Thus, modeling projections used in the design of the HFE are based on an estimated amount of sand about which the USGS/GCMRC has a very high degree of confidence. Estimates of sand input from the Paria River through September 30, 2013, for the lower and upper bounds were 1,496,000, and 2,224,000 metric tons, respectively.

The sand mass balance for Upper Marble Canyon where virtually all of the available sand is presently stored was estimated by GCMRC and provided to Reclamation. The latest estimates available were for September 27, 2013 (the last update available before this report was completed). The estimates for the lower and upper bounds were, respectively, 1,400,000, and 2,400,000 metric tons.

HFE Types

Appendix E of the HFE EA listed 13 possible HFE types ranging from a peak magnitude of 31,500 to 45,000 cfs and ranging in peak duration from 1 to 96 hours. Although the HFE Protocol model evaluates performance of 13 possible types of HFEs (Table 1), the HFE Protocol decision and implementation phase allows for modifications based on resource conditions and predicted benefits to resources. Thus the HFE Protocol allows for HFEs of from 1 to 96 hours in duration, 31,500 to 45,000 cfs in magnitude, and utilizing the rate limits of 4,000 cfs/hour increasing and 1,500 cfs/hour decreasing as defined in the HFE Protocol Finding of No Significant Impact (FONSI; Bureau of Reclamation 2012) and the operating criteria for Glen Canyon Dam (62 FR 9447). The modeling for this HFE initially used a peak magnitude of

32,000 cfs rather than 45,000 cfs due to expected maintenance at Glen Canyon Dam and other limitations due to power regulation and reserves.

Beginning in September model runs have been conducted using 37,200 cfs as the peak magnitude for HFE types. This change was made to the modeling because Reclamation and Western coordinated to maximize the possible release peak rate by slightly shifting scheduled maintenance and moving power reserves to increase the Glen Canyon release capacity and thus the peak magnitude of a potential HFE. To assist with creating additional generation at Glen Canyon Dam, Western offered to move power reserves decreasing their normal 81 megawatts (MW) of regulation/reserve requirement to 40 MW which increased the maximum possible peak magnitude.

Table 1. The 13 HFE types tested in model runs.

HFE No.	**Peak Magnitude (cfs)**	**Peak Duration (hrs)**
1	37,200	96
2	37,200	72
3	37,200	60
4	37,200	48
5	37,200	36
6	37,200	24
7	37,200	12
8	37,200	1
9	35,325	1
10	33,450	1
11	31,575	1
12	29,700	1
13	27,825	1

All HFEs tested assumed a ramp-up rate of 4,000 cfs/hr from baseflow to powerplant capacity, a rate of half a bypass tube (~1,875 cfs) every hour up to peak magnitude, and a ramp-down rate of 1,500 cfs/hr to baseflow. These ramp rates are in accordance with the HFE Protocol EA and FONSI, 1995 EIS, 1996 Record of Decision, and the Operating Criteria for Glen Canyon Dam (62 FR 9447).

HFE Model Results

The model simulation for the lower bound estimate for Paria River sand input and the HFE hydrograph completed October 15 estimated 1,553,000 metric tons of sand supply in all of Marble Canyon (i.e the Upper and Lower parts) on November 10 prior to the start of a potential HFE and an estimated 836,000 metric tons on November 30 following a potential HFE and at the end of the accounting period.

The model results were compared with the lower bound estimate for sand mass balance in Upper Marble Canyon on September 27. The measured estimate was 1,400,000 metric tons compared to the modeled value of 1,532,000 metric tons for a difference of less than 10%, indicating that the model results are accurate.

Sand budget model results through September 30, 2013, determined an HFE with a peak magnitude of 37,200 cfs and a peak duration of 96 hours. Reclamation consulted with USGS/GCMRC about the modeling results, and USGS/GCMRC recommended an HFE hydrograph with maximum duration and magnitude allowable under the HFE Protocol. USGS/GCMRC recommended that a sustained 96-hr duration peak would facilitate scientific comparison with previous HFEs and thereby maximize scientific understanding of sediment transport processes. Based on the best professional judgment of its geomorphology and sediment transport experts, USGS/GCMRC recommended that maintaining maximum magnitude, 37,200 cfs under current conditions at Glen Canyon Dam, for 96 hours would provide the maximum potential benefit to fine-sediment-dependent resources in Marble Canyon. USGS/GCMRC and Reclamation also consider ramp-up and ramp-down rates. The USGS/GCMRC final recommendation for the shape of the HFE included a ramp-up rate of 4,000 cfs/hr from baseflow to powerplant capacity, ramp up of half a bypass tube (~1,875 cfs) every hour to a peak magnitude of 37,200 cfs, a peak duration of 96 hours, and a ramp-down rate of 1,500 cfs/hr to baseflow. These recommendations were used in the final run of the sand budget model and are the basis for the final proposed HFE recommendation.

HFE Recommendation

GRMRC and Reclamation recommend that the HFE:

- Ramp up from base releases at 4,000 cfs/hr at approximately 9:00 am on Monday, November 11 (all times Mountain Standard Time) until reaching powerplant capacity (~22,200 cfs)
- Open first bypass tube at 2:00 pm November 11
- Ramp up from powerplant capacity to full bypass (~37,200 cfs) at half a bypass tube (~1,875 cfs) per hour in 8 hrs
- Stay at peak release (~37,200 cfs) for 96 hrs
- Ramp down from peak release to base releases at 1,500 cfs/hr

These recommendations result in the following release schedule at Glen Canyon Dam

- Begin ramp up from 8,000 cfs at 9:00 am on November 11 (Monday)
- Reach powerplant capacity at approximately 1:00 pm on November 11
- Open bypass tubes at approximately 2:00 pm November 11
- Reach full bypass at 8:00 pm on November 11
- Begin ramp-down from bypass at 8:00 pm on November 15 (Friday)
- Complete HFE (back to 8,000 cfs) at 3:00 pm on November 16 (Saturday)

Unlike the Team's recommendation for a 2012 HFE, the 2013 HFE does not include a unique slower down ramp rate of 200 cfs/hour from peak release to power plant release (the 2013 HFE

recommendation uses 1,500 cfs/hour). The recommendation last year was based on a smaller amount of sediment available in the system, and the slower down ramp rate and corresponding reduction in time at peak release, was recommended to both better utilize a relatively small sediment supply, and provide for sandbars with a shallow bar angle. In contrast, as described above, there is currently a very large amount of sediment in the system and the 2013 HFE recommendation is therefore to conduct the largest and longest possible HFE to fully utilize this available sediment resource. The recommendation also incorporates a faster up ramp rate up to power plant capacity of 4,000 cfs/hour (compared to 1,500 cfs/hour in the 2012 HFE hydrograph). The faster up ramp rate is recommended to improve sandbar building in upper Marble Canyon, the portion of the system with the poorest sandbar condition.

This recommendation ensures that monitoring to increase scientific knowledge is a priority and places a high priority on USGS/GCMRC's field collection of samples at RM87. 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, daylight conditions will be available for sampling at all sites.

III. Assessment of Resources

In making this decision, the Team completed an assessment of key resources that may be impacted or affected by a 2013 HFE based on the most recent information, and in particular, information collected since the fall 2012 HFE. 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 2013 HFE as described above using the best available science. The Team refers to Reclamation (2011) and Melis (2011) for more complete summaries of resource effects from HFEs. The following key resources were considered:

- Sediment Resources
  - In-channel sediment storage
  - Sandbar campable area
  - High-elevation sand deposits

- Cultural Resources
  - Archaeological site condition and stability
  - Access to archaeological sites by tribes

- Biological Resources
  - Aquatic food base
  - Lees Ferry trout population
  - Lees Ferry fishery recreation experience quality
  - Endangered humpback chub and other fish abundance
  - Riparian vegetation
  - Endangered Kanab ambersnail

- Hydropower and water delivery
  - Water quality

- Water delivery
- Dam maintenance
- Hydropower production and marketable capacity

In our resource assessment, we did not find any information that would indicate a fall 2013 HFE would have adverse effects to a resource that would lead to a decision to not conduct the HFE. Several issues warranted further consideration as described in this section.

Sediment Resources: See discussion in Section II.

Cultural Resources: Reclamation (2011) determined that the HFE Protocol could, through multiple HFEs, potentially affect historic properties and the effect would be adverse per 36 CFR 800.5(2)(iv). Reclamation also found that adverse effects to sacred sites could result from the HFE Protocol, primarily from limitation of access of tribes to sacred sites. Reclamation completed the HFE Protocol Memorandum of Agreement (MOA; Reclamation 2012) 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 directly adversely affect sites through erosion, but deposition may help protect sites directly or by providing sources of sand that can bury historic properties via eolian transport (Reclamation 2011, Schmidt and Grams 2011). HFEs also may affect access of tribes to historic properties and alter visitation patterns to historic properties (Reclamation 2011).

The MOA has a stipulation, Stipulation 2c, that requires a meeting be conducted with the parties after each HFE event, to review the effects of the HFE, and use the results of the meeting to inform monitoring for future HFEs, and to design and implement any measures necessary to prevent or control adverse effects of future HFEs. Reclamation held a meeting on February 12-13, 2013 to meet this stipulation of the MOA by reviewing the effects of the fall 2012 HFE. No adverse effects to historic properties of the 2012 HFE were identified.

The MOA also includes a stipulation, Stipulation 2b, that requires all the parties be notified at least 30-days in advance of any planned HFEs, and consult with tribes to resolve any conflicts with tribal access to or uses of the Colorado River. DOI began notifying the parties of the potential for an HFE in early September and asking tribes if they wanted tribal consultation meetings, and the parties were also officially notified of a potential HFE in fall 2013 on September 30, 2013 via letter. The Pueblo of Zuni and the Navajo Tribe requested government-to-government tribal consultation meetings. DOI representatives met with government and religious leaders from the Pueblo of Zuni on September 10, 2013, and cultural program specialists from the Navajo Nation on September 11, 2013. Both tribes were supportive of a fall 2013 HFE.

Biological Resources: 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). HFEs may displace young fish to downstream habitats or result in mortality of young fish, in particular trout

in Glen Canyon (Kennedy and Ralston 2011). HFEs may improve spawning habitat for rainbow trout in Glen Canyon by scouring fine sediment and cleaning gravel beds used for spawning. HFEs also alter the distribution of fine sediment resulting in changes in aquatic habitat, for example the creation of backwaters (Kennedy and Ralston 2011). HFEs also change the water quality in the river and in Lake Mead downstream by increasing turbidity and altering water chemistry, in particular, temperature, dissolved oxygen, and specific conductance (Reclamation 2011, Southern Nevada Water Authority unpublished data).

Information on effects of HFEs on food base and fisheries in Glen and Grand Canyons is limited. Most information is from the March 2008 HFE. Although there was a 55% decline in total invertebrate biomass following the March 2008 HFE, rainbow trout production increased 194%, largely due to a shift in invertebrate biomass to better food sources for trout, blackflies (Simulidae) and midges (Chironomidae); (Cross et al. 2011). The March 2008 HFE also reduced biomass and production of New Zealand mudsnails (Cross et al. 2011), another beneficial effect to fish food base, as the species is indigestible by rainbow trout and Grand Canyon native fishes. Multiple HFEs could lead to a shift to more flood-tolerant invertebrate species, a potential benefit to higher trophic levels (fish). The first HFE in the spring of 1996 also led to increases in rainbow trout in Glen Canyon; increases in rainbow trout are a potential adverse effect to humpback chub because nonnative rainbow trout are known to prey on and compete with native humpback chub (Wright and Kennedy 2011).

There are fewer data to evaluate fall-season HFEs, but food base is expected to take longer to recover over the winter period. Although data have not been analyzed fully from the 2012 fall HFE, initial results do not indicate a strong effect on food base (GCMRC unpublished data). Concentrations of blackflies in the drift were elevated in Glen Canyon in January 2013 as compared to September 2012 while no change was observed midges over the same interval. The 2013 HFE hydrograph includes pre- and post-HFE operations of the dam in November of 5,000 to 8,000 cfs daily which is a lower operation than the 7,000 to 9,000 background operation conducted in 2012. The Glen Canyon angling community has indicated a concern that this lower operation may negatively affect rainbow trout by adversely affecting the aquatic food base. GCMRC will implement additional monitoring to assess potential impacts of this lower operation.

Rainbow trout densities are currently high in the upstream third of Marble Canyon and remain low near the confluence with the Little Colorado River. Monitoring indicates that rainbow trout in Glen Canyon moved very little during the period that included the fall 2012 HFE. Approximately 90% of age-0 rainbow trout were recaptured within 0.25 miles of their initial release locations. Other studies suggest some rainbow trout reproduction might have occurred downstream from Lees Ferry in 2013, although it is unknown if this was due to some effect of the 2012 HFE. The 2013 HFE would differ from the 2012 HFE in using a faster upramp rate that could result in increased displacement of trout. Continuation of the trout monitoring program now in place will provide an assessment of this effect from a 2013 HFE. Brown trout catches in the river near the confluence of the Little Colorado River (LCR) were higher in 2013 than in 2012, and recent catches were dominated by smaller fish (< 300 mm). These data may indicate that brown trout populations near the LCR are increasing, although it is unlikely that this is due

to the fall 2012 HFE since brown trout do not reproduce in Marble Canyon. Brown trout are a highly piscivorous species known to eat humpback chub and other native species.

HFEs have had no measurable positive effect on humpback chub or other native fish, although their populations have increased significantly over the last decade, a period that has included three HFEs in 2004, 2008, and 2012 (Kennedy and Ralston 2011). HFEs may have adverse effects to humpback chub due to displacement of young humpback chub downstream and beneficial effects to rainbow trout populations, but also may improve habitats for humpback chub through the creation of more diverse near shore habitats, i.e. backwaters (Kennedy and Ralston 2011). Based on provisional unpublished data, humpback chub appear to have been essentially unaffected by the 2012 HFE, with adult and juvenile populations appearing to have been stable over the period of the HFE. Juvenile humpback chub data from a recent monitoring trip in September 2013 were not available in time to be considered in this report, but other data collected this year indicate that there are no issues of concern relative to a fall 2013 HFE. The spring population estimate for adult (> 200 mm) and subadult (150-200 mm) humpback chub in the Little Colorado River appeared to increase slightly in 2013 (post-HFE), although not significantly so. Juvenile humpback chub (40-100 mm) densities in the mainstem near the Little Colorado River are similar to the densities of humpback chub measured in July 2012, prior to the 2012 HFE. The 2013 HFE would differ from the 2012 HFE in using a faster upramp rate; a similar upramp rate was also used in the 1996 HFE. This faster upramp rate could result in increased displacement of young humpback chub, although there is no evidence of this from the 1996 HFE. Improved monitoring of juvenile humpback chub now in place will provide a better assessment of this effect from a 2013 HFE.

A small reproducing population of endangered razorback sucker occurs downstream in Lake Mead, and a single adult was caught in October 2012 near Spencer Canyon in the riverine part of Lake Mead that is within western Grand Canyon. Thus this population uses the riverine parts of the reservoir in western Grand Canyon. Changes in flows are unlikely to have any significant effect to razorback suckers in the Colorado River inflow area since effects of those releases are attenuated by the time the water reaches what is likely to be occupied habitat, and razorback sucker are very rare in the area. The HFE flows could have some effect to spawning and recruitment if conducted during the spring, but a fall HFE will not have this effect.

As described in the 2011 U.S. Fish and Wildlife biological opinion, endangered Kanab ambersnail would be adversely affected by HFEs (U.S. Fish and Wildlife Service 2011). HFEs will scour snail habitat resulting in loss of some snails at Vasey's Paradise. FWS found in its 2011 biological opinion that this loss of snails and snail habitat would not jeopardize the continued existence of the Kanab ambersnail. A recent report by the USGS found that Kanab ambersnails are part of a much more widespread species of snail and may not qualify as an endangered species (Culver et al. 2013).

Whirling disease, a serious disease of trout species, was detected in Glen Canyon in 2011 by the Arizona Game and Fish Department (AGFD). Although there is no data on how HFEs affect whirling disease, GCMRC completed an assessment of the potential for HFEs to spread whirling disease in 2012 that concluded HFEs pose little risk of spreading whirling disease. The AGFD has not specifically monitored for the disease in Marble and Grand Canyons. However annual

monitoring of rainbow trout in Glen, Marble, and Grand Canyons indicate the disease has not spread since the 2012 HFE.

Hydropower and Water Delivery: For the proposed HFE, Reclamation and Western have coordinated to ensure that the maximum possible release from the dam can be achieved. While there are a number of unknown factors that might impact the maximum release rate that can be made during the HFE, Reclamation anticipates that a release of approximately ~37,200 cfs is possible. Each month the generating units are tested to determine their specific capacity. These capacities change based on the changing elevation of the reservoir.

The best case maximum estimate for total release from Glen Canyon Dam for a HFE in November 2013 is 40,000 cfs (25,000 cfs through the powerplant and 15,000 cfs of bypass). This estimate is based on the most recent unit testing completed in October 2013 and a maintenance assumption that seven of the eight units at Glen Canyon Powerplant will be available November 8-18, 2013. Total releases through the powerplant (with each unit at 100% gate opening) could be as high as approximately 26,200 cfs, however a raised tailwater elevation during an HFE will decrease unit efficiencies. In addition, 40MW (approximately 1,200 cfs) of system regulation must be maintained at Glen Canyon. Therefore, the estimated maximum flow through the powerplant is approximately 25,000 cfs. The bypass tubes provide an additional 15,000 cfs release resulting in a best case maximum possible release of 40,000 cfs. Given the variability in efficiency, Reclamation used the lower estimate of 37,200 cfs for modeling purposes and as a target for a potential HFE due to increased certainty of achieving this release. This corresponds to approximately 90% gate opening for the available seven units.

Western completed an analysis of the potential financial costs to Western as a result of running the fall 2013 HFE. Western estimates that the HFE described in this document will have a financial impact on firm power customers of about $1.74 million due to additional power purchases to replace generation losses before, during and after the HFE. The Technical Team was able to schedule the HFE to start on Monday, November 11, which resulted in better conditions for Western to market hydropower generated by the HFE and resulted in a cost savings of $30,000.

The release volume required in November for the proposed HFE is approximately 700,000 acre feet. The October 24-Month Study projected 500,000 acre feet release volume in November, therefore it is necessary to reallocate approximately 200,000 acre feet from months later in the water year. Approximately 129,000 acre feet of water would be bypassed during the proposed HFE. Western and Reclamation will coordinate on the scheduled reallocation of monthly release volumes with the goal of protecting minimum MLFF monthly thresholds whenever practicable as described in the EA as well as maximizing the economic value of hydropower. However, the annual release for water year 2014 under the 2007 Interim Guidelines for the Colorado River for Lower Basin Shortages (2007 Interim Guidelines) is 7.48 maf, so some months will be below these thresholds regardless of the HFE release. Hourly releases for the days prior to and after the proposed HFE are anticipated to fluctuate between 5,000 to 8,000 cfs.

Releases from Glen Canyon Dam in November may fluctuate beyond the scheduled releases due to system regulation and/or reserve requirements. Throughout the entire month of November,

Glen Canyon Dam will maintain 40MW of system regulation. These instantaneous release adjustments stabilize the electrical generation and transmission system and 40MW translates to a range of approximately 1,200 cfs above or below the hourly scheduled release rate. For the days prior to and after the proposed HFE, Glen Canyon Dam will also maintain 43MW of reserves. To provide system reliability, all participating electricity generators within the balancing area maintain a specified level of generation capacity (i.e. reserves) that can be called upon when an unscheduled outage occurs. If reserves are called upon at Glen Canyon Dam, releases may increase by up to an additional approximately 1,200 cfs. Maintaining regulation and reserves is necessary for NERC-WECC compliance and safe operation of the hydropower facility.

Reclamation thoroughly evaluated the effect of conducting a fall 2013 HFE on the delivery annual release volume from Lake Powell in compliance with the 2007 Interim Guidelines. Reclamation currently projects the annual release volume for water year 2014 will be 7.48 million acre feet under all probable inflow hydrology scenarios. An HFE in November will not affect the annual release volume from Lake Powell nor the Operational Tier in accordance with the 2007 Interim Guidelines. In the HFE FONSI, Reclamation also committed to consulting with the Basin States prior to conducting an HFE as to the issue of compliance with the 2007 Interim Guidelines. On October 22, 2013, in accordance with the HFE FONSI, representatives from Reclamation met with representatives from the Basin States to review information relevant to the 2007 Interim Guidelines in consideration of a decision to conduct a fall 2013 HFE. Reclamation also presented additional information about the HFE (e.g., modeling information, resource assessments) to the Basin States.

The Pueblo of Zuni, in a letter dated September 20, 2012 expressed concern that successive iterations of HFEs under the HFE Protocol could have cumulative negative impacts on power generation and a resultant effect on raising the cost of purchasing power for individual rate payers, and that this is especially of concern to economically disadvantaged minority communities such as Zuni. The Pueblo of Zuni requested that Reclamation provide a detailed description on how the economic effects of successive HFEs on power rate payers will be monitored. Reclamation is working with Western to carefully assess this issue and provide for post-HFE monitoring that will analyze, to the extent possible, effects to ratepayers from HFEs conducted under the HFE Protocol. At this time, Western does not anticipate that the cost of HFEs will cause near-term changes in power rates.

IV. SAFETY CONSIDERATIONS

As identified in the environmental assessment and FONSI, 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 the proposed HFE are within the range experienced by recreational users in the past, and Reclamation and NPS have been working together to ensure that safety measures are implemented, including restricting access to the river immediately below the dam during the HFE. NPS Boating Safety Rules will continue to apply to all boaters.

The primary concessionaire on the Glen Canyon reach, Colorado River Discovery (CRD), cannot operate its pontoon fleet during HFEs which utilize the bypass tubes. NPS has notified CRD that

the HFE may occur and has updated the company on a weekly basis as new information is received. If the Leadership Team decides to conduct a fall 2013 HFE, CRD will move boats and associated infrastructure out of the river at the Lees Ferry launch ramp using a hydraulic system to other locations to avoid damage, and will make alternate arrangements for their customers during the HFE. Revenue losses for a six-day HFE in November were estimated at $8,100 in lost concession revenue, $600 in lost NPS amenities revenues, and $1,620 in lost NPS concession franchise fee. Direct expenses associated with the removal of the concession assets from the river per HFE were estimated at $9,961 in payroll and fuel costs.

Reclamation and NPS have been coordinating to ensure that safety and security issues have been addressed. This planning has assumed that a public event at Glen Canyon Dam may or may not occur. The safety planning conducted by the Team is in place for either scenario.

Each of the three park service units affected, Glen Canyon National Recreation Area (GCNRA), Grand Canyon National Park (GCNP) and Lake Mead National Recreation Area have worked together to collaboratively plan necessary actions for the HFE. Each park unit will be affected uniquely and for different periods of time. The focus is on maximizing 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 also considered communications plans, medical plans and resource capabilities for search and rescue responses. The three park units will maintain frequent communication and information sharing leading up and during the HFE.

GCNP will 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 GRCA and Lake Mead National Recreation Area. A plan has been developed to provide alternative trip dates should the permitted river trip decide not to launch during the projected HFE. All permit holders have been 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 will be alerted to potential campsite inundation areas.

GCNRA has identified and will communicate with the holders of commercial use authorizations for commercial services (primarily fishing guides) on the Colorado River within GCNRA 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 the pending HFE and safety considerations will be provided to recreational users at Lees Ferry in coordination with the Technical Team Communications group. Information will be provided via public media, the GCNRA web site and on-site NPS staff. A fact sheet explaining potential impacts to park visitors will be developed and distributed to potentially affected visitors. Notifications will be provided at Lees Ferry and Phantom Ranch and the fact sheet will be available at these locations, as well as the GCNP 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 downstream. USGS

crews will have been deployed to locations in the days before the high flow release and will be supported by motorized rafts, and boats and cableways. They will be making critical measurements of discharge, suspended sediment transport, and organic drift. At sites downstream from the Paria River (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.

V. COMMUNICATIONS PLAN

The second HFE conducted pursuant to the High Flow Protocol presents an excellent opportunity to increase scientific understanding for the general public and to explain to the public the purpose of the HFE Protocol and expected beneficial impacts. The communications/public affairs aspect of the 2013 HFE will vary depending on if the 2013 HFE includes a public/media event at Glen Canyon Dam, but includes communications product development and media coordination, and perhaps event coordination if an event is planned.

Reclamation's Upper Colorado Region Public Affairs Office in primary coordination with National Park Service and U.S. Geological Survey public affairs contacts and DOI is leading development of communications product development. Several communication products are being developed including a news release and a web page for the 2013 HFE. If the decision is made to proceed with the HFE, and a public event is planned for the HFE, materials will be distributed and social media channels including Facebook and Twitter will be used to alert the media and public to the event and these information items. NPS, FWS, USGS and BIA public affairs contacts are working with Reclamation to develop these products.

If the Leadership Team decides to conduct a fall 2013 HFE, a simple press release will be sent to the media list via e-mail. A final news release will be issued by the Secretary's office. The content of these products will vary depending on whether a public event is also planned as part of the HFE.

VI. POST HFE-REPORTING AND FEEDBACK

Reclamation committed in the HFE EA and FONSI to provide reports on effects of HFEs conducted in a given year. If the Leadership Team decides to conduct a fall 2013 HFE, the Technical Team will coordinate to report initial findings at the 2013 Glen Canyon Dam Adaptive Management Program (GCDAMP) Annual Reporting Meeting on January 28-29, 2013 in Phoenix.

The Technical Team will schedule additional meetings as necessary and will also report ongoing findings at meetings of the GCDAMP Technical Work Group and Adaptive Management Work Group. Reclamation also has a commitment to provide an annual monitoring report to the FWS Arizona Ecological Services Office (AESO) in compliance with the 2011 Biological Opinion; this report will also include a summary of effects of HFEs conducted under the protocol. Also,

under the High Flow Experimental Protocol Memorandum of Agreement for National Historic Preservation Act section 106 compliance, Reclamation will conduct a reporting meeting with the signatories to that agreement, describing the effects of the HFE. Reclamation will use the monitoring information and feedback from AESO and the MOA signatories to inform monitoring for future HFEs, and to design and implement any measures necessary to prevent or control adverse effects of future HFEs.

In addition, GCMRC developed a science plan for the HFE Protocol that describes a program of monitoring and research activities that support ongoing information needs associated with implementation of the HFE Protocol. The approach described in this science plan relies on water quality, sediment, aquatic biology, and other resource monitoring and research projects funded in the GCDAMP Fiscal Year (FY) 2013-14 Budget and Work Plan (BWP, Reclamation and GCMRC 2012). While no new studies were proposed, some existing FY2014 monitoring and research efforts in the BWP have been modified to provide information that is directly relevant to the evaluation of a high flow experiment in 2013. These ongoing projects will inform the effect of future HFEs on the aquatic biology and the fishery of Glen, Marble, and Grand Canyons. These projects from the BWP are further discussed below.

Project H: Understanding the Factors Limiting the Growth of Rainbow Trout in Glen and Marble Canyons will involve monitoring and tagging trout in Glen Canyon prior to the HFE and a recapture effort after the event. This study will help assess the effects of the HFE on the adult and juvenile trout population in Glen Canyon. Project F (The Monitoring of Native and Non-native Fishes in the Mainstem Colorado River and the lower LCR) activities will also include monitoring trout redds this winter and age-0 trout in the spring, monitoring of the trout abundance and distribution in Glen Canyon in January and April 2014, and a system-wide assessment after the HFE, if conducted, in April 2014, which will help assess any system-wide effects of an HFE on the Colorado River fishery. This project also has been monitoring rainbow trout abundance in Marble Canyon, and will serve to help assess how HFEs affect the downstream dispersal of trout from Glen Canyon. Project E (The Humpback Chub Early Life History in and Around the LCR Mainstem) monitors the status of juvenile humpback chub (<150 mm total length) in the mainstem at the LCR quarterly, and monitoring in September 2013 and January 2014 will provide pre- and post-monitoring for a fall 2013 HFE, providing information on its effects to juvenile humpback chub survivorship. Project D (The Humpback Chub Aggregation Studies and Metapopulation Dynamics) conducts annual monitoring of all nine humpback chub aggregations in Marble and Grand Canyon every September and this monitoring will provide important information on the effect of HFEs on all of the humpback chub aggregations. Also, GCMRC will conduct aquatic food base monitoring before, during, and following HFEs at Lees Ferry and Diamond Creek to assess the effect of HFEs on this important resource. This suite of projects will provide the monitoring needed to inform future decision making about the effects of an HFE on key resources such as humpback chub, rainbow trout, and the aquatic food base.

As described in the HFE Protocol EA, the HFE planned for fall 2013 is not being implemented as 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 every 4 years. These activities are described in detail in the BWP. It is also important, however, to evaluate the sandbar building response of each high flow to ensure that 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 2014.

GCMRC scientists have installed digital cameras that capture 5 images every day at 33 sandbar monitoring sites throughout Marble and Grand Canyon 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. They will also be used to assess the rate of post-HFE sandbar erosion. GCMRC scientists tested the effectiveness of this monitoring method based on images collected at 22 sites for the 2008 HFE. The assessment of sandbar gains and losses based on a categorical ranking of changes from the images agreed with the changes detected by detailed topographic surveys at 86% of the sites. 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 2013 HFE relative to the previous events. NPS will also be providing post-HFE monitoring of sandbars using photography.

Remote camera images will be analyzed in conjunction with repeat topographic surveys of 8 sandbars in Upper Marble Canyon in April-May 2014. Although these surveys will be completed about 5 months following the HFE, monitoring of the 2012 HFE found that sufficient HFE-deposits remain to make this evaluation. All of the long-term sandbar monitoring sites will be surveyed in fall 2014 prior to a fall 2014 HFE if one is conducted. This assessment of the size and distribution of HFE deposits approximately 11 months following the 2013 HFE will provide the most informative assessment of sandbar-building effectiveness. These measurements will indicate the degree to which deposits created by the fall 2013 HFE provide enhanced sandbars for use in the following summer recreation season and whether the HFE Protocol is resulting in cumulative increases in sandbar size.

VII. CONSULTATION

Consultation was conducted with the affiliated Tribes. Government-to-Government tribal consultation meetings were held with the Pueblo of Zuni on September 10 and the Navajo Nation on September 11. Reclamation and the GCMRC also presented much of the information in this report that was available at that time to the Adaptive Management Work Group at its August 8-9, 2012 meeting. On October 22, 2013, DOI, Reclamation and GCMRC staff met with the Colorado River Basin states and presented much of the information in this report.

VIII. CONCLUSION

Preparing to conduct an HFE required coordination of many details and effective communication amongst agency technical staff. The Team members relied heavily on multiple 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

HFE Protocol EA and FONSI. The Team's recommendation to proceed with implementation of the HFE is based on the careful research developed over the last 15 years, the specific information developed relevant to implementation of an HFE in November 2013 as described in this report, and the inclusion of monitoring of the HFE to ensure continued learning and adaptation. The success of this important initiative is in large part due to the commitment of the Team to ensuring that the HFE Protocol is a success.

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RECLAMATION

Managing Water in the West

Fall 2013 HFE Protocol Decision Process

Glen Knowles
Katrina Grantz
Nick Williams

Bureau of Reclamation
DOI Leadership Team
October 24, 2013

U.S. Department of the Interior
Bureau of Reclamation

HFE Decision Making Process

1. Planning and Budgeting Component
   - Annual resource status assessment
   - GCDAMP Annual Reporting (Jan 28-29, 2013)
   - GCDAMP Budget and Work Plan Process
2. Modeling Component
3. Decision and Implementation Component
   - Review Modeling Component
   - Review Status of Resources
   - GCDAMP- Consultation with agencies and tribes, AMWG and TWG presentations
   - Basin States Consultation
   - DOI/DOE Technical Team Recommendation/DOI GCD Leadership Team Decision

RECLAMATION

HFE Protocol Parameters

Possible Timing

- **March-April and October-November through 2020**
- **Spring HFEs will not be considered until 2015**

Duration range

- **1 hr – 96 hrs (at full magnitude)**
- **1 ½ days – 6 ½ days (including ramping)**

Magnitude range

- **31,500 cfs – 45,000 cfs (depends on maintenance and reservoir conditions)**

Ramping rates

- **Ramping rates are defined by 1996 ROD and 1997 Glen Canyon Dam Operating Criteria (62 FR 9447, 4,000 cfs up and 1,500 cfs down)**

Model Constraints

- **"the Leadership Team's view is that it would be inappropriate to adjust the model output in a way that would increase the amount of water to be released or increase power costs associated with an HFE release." November 7, 2012 memo from Anne Castle**

RECLAMATION

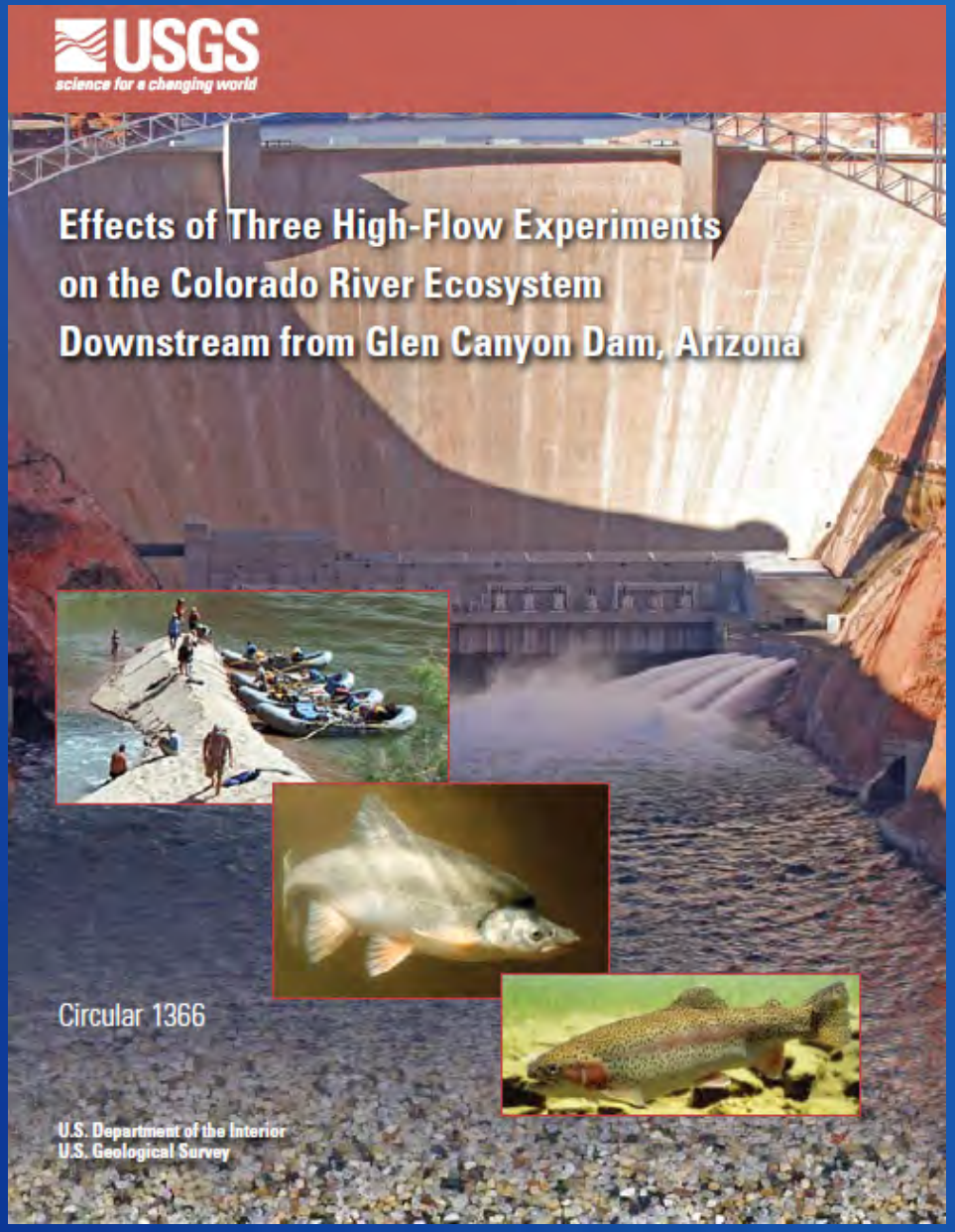
HFE Protocol Reporting

1. GCDAMP Annual Reporting meeting every January.
2. Updates at TWG and AMWG GCDAMP meetings.
3. Meet with the HFE MOA consulting parties and consult with tribes as needed.
4. The HFE Technical Team report to the Secretary's Glen Canyon Leadership Team for their consideration in HFE decisions.
5. US Fish and Wildlife Service report early each year on the effects of prior HFEs and conservation measures of the FWS biological opinion (first report Feb 2014).

RECLAMATION

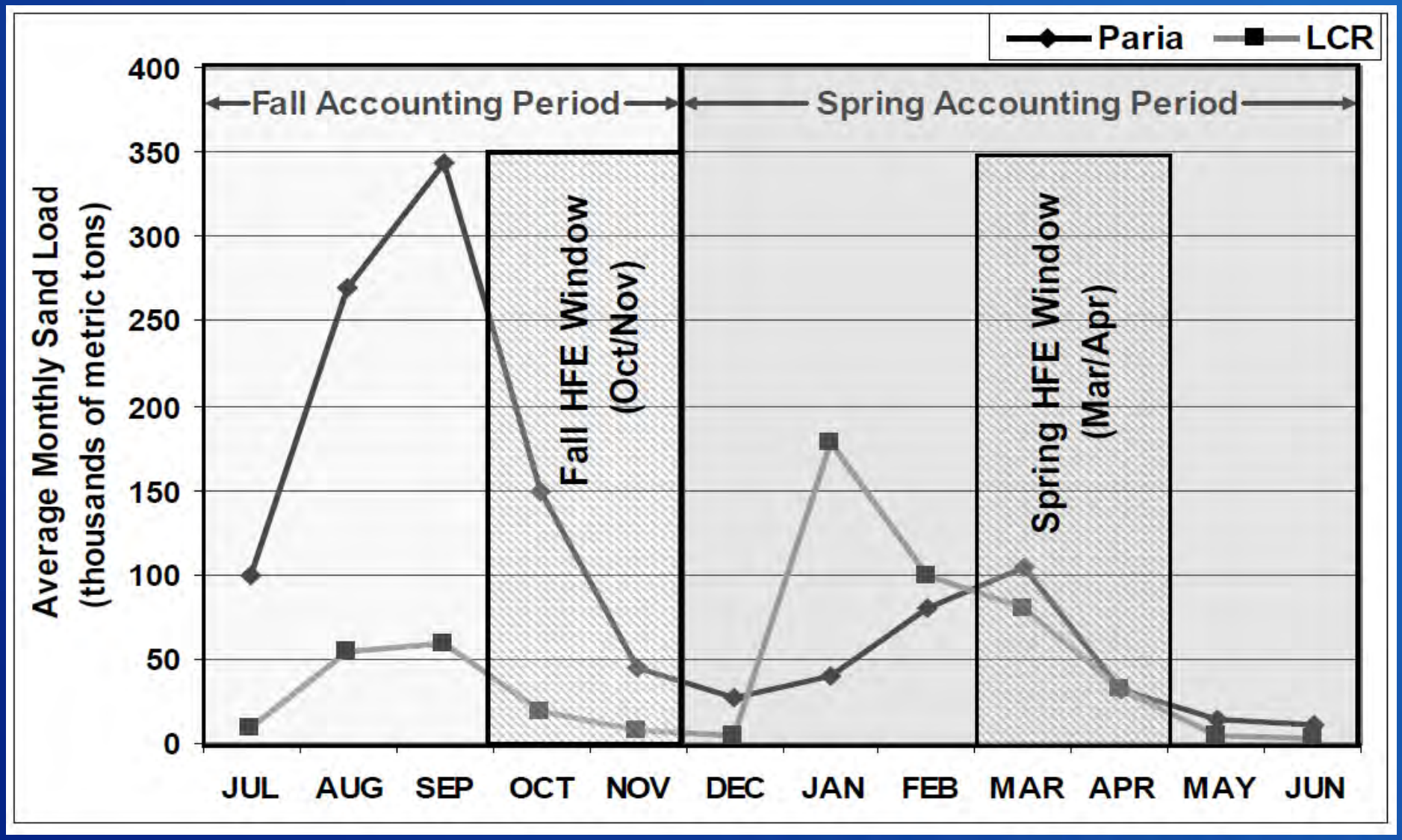
USGS Circular 1366

- Synthesis report of results of 1996, 2004, 2008 HFEs.
- Extensive summary of effects to physical and biological resources.
- Forms basis for Tech Team Report
- Available online at *pubs.**usgs**.gov/circ/**1366**/c**1366**.pdf*



RECLAMATION

Modeling Component



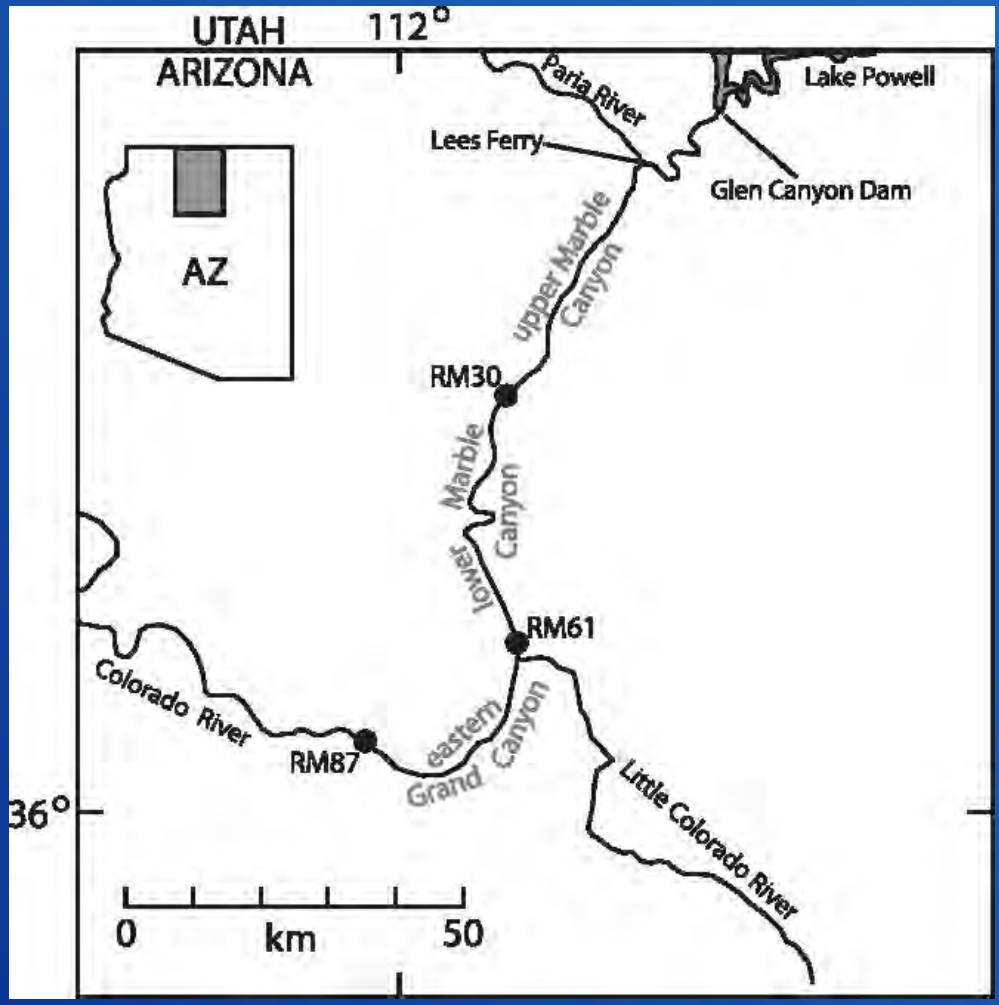
RECLAMATION

Sand Budget Model

- Developed from USGS model (Wright et al. 2010)
  - Empirically based rating curves
  - Computes sand budget in 3 reaches
- Inputs:
  - Hourly Paria sand load
  - Antecedent conditions (bed thickness, median grain size)
- Determines HFE peak and duration
  - Potential HFE range:
    - 45,000 to 31,000 cfs, 96 hours to 1 hour
- Output
  - Sand mass balance between RM 0 and RM 61

Model Reaches

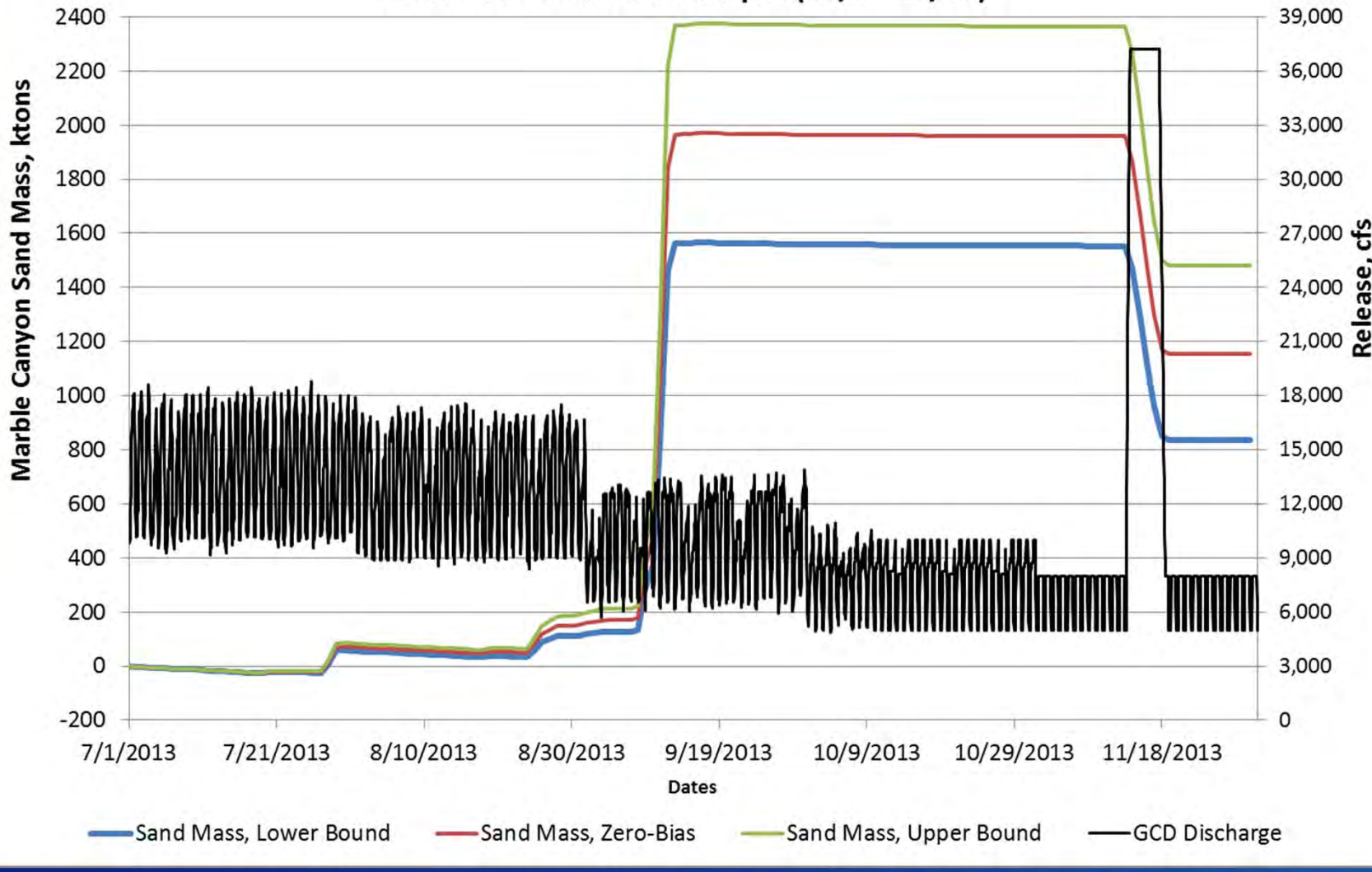
- **Sand Budget Model Reaches**
  - **RM30 (upper Marble Canyon)**
  - **RM61 (lower Marble Canyon)**
  - **RM87 (eastern Grand Canyon)**



RECLAMATION

****PROVISIONAL****

Sand Budget Model Results, 2013 Jul - Nov
Paria Sand Input through 9/30/2013
Zero Future Paria Sand Input (10/1 - 11/30)



RECLAMATION

2013 HFE Recomendation

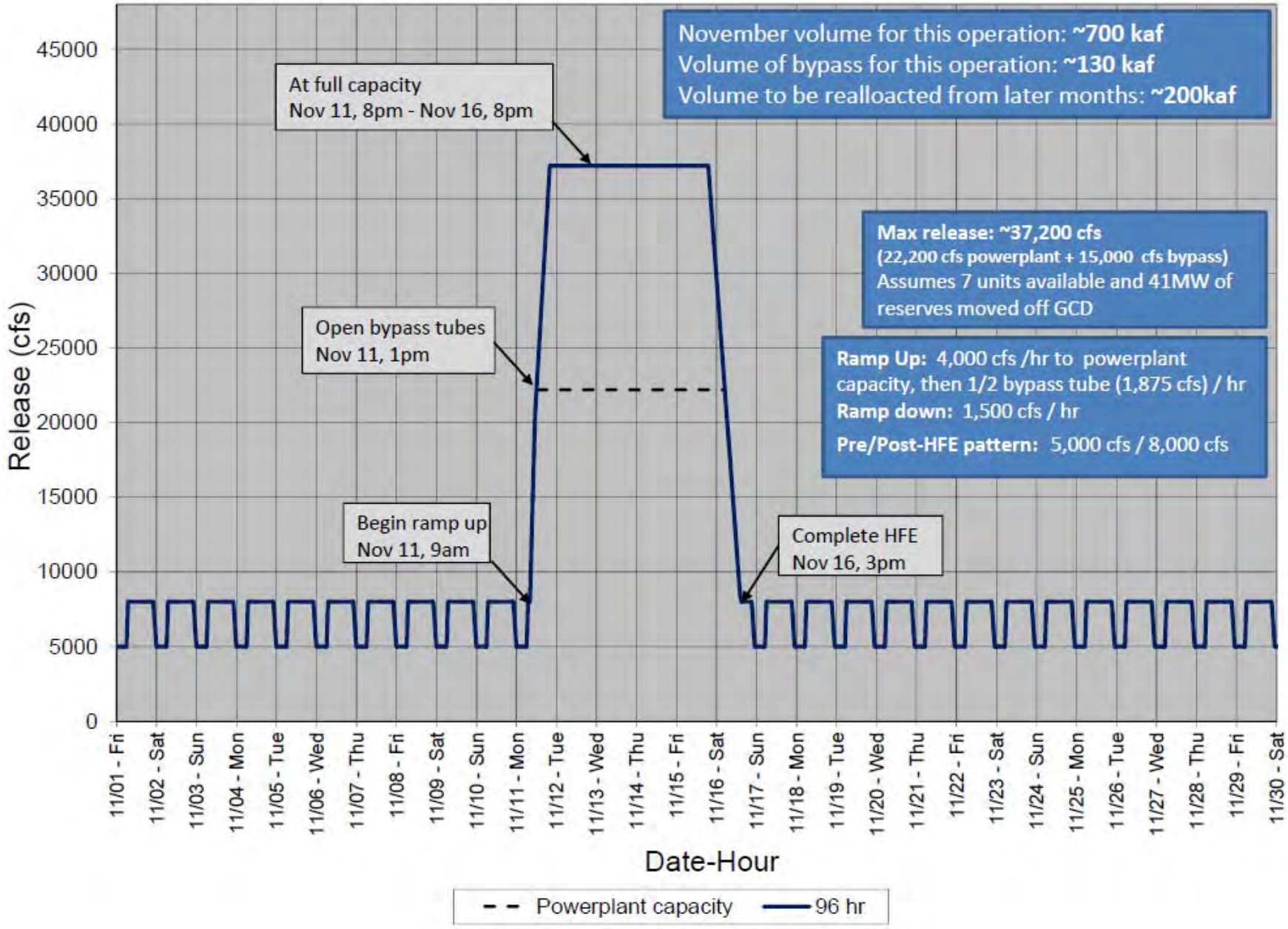
DOI/DOE Technical Team recommends that the HFE:

- Ramp up from base releases at 4,000 cfs/hr at until reaching powerplant capacity (~22,200 cfs)
- Ramp up from powerplant capacity to full bypass (~37,200 cfs) at half a bypass tube (~1,875 cfs, consistent with prior HFEs) per hour in 8 hrs
- Stay at peak release (37,200 cfs) for 96 hrs
- Ramp down from peak release to base releases at 1,500 cfs/hr

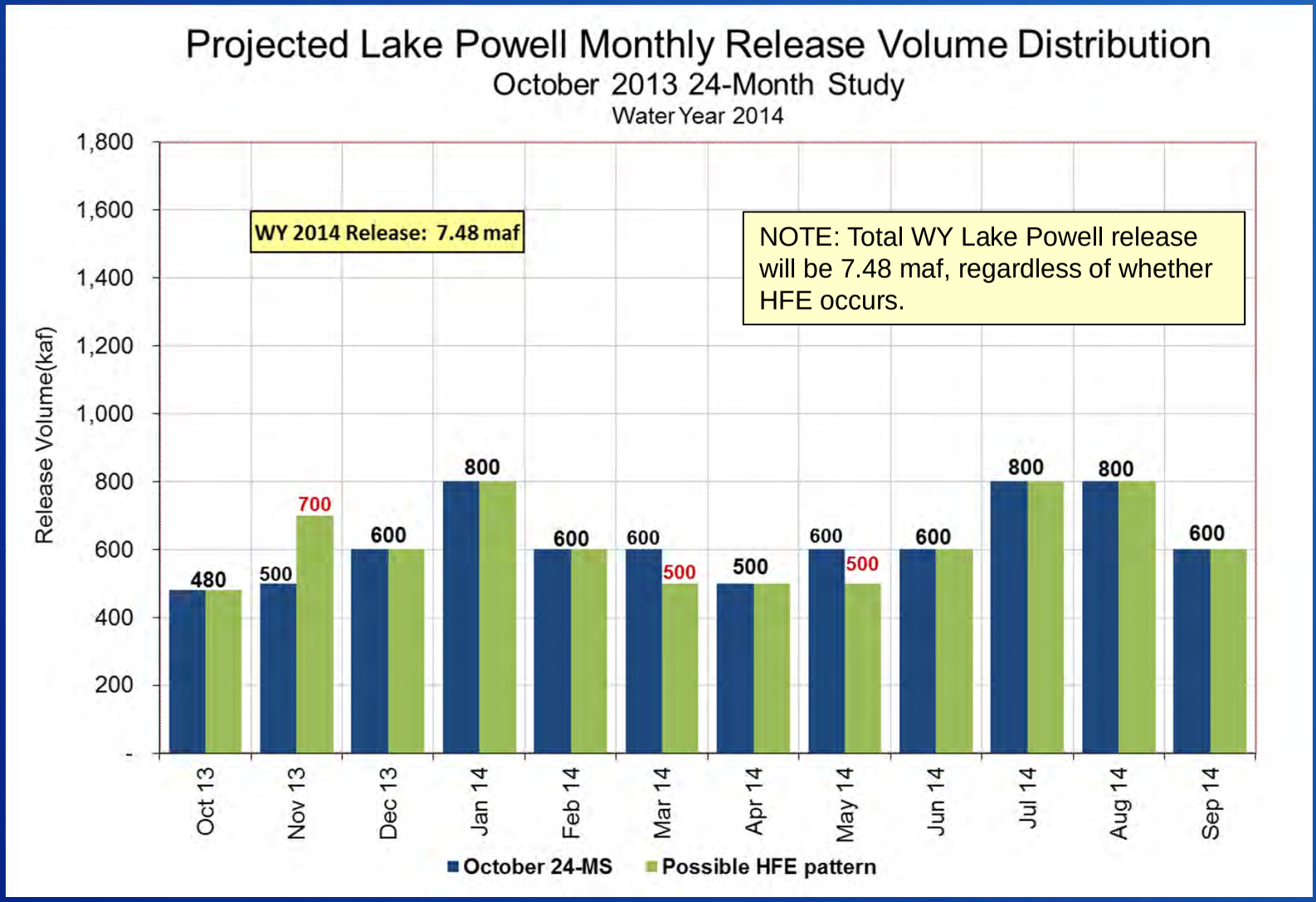
- Begin ramp up from 5,000 cfs at 9:00 am on November 11
- Reach powerplant capacity at 1:00 pm November 11
- Open bypass tubes at 2:00 pm November 11
- Reach full bypass at 8:00 pm on November 11
- Begin ramp-down from bypass at 8:00 pm on November 15
- Complete HFE (back to 8,000 cfs) at 3:00 pm on November 16

RECLAMATION

Possible Glen Canyon Dam HFE Release Pattern



Possible Monthly Release redistribution



RECLAMATION

Possible Monthly Release redistribution

7.48 maf Annual Release Pattern (values in kaf)		
	No HFE	Proposed HFE
Oct	480	480
Nov	500	**700**
Dec	600	600
Jan	800	800
Feb	600	600
Mar	600	**500**
Apr	500	500
May	600	**500**
Jun	600	600
Jul	800	800
Aug	800	800
Sep	600	600
WY total	7480	7480

RECLAMATION

Resource Status Assessment

Sediment Resources
In-channel sediment storage
Sandbar campable area
High-elevation sand deposits

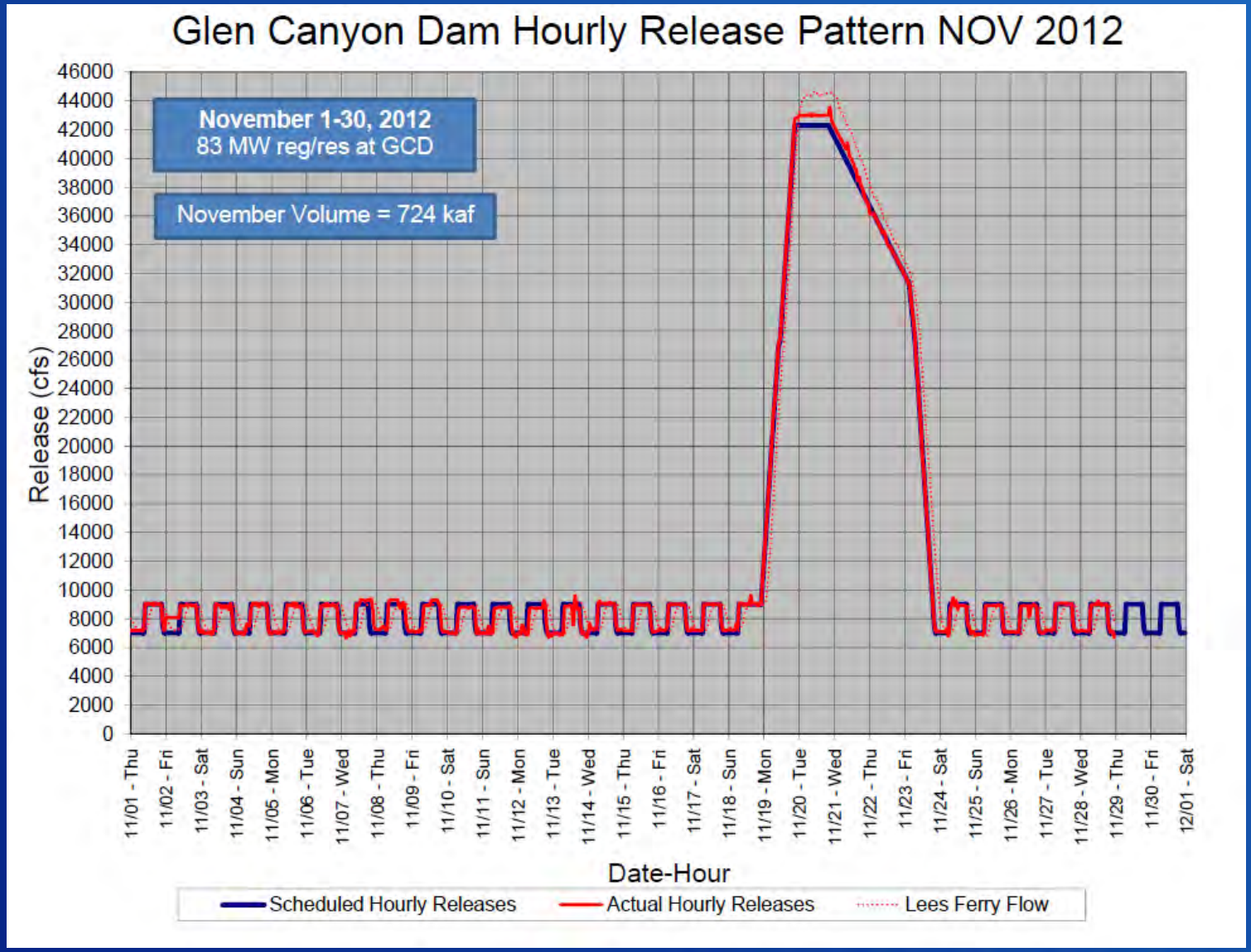
Cultural Resources
Archaeological site condition and stability
Access to archaeological sites by tribes

Biological Resources
Aquatic food base
Lees Ferry trout population
Lees Ferry fishery recreation experience quality
Endangered humpback chub and other fish abundance
Riparian vegetation

Hydropower and water delivery
Water quality
Water delivery
Dam maintenance
Hydropower production and marketable capacity

RECLAMATION

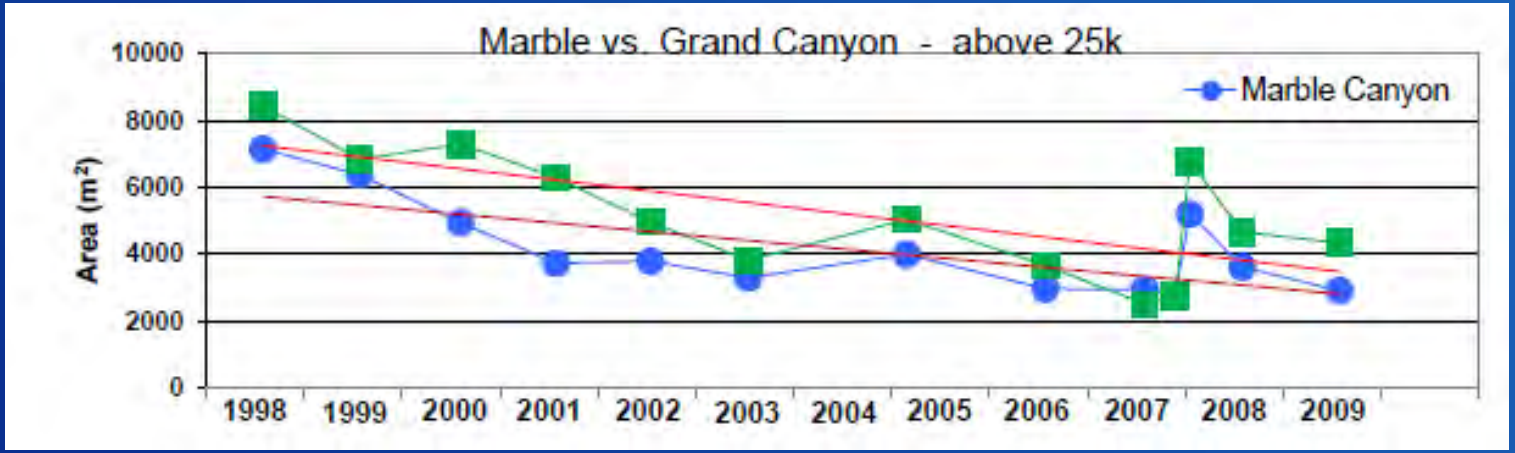
2012 High Flow Experiment

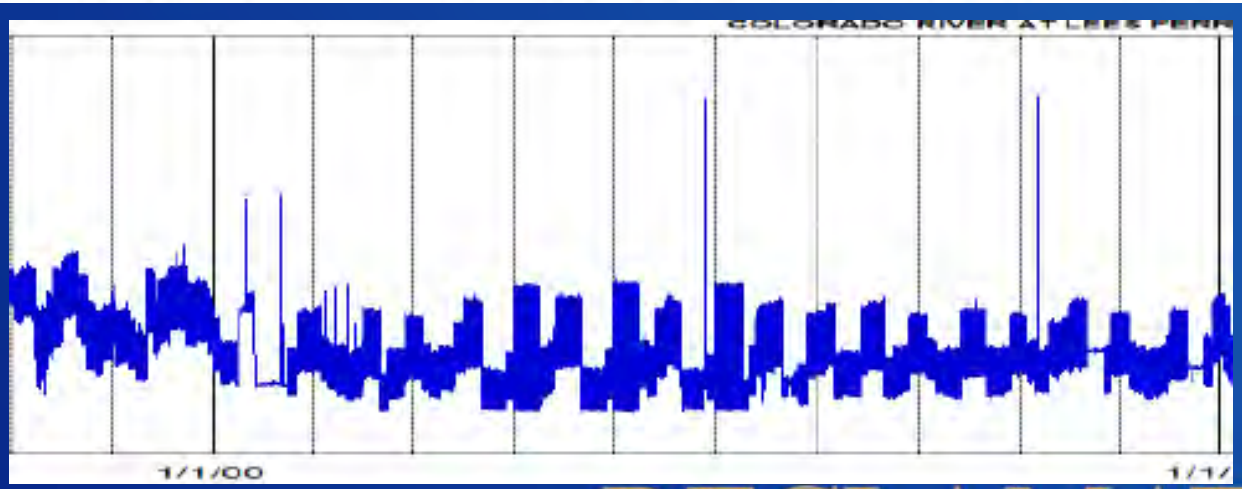


RECLAMATION

Sediment – Campsite Area

Sand bar size and campsite area have been decreasing, but have increased with each HFE, including 2012; the protocol will increase frequency of HFEs which should improve this resource.





RECLAMATION

Cultural Resources

- HFE-caused erosion is a consideration, most sites already mitigated.
- The HFE MOA requires reporting and consultation after HFEs.
- Reclamation met with MOA signatories Feb. 12-13, 2013.
- No impacts to sites were identified from the 2012 HFE, no reports of issues with access to sites.
- The MOA for the HFE Protocol requires notification to all the consulting parties at least 30 days in advance of a HFE and will consult with tribes to resolve any issues.

A 30-day letter was sent notifying MOA signatories of a possible HFE in November 2013 on September 30, 2013.

RECLAMATION

Hydropower/Socioeconomic Impacts

- HFEs effect hydropower production negatively:
  - Water released during an HFE counts against the annual release and is not available to be programmed in peaking releases during high demand months (HFE windows of Mar/Apr and Oct/Nov are low-demand shoulder months).
  - 30-40% of HFE releases bypass the power plant.
  - Lake Powell is lowered, reducing hydrologic head.
- Other impacts – Hualapai Enterprise, regional.

Western Area Power Administration estimate hydropower impact of $1.74M from Fall 2013 HFE

(2012 HFE was $1.318).

RECLAMATION

Lees Ferry Rainbow Trout

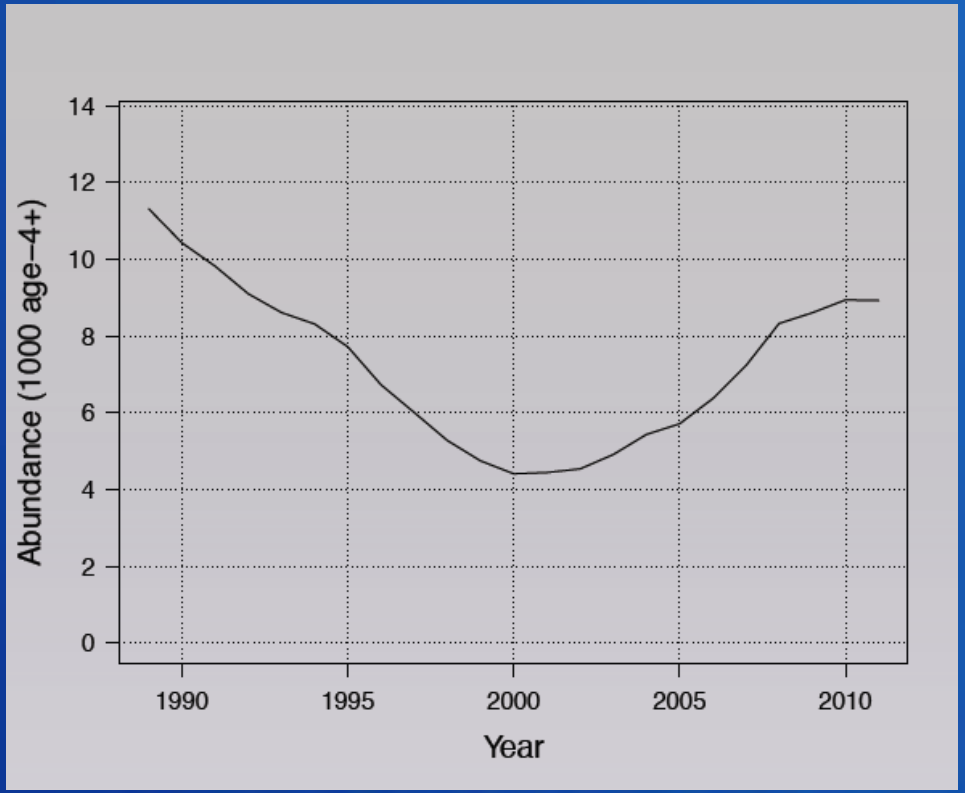
- 1996 and 2008 Spring HFEs led to increases in rainbow trout in Lees Ferry, 2011 high steady releases led to very large recruitment event in Lees Ferry.
- Rainbow trout moving into Marble Canyon, no increase yet at Little Colorado River.
- Effects of Fall HFEs on Lees Ferry Trout is poorly understood.
- 2004 Fall HFE appears to have resulted in displacement or mortality of very young trout.
- Condition overall declined slightly following 2004 November HFE.
- Appears that rainbow trout declined system-wide over period of 2012 HFE, although near removal trigger number at LCR.

RECLAMATION

Humpback Chub and other native fish

Humpback chub adult population size in the Little Colorado River Using Age-Structured Mark Recapture Estimate (ASMR) 2012

- **9,000 adults in 2012**
- **Increases over period with HFEs in 2004, 2008, 2012**
- **Other native fish populations have responded similarly**



RECLAMATION

Humpback Chub and other native fish

Humpback chub sub-adult and juveniles, recruitment

- **Some evidence that HFEs can cause displacement.**
- **Improved monitoring is helping evaluate effects to survivorship; survivorship in mainstem appeared to remain stable over the period of the 2012 HFE.**

RECLAMATION

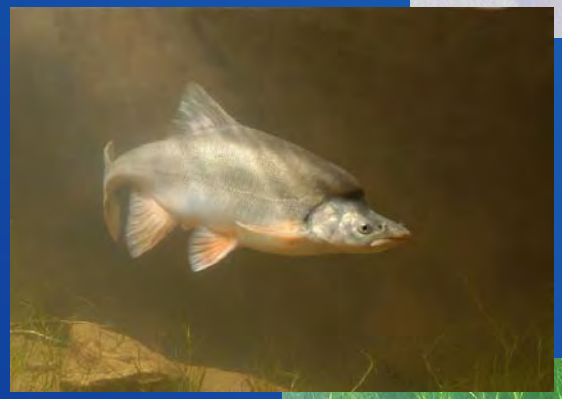
Aquatic Food Base

- Primary effect of HFEs on Food Base is scouring in Lees Ferry of algae and aquatic plants and animals.
- The degree of this effect is proportional to discharge, little effect at 31,500.
- Little effect at LCR.
- Food base recovered from the 2008 HFE in 4 months.
- New Zealand mud snails were significantly reduced, a beneficial effect.
- Multiple HFEs could shift to flood-tolerant species, a potential benefit to higher trophic levels (trout).
- Food base little affected by 2012 fall HFE, more blackflies in drift Jan. than Sept.

RECLAMATION

Biological Resources

- 2012 HFE appears to have had little effect on food base or trout and native fishery.
- Trout populations in Lees Ferry and downstream may have decreased, but not significantly so.
- None of the triggers for nonnative fish control have been met, although rainbow trout numbers at the LCR are near the trigger.
- Humpback chub status appears to be stable or increasing.



RECLAMATION