Glen Canyon Dam Adaptive Management Work Group
Agenda Item Information
August 24-25, 2010

Agenda Item

Fiscal Year 2011-12 Hydrograph

Action Requested

✓ See the motion, below, passed by TWG.

Presenters

- Larry Walkoviak, Regional Director, Bureau of Reclamation
- Jane Lyder, Deputy Assistant Secretary for Fish and Wildlife and Parks, Department of the Interior
- Paul Grams, Supervisory Hydrologist, Grand Canyon Monitoring and Research Center
- LaVerne Kyriss, Colorado River Storage Project Manager, Western Area Power Administration

Previous Action Taken

✓ On July 23, 2010, Anne Castle sent to the AMWG email list the Federal agencies' preliminary recommendation for the 2011 hydrograph. That recommendation is attached to this AIF.

✓ By TWG: At its July 2010 conference call, TWG passed the following motion:
The TWG recommends to AMWG the hydrograph be considered as proposed by the Federal agencies in the July 23, 2010 hydrograph recommendation for WY 2011. This consideration should include a more detailed explanation of the expected resource results, the proposed impacts of energy and capacity for each of the three scenarios, and operational concerns of any of the three scenarios.

Relevant Science

Wright, S.A., and Grams, P.E., 2010, Evaluation of Water Year 2011 Glen Canyon Dam Flow Release Scenarios on Downstream Sand Storage along the Colorado River: U.S. Geological Survey Open-File Report 2010-1113. (http://pubs.usgs.gov/of/2010/1133/)

This report describes numerical modeling simulations of sand transport and sand budgets for reaches of the Colorado River below Glen Canyon Dam. Two hypothetical Water Year 2011 annual release volumes were each evaluated with six hypothetical operational scenarios. The six operational scenarios include the current operation, scenarios with modifications to the monthly distribution of releases, and scenarios with modifications to daily flow fluctuations. Uncertainties in model predictions were evaluated by conducting simulations with error estimates for tributary inputs and mainstem transport rates. The modeling results illustrate the dependence of sand transport rates and sand budgets on the annual release volumes as well as the within year operating rules. The six operational scenarios were ranked with respect to the predicted annual sand budgets for Marble Canyon and eastern Grand Canyon reaches. While the actual WY 2011 annual release volume and levels of tributary inputs are unknown, the hypothetical conditions simulated and reported herein provide reasonable comparisons between the operational scenarios, in a relative sense, that may be used by decision makers within the Glen Canyon Dam Adaptive Management Program.

Background Information

The five Interior agencies and the Western Area Power Administration developed a proposed hydrograph for the projected operation of Glen Canyon Dam during the 2011 water year. The attached is the preliminary recommendation for the 2011 hydrograph, accompanied by additional information.

This recommended hydrograph works within the existing operational constraints for Glen Canyon Dam (e.g., the MLFF regime selected in the 1996 ROD, the September-October Steady Flow Experiment approved in Feb. 2008), while also potentially enhancing downstream resource protection in Grand Canyon National Park and Glen Canyon National Recreation Area.

It is based on projected hydrological conditions, and reflects a range of potential annual release volumes from Glen Canyon Dam, based on minimum, maximum, and most probable inflow scenarios. The recommended operations described in the attachment are based on the current scientific studies concerning preservation of resources downstream of Glen Canyon Dam, and reflect that more stable and relatively lower monthly volume releases are most effective at limiting erosion of sandbars, retaining new sand, and improving access to backwaters by fish. Retention of sand is desirable because sandbars create habitat for native plants and animals, provide camping beaches for river runners and hikers, and act as the source of sediment needed to protect archeological resources. Our program of adaptive management requires that we learn from and take advantage of new science as it is developed.

The attachment details some of the key considerations that went into the development of this recommendation, and includes draft language that Reclamation is considering for inclusion into the 2011 Colorado River Annual Operating Plan to describe the 2011 water year. This preliminary recommendation represents significant work and input on the part of each of the five Interior AMP agencies and the Western Area Power Administration.

TWG Report

The TWG considered two recommendations for a WY 2011 hydrograph at its July conference call. Rick Johnson (Grand Canyon Trust) provided a proposal that implemented a version of Year-Round Steady Flows if the volume forecast is greater than 9.25 maf, as well as an HFE if enriched conditions were to occur. The motion was considered and failed 11-2 (with 4 abstentions).

A joint DOI/DOE hydrograph proposal was also considered. Reclamation explained the proposal and the National Park Service discussed the expected benefits, including that the concept behind the proposal was to retain as much sediment as possible within the constraints of the ROD. Western explained that it did not expect impacts on power. The TWG discussed several issues, including whether the proposal was within MLFF and the need for additional information about energy, resource, and operational issues.

TWG recommended that the hydrograph be considered as proposed by the Federal agencies in the July 23, 2010 recommendation, with a more detailed explanation of expected resource results, energy and capacity impacts, and operational concerns for any of the three scenarios.

DEPARTMENT OF THE INTERIOR AND DEPARTMENT OF ENERGY OPERATING HYDROGRAPH RECOMMENDATIONS FOR GLEN CANYON DAM

July 23, 2010

Introduction: The Federal agencies involved in the Glen Canyon Dam Adaptive Management program have jointly drafted this recommendation for the projected operation of Glen Canyon Dam in 2011. This recommendation is consistent with the Law of the River and the Grand Canyon Protection Act, which states that the Secretary of Interior will operate Glen Canyon Dam "in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use." This recommendation is designed to enhance protection of downstream resources. It can be implemented consistent with existing environmental and operational limitations applicable to Glen Canyon Dam, the annual release requirements of the 2007 Interim Guidelines, applicable operating limitations for Glen Canyon Dam, and the 1996 Glen Canyon Dam Record of Decision (ROD). This approach to operations does not modify the Interim Guidelines, operating criteria or ROD and is an adaptive management-based experimental approach to 2011 operations that falls within the parameters of the Modified Low Fluctuating Flow alternative adopted in the ROD.

The National Park Service and U.S. Fish and Wildlife Service provided the initial draft of the operational concepts included in the recommendation to enhance protection of downstream resources. The Bureau of Reclamation provided technical support, clarifications, and refinements to assure these operational concepts would be consistent with the annual release requirements of the Interim Guidelines and applicable operational limitations for Glen Canyon Dam. The Bureau of Indian Affairs has had the opportunity to participate in the development of this recommendation and has reviewed the drafts. The USGS Grand Canyon Monitoring and Research Center has reviewed this recommendation and added its comments. Western Area Power Administration has evaluated the recommendation, participated in discussions concerning its operational impacts, and supports it.

It is Interior's intention to share this proposed recommendation with stakeholders in the Glen Canyon Dam Adaptive Management Work Group prior to the beginning of the 2011 water year, so as to provide an opportunity for input from the participating AMWG stakeholders. It is also Interior's intention to include a projected operation for Glen Canyon Dam during the 2011 water year in a Draft 2011 Annual Operating Plan for Colorado River Reservoirs at the earliest appropriate opportunity. In addition, language will be added to the 2011 Annual Operating Plan to reference the ongoing NEPA process

to develop an Experimental Protocol for High-Flow Releases from Glen Canyon Dam, and such language will note that pending completion of the ongoing NEPA process, if a high-flow release is undertaken in Water Year 2011, projected operations of Glen Canyon Dam will be modified consistent with the final experimental protocol. A draft of the information proposed to be added to the Draft 2011 AOP is attached as Attachment 1 to this summary.

Purpose: To develop recommendations for operational 2011 hydrographs based on anticipated possible annual release volumes for Water Year 2011 from Glen Canyon Dam consistent with Section 1802 of the Grand Canyon Protection Act. The operational hydrographs are within the framework of the 1996 Record of Decision and Modified Low Fluctuating Flow (MLFF) operation, consistent with balancing other resources, including power production, and recognize the variability of possible annual release volumes from Glen Canyon Dam under the 2007 Interim Guidelines.

The concept is to apply sound science principles within the framework of adaptive management to adjust the timing of water deliveries to protect and restore flow-dependent resource conditions. The fundamental principle is conservation of the sand resource in order to minimize sand export to Lake Mead and degradation of sandbar resources within the Colorado River ecosystem (CRE). (Note: Recently, a new sand routing model was developed for the CRE [Wright and others, 2010] that evaluates a variety of operational hydrographs from Glen Canyon Dam [including typical MLFF releases] using average annual sand production from both the Paria and Little Colorado Rivers.)

Two scenarios are presented below based upon the range of probable 2011 water year releases from Glen Canyon Dam. It is anticipated that the annual release volumes would likely fall within two sets of annual operations as described below. The agencies expect that the projected releases will be modified as the year progresses to address changing conditions in the same manner as typically occurs. Proposed parameters for such ongoing operational modifications are also provided.

Water Year Scenario #1: 8.23 – 9.0 million acre feet (maf) - Balancing

Objective: To implement reasonable measures to minimize export of tributary sand inputs delivered to the main channel so as to benefit the lower elevation ecosystem of Grand Canyon National Park, including the ecological processes and functions that affect native flora and fauna, archeological and cultural resources, recreation uses, and other values for which Grand Canyon National Park was established.

Science Principles: For any given annual volume of water released from the dam, sand export is known to be minimized by reducing daily/monthly/seasonal variations in dam

releases. (Rubin and others, 2002; Wright and others, 2005; Wright and others, 2008; ASCE, 1975; USDOI, 1995; Topping and others, 2006).

Proposed Operating Parameters:

- Monthly Release Volumes will be adjusted each month based on the most current forecast of the annual release required by the 2007 Interim Guidelines.
- Monthly Release Volumes will vary within a range of +/- 100,000 acre-feet from the Average Monthly Release Volume over the water year (defined in the next bullet). This monthly operational flexibility will be used for existing power production operations under the Modified Low Fluctuating Flow (MLFF) alternative selected by the 1996 ROD and contained in the 1995 FEIS. Modifications of monthly release volumes will be made in consultation with Western Area Power Administration.
- Average Monthly Release Volumes will be the amount of remaining water to release for the water year divided by the remaining months in the water year (excluding the September/October steady flows).
- Daily peaks will be no greater than 16,000 cubic feet per second (cfs), with all other flow parameters of the current MLFF in place.
- Steady flows in September and October per the 2008 HFE Environmental Assessment (EA), with monthly volumes of approximately 500,000 to 600,000 acre feet (about 8,000 to 10,000 cfs).

Expected Resource Results: Under this scenario, at the lower release volume of 8.23 maf, accumulation of some portion of new tributary sand inputs would likely occur in both Marble and Grand Canyons (Wright and Grams, 2010), but it is less certain that any new sand inputs would accumulate at the higher 9.0 maf volume. Recreational camping beaches would be expected to continue to degrade at previously reported rates associated with MLFF, with perhaps lower erosion rates of camps in summer and winter months (Kaplinski and others, 2005). It is not expected that there would be an increase in size and distribution of camping beaches throughout the river corridor; recreational rafting safety would be unaffected. Terrestrial and river edge aquatic riparian habitats, archaeological sites and historic properties would show no improvement. With lower summer peaks associated with this scenario there may be some vegetation encroachment on sand bars and camping beaches.

Water Year Scenario #2: Above 9.0 million acre feet (maf) - Equalization

Objectives: To implement reasonable measures to minimize erosion of sandbar deposits for purposes of reducing degradation to the lower elevation ecosystem of Grand Canyon National Park, including the ecological processes and functions that affect native flora and fauna, archeological and cultural resources, recreation uses, and other values for which Grand Canyon National Park was established.

Science Principle: For any given annual volume release of water, sandbar erosion and sediment transport is minimized by reducing both daily/monthly/seasonal variations in volume releases, and by minimizing subsequent daily variations in discharges. (Rubin and others, 2002; Wright and others, 2005; Wright and others, 2008; ASCE, 1975; USDOI, 1995; Topping and others, 2006).

Proposed Operating Parameters:

- Monthly Release Volumes will be adjusted each month based on the most current forecast of the annual release required by the 2007 Interim Guidelines.
- Monthly Release Volumes will vary within a range of +/- 100,000 acre-feet from the Average Monthly Release Volume over the water year (defined in the next bullet). This operational flexibility will be used for existing power production operations under the Modified Low Fluctuating Flow (MLFF) alternative selected by the 1996 ROD and contained in the 1995 FEIS. Modifications of monthly release volumes will be made in consultation with Western Area Power Administration.
- Average Monthly Release Volumes will be the amount of remaining water to release for the water year divided by the remaining months in the water year (excluding the September/October steady flows).
- Daily peaks will be no greater than 22,000 cfs, with all other flow parameters of the current MLFF in place (including daily range in fluctuating flows up to 8,000 cfs), including the fall steady flows required in the 2008 High Flow Experiment Environmental Assessment (2008 HFE EA).
- Steady flows in September and October per the 2008 HFE Environmental Assessment (EA).

Expected Resource Results: Under this scenario, loss of recreational camping beaches would be reduced to the extent possible by minimizing sediment transport (Wright and Grams, 2010). Recreational rafting values may benefit from the more limited fluctuations. Terrestrial and aquatic river edge riparian habitats and archaeological sites may continue to degrade, but the amount of loss may be reduced under this recommended flow regime.

Supporting Research Publications

ASCE, 1975, Sedimentation Engineering, Vanoni, V.A. ed.: ASCE Manuals and Reports on Engineering Practice, no. 54, 745 p.

Gloss, Steven P., Jeffrey E. Lovich, and Theodore S. Melis, 2005. The State of the Colorado River Ecosystem in Grand Canyon: A Report of the Grand Canyon Monitoring and Research Center 1991–2004, USGS Circular 1282

Grams and others, 2010, 2008 High-Flow Experiment at Glen Canyon Dam: Morphologic Response of Eddy-Deposited Sandbars and Associated Aquatic Backwater Habitats along the Colorado River in Grand Canyon, Paul E. Grams, John C. Schmidt, Matthew E. Andersen [currently available at www.gcmrc.gov and http://www.usgs.gov/pubprod/pubs.html as U.S. Geological Survey Open File Report 2010-1032],

Hazel and others, 2010, Sandbar Response Following the 2008 High-Flow Experiment on the Colorado River in Marble and Grand Canyons, Arizona, Joe E. Hazel Jr., Paul E. Grams, John C. Schmidt and Matt Kaplinski [currently available at: www.gcmrc.gov and http://www.usgs.gov/pubprod/pubs.html as U.S. Geological Survey Scientific Research Investigations Report 2010-5015]Kaplinski, M., 2005, State of the Colorado River Ecosystem, *in* eds. Gloss and others, U.S. Geological Survey Circular 1282, Chapter 12, pp. 193-206

Melis, T.S., and several other authors, 2010, 2008 High-Flow Experiment at Glen Canyon Dam Benefits Colorado River Resources in Grand Canyon National Park, U.S. Geological Survey Fact Sheet 2010-3009, 4 p.

Melis, T.S., Topping, D.J., Rubin, D.M., Wright, S.A.
2007 Research furthers conservation of Grand Canyon sandbars: *U.S. Geological Survey Fact Sheet* 2007-3020, 4 p.

Rubin, D.M., Topping, D.J., Schmidt, J.C., Hazel, J., Kaplinski, M., and Melis, T.S.
2002 Recent sediment studies refute Glen Canyon Dam hypothesis: *Eos*, Transactions, American Geophysical Union, Vol. 83, No. 25, 18 June 2002, Pages 273, 277-278

Topping, D.J., Rubin, D.M., Schmidt, J.C., Hazel, J.E., Jr., Melis, T.S., Wright, S.A., Kaplinski, M., Draut, A.E., and Breedlove, M.J. 2006 Comparison of sediment-transport and bar-response results from the 1996 and 2004 controlled-flood experiments on the Colorado River in Grand Canyon: CD-ROM *Proceedings of the 8th Federal Inter-Agency Sedimentation Conference*, Reno, Nevada, April 2-6, 2006, ISBN 0-9779007-1-1.

U.S. Department of the Interior, 1995 Final Environmental Impact Statement on the Operation of Glen Canyon Dam. Bureau of Reclamation, U.S. Government Printing Office, Denver.

U.S. Department of the Interior, Experimental releases from Glen Canyon Dam, 2008 Coconino County, Arizona, 2008 through 2012. Bureau of Reclamation.

Wright, S.A., Melis, T.S., Topping, D.M. and Rubin, D.M., 2005, State of the Colorado River Ecosystem, *in* eds. Gloss and others, U.S. Geological Survey Circular 1282, Chapter 1, pp. 1-16

Wright, S.A., Schmidt, J.C., Melis, T.S., Topping, D.J., and Rubin, D.M. Is there enough 2008Sand? Evaluating the fate of Grand Canyon sandbars. In *GSA Today*, v. 18, no. 8, doi: 0.1130/GSATG12A.11

Wright, S.A. and Grams, P.E., in press, Evaluation of glen Canyon Dam flow release scenarios on downstream sand storage along the Colorado River, Water Year 2011, U.S. Geological Survey Open File Report 2010-xxxx, ?p.

Wright, S.A., Topping, D.J., Rubin, D.M. and Melis, T.S., 2010, An approach for modeling sediment budgets in supply-limited rivers, Water Resources Research, [available: http://www.agu.org/journals/wr/papersinpress.shtml#id2009WR008600]

Attachment 1 – Information Proposed for inclusion in the Draft 2011 Annual Operating Plan (note: Table 9 metric conversion will be compiled)

Table 8. Range of Projected Monthly Releases from Lake Powell Under Water Year 2011 Inflow Scenarios (English Units)[1]

Month	Minimum Probable Inflow Scenario Projected Monthly Release Volume 11.5 maf dropping to 9 maf in March	Most Probable Inflow Scenario Projected Monthly Release Volume at Remaining at 11.5 maf	Maximum Probable Inflow Scenario Projected Monthly Release Volume 11.5 maf increasing to 13 maf/yr in Feb/March
October 2010	492	492	492
November 2010	927	927	927
December 2010	938	938	938
January 2011	951	951	951
February 2011	965	965	965
March 2011	982	982	1065
April 2011	554	1001	1266
May 2011	579	1027	1390
June 2011	612	1060	1391
July 2011	724	1209	1391
August 2011	800	1210	1391
September 2011	476	738	833
Water Year 2011	**9 maf**	**11.5 maf**	**13 maf**

Units are in 1,000 af/month.

Most and Max Probable will likely be adjusted somewhat in August 24 Month Study based on that month's forecast. These numbers should be fairly representative of the range of possibilities.

New Text proposed to be added to June 1, 2010 Draft AOP on page 30, at ln. 4:

On December 10, 2009, Secretary of the Interior Ken Salazar announced that the Department of the Interior would initiate development of a High-Flow Experimental Protocol (Protocol) for releases from Glen Canyon Dam as part of the ongoing implementation of the Glen Canyon Dam Adaptive Management Program (AMP). High-flow experimental releases have been undertaken in the past and will be further analyzed and implemented pursuant to the direction of the Secretary to assess the ability of such releases to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established. As part of the AMP, the Department's effort to develop the Protocol is a component of its ongoing responsibility to comply with the requirements and obligations established by the Grand Canyon Protection Act of 1992 (Pub. L. 102–575) (GCPA). Further information on the Protocol may be found at 74 Fed. Reg. 69361 (Dec. 31, 2009).

The High-Flow Experimental Protocol is currently the subject of an ongoing analysis, including analysis pursuant to NEPA. The Department anticipates that the Protocol is likely to be completed during Water Year 2011. Pending completion of the ongoing NEPA process, if a high-flow release is undertaken in Water Year 2011, projected operations of Glen Canyon Dam will be modified consistent with the final experimental protocol. Implementation of an experimental high-flow release will modify the projected releases for Water Year 2011 displayed in Tables 8 and 9.

From: Whetton, Linda A
To: Benemelis, Perri; Caan, George M.; Charley Bulletts; Downer, Alan; Gimbel, Jennifer; Gold, Anamarie; Heuslein, Amy; Jackson-Kelly, Loretta; James, Leslie; Jansen, Sam; Jordan, John; Kucate, Arden; Kuwanwisiwma, Leigh J.; Kyriss, LaVerne; Lash, Nikolai; Lopez, Estevan; Martin, Steve P.; Orton, Mary; Potochnik, Andre; Rampton, Ted; Senn, Michael J.; Shields, John W.; Spiller, Sam; Stevens, Larry; Strong, Dennis J.; Walkoviak, Larry P.; Zimmerman, Gerald R.; Balsom, Janet R.; Barrett, Clifford; Bills, Debra; Cantley, Garry; Christensen, Kerry; Cox, Jerry; Davis, William; Dongoske, Kurt; Hahn, Martha; Harris, Christopher; Joe, Tony; Johnson, Rick; King, Robert; Ostler, Don; Palmer, S. Clayton; Peterson, McClain; Ryan, Thomas P; Skrzynski, LeAnn; Stewart, Bill; Yazzie, Curtis; Yeatts, Michael;
cc: pwicker9@msn.com; Barger, Mary; Capron, Shane; Caramanian, Lori; Crawford, Marianne; Henderson, Norm; Knowles, Glen W; Kowalski, Ted; Kubly, Dennis; Noojibail, Gopaul; O"Brien, John; Persons, Bill; Sponholtz, Pam; Wegner, David; English, Jeff; Kaplinski, Matt; Makinster, Andy; Omama, Emily; Thiriot, James; Andersen, Matthew; Bennett, Glenn; Daugherty, Mary; Fairley, Helen; Grams, Paul; Hamill, John; Kitchell, Kate; Mankiller, Serena; Melis, Ted; Sogge, Mark;
Subject: Glen Canyon Dam Adaptive Management Program – 2011 Hydrograph Recommendation.
Date: Friday, July 23, 2010 4:02:00 PM
Attachments: July 23 final Draft DOI-DOE proposed hydrograph recommendations.pdf

---

Dear AMWG and TWG Members,

As we have previously discussed, the Federal representatives on the Adaptive Management Work Group (AMWG) have been working to develop information regarding a hydrograph for the projected operation of Glen Canyon Dam during the upcoming 2011 water year. As I indicated during our February 2010 AMWG Meeting in Phoenix, and on a number of subsequent occasions, I have asked the Federal agencies to work together to craft an approach to the 2011 water year that would work within the existing operational constraints for Glen Canyon Dam (e.g., the MLFF regime selected in the 1996 ROD, the Sept./Oct. Steady Flow Experiment approved in Feb. 2008), while also potentially enhancing downstream resource protection in Grand Canyon National Park and Glen Canyon National Recreation Area. Most recently during the June 'webinar,' I indicated that it was my intention that this information be carefully considered by the TWG prior to the August AMWG meeting and that we reserve sufficient time for a full discussion of this issue during our upcoming AMWG meeting in Phoenix on Aug. 24-25, 2010.

Attached to this email, you will find a document detailing the Federal agencies' preliminary recommendation for the 2011 hydrograph. The attached recommendation is based on the most current projected hydrological conditions, and reflects a wide range of potential annual release volumes from Glen Canyon Dam. The recommended operations described in the attachment are based on the developing best available science concerning preservation of resources downstream of Glen Canyon Dam.

The attachment details some of the key considerations that went into the development of this recommendation, and also includes draft language that Reclamation is considering for inclusion into the 2011 Colorado River Annual Operating Plan to describe the 2011 water year. This preliminary recommendation represents significant work and input on the part of

each of the five Interior AMP agencies and the Western Area Power Administration. As we work to improve the effectiveness of the Federal agencies on Colorado River issues, as well as within the Adaptive Management Program, we are striving to honor the commitment Secretary Salazar made to ensure that we improve our internal coordination and "speak with one voice" on Colorado River management issues. I have been impressed by the cooperative effort among our Interior agencies in recent months, and I appreciate the hard work and work and effort that went into the development of the preliminary 2011 Hydrograph. I also want to recognize and applaud the efforts of our sister agency, Western, which were instrumental in developing this joint proposal.<

The TWG will review and discuss this federal family recommendation at its meeting on July 27. Reclamation has mapped the impact of the recommendation against historical Glen Canyon Dam releases and will have that information available at the TWG meeting. The TWG's feedback and recommendations will be available for discussion at the August AMWG meeting.

I look forward to seeing each of you at the upcoming meeting in Phoenix. I would be glad to discuss any questions you may have with respect to the 2011 projected hydrograph.

Anne Castle

DEPARTMENT OF THE INTERIOR AND DEPARTMENT OF ENERGY OPERATING HYDROGRAPH RECOMMENDATIONS FOR GLEN CANYON DAM

July 23, 2010

Introduction: The Federal agencies involved in the Glen Canyon Dam Adaptive Management program have jointly drafted this recommendation for the projected operation of Glen Canyon Dam in 2011. This recommendation is consistent with the Law of the River and the Grand Canyon Protection Act, which states that the Secretary of Interior will operate Glen Canyon Dam "in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use." This recommendation is designed to enhance protection of downstream resources. It can be implemented consistent with existing environmental and operational limitations applicable to Glen Canyon Dam, the annual release requirements of the 2007 Interim Guidelines, applicable operating limitations for Glen Canyon Dam, and the 1996 Glen Canyon Dam Record of Decision (ROD). This approach to operations does not modify the Interim Guidelines, operating criteria or ROD and is an adaptive management-based experimental approach to 2011 operations that falls within the parameters of the Modified Low Fluctuating Flow alternative adopted in the ROD.

The National Park Service and U.S. Fish and Wildlife Service provided the initial draft of the operational concepts included in the recommendation to enhance protection of downstream resources. The Bureau of Reclamation provided technical support, clarifications, and refinements to assure these operational concepts would be consistent with the annual release requirements of the Interim Guidelines and applicable operational limitations for Glen Canyon Dam. The Bureau of Indian Affairs has had the opportunity to participate in the development of this recommendation and has reviewed the drafts. The USGS Grand Canyon Monitoring and Research Center has reviewed this recommendation and added its comments. Western Area Power Administration has evaluated the recommendation, participated in discussions concerning its operational impacts, and supports it.

It is Interior's intention to share this proposed recommendation with stakeholders in the Glen Canyon Dam Adaptive Management Work Group prior to the beginning of the 2011 water year, so as to provide an opportunity for input from the participating AMWG stakeholders. It is also Interior's intention to include a projected operation for Glen Canyon Dam during the 2011 water year in a Draft 2011 Annual Operating Plan for Colorado River Reservoirs at the earliest appropriate opportunity. In addition, language will be added to the 2011 Annual Operating Plan to reference the ongoing NEPA process

to develop an Experimental Protocol for High-Flow Releases from Glen Canyon Dam, and such language will note that pending completion of the ongoing NEPA process, if a high-flow release is undertaken in Water Year 2011, projected operations of Glen Canyon Dam will be modified consistent with the final experimental protocol. A draft of the information proposed to be added to the Draft 2011 AOP is attached as Attachment 1 to this summary.

Purpose: To develop recommendations for operational 2011 hydrographs based on anticipated possible annual release volumes for Water Year 2011 from Glen Canyon Dam consistent with Section 1802 of the Grand Canyon Protection Act. The operational hydrographs are within the framework of the 1996 Record of Decision and Modified Low Fluctuating Flow (MLFF) operation, consistent with balancing other resources, including power production, and recognize the variability of possible annual release volumes from Glen Canyon Dam under the 2007 Interim Guidelines.

The concept is to apply sound science principles within the framework of adaptive management to adjust the timing of water deliveries to protect and restore flow-dependent resource conditions. The fundamental principle is conservation of the sand resource in order to minimize sand export to Lake Mead and degradation of sandbar resources within the Colorado River ecosystem (CRE). (Note: Recently, a new sand routing model was developed for the CRE [Wright and others, 2010] that evaluates a variety of operational hydrographs from Glen Canyon Dam [including typical MLFF releases] using average annual sand production from both the Paria and Little Colorado Rivers.)

Two scenarios are presented below based upon the range of probable 2011 water year releases from Glen Canyon Dam. It is anticipated that the annual release volumes would likely fall within two sets of annual operations as described below. The agencies expect that the projected releases will be modified as the year progresses to address changing conditions in the same manner as typically occurs. Proposed parameters for such ongoing operational modifications are also provided.

Water Year Scenario #1: 8.23 – 9.0 million acre feet (maf) - Balancing

Objective: To implement reasonable measures to minimize export of tributary sand inputs delivered to the main channel so as to benefit the lower elevation ecosystem of Grand Canyon National Park, including the ecological processes and functions that affect native flora and fauna, archeological and cultural resources, recreation uses, and other values for which Grand Canyon National Park was established.

Science Principles: For any given annual volume of water released from the dam, sand export is known to be minimized by reducing daily/monthly/seasonal variations in dam

releases. (Rubin and others, 2002; Wright and others, 2005; Wright and others, 2008; ASCE, 1975; USDOI, 1995; Topping and others, 2006).

Proposed Operating Parameters:

- Monthly Release Volumes will be adjusted each month based on the most current forecast of the annual release required by the 2007 Interim Guidelines.
- Monthly Release Volumes will vary within a range of +/- 100,000 acre-feet from the Average Monthly Release Volume over the water year (defined in the next bullet). This monthly operational flexibility will be used for existing power production operations under the Modified Low Fluctuating Flow (MLFF) alternative selected by the 1996 ROD and contained in the 1995 FEIS. Modifications of monthly release volumes will be made in consultation with Western Area Power Administration.
- Average Monthly Release Volumes will be the amount of remaining water to release for the water year divided by the remaining months in the water year (excluding the September/October steady flows).
- Daily peaks will be no greater than 16,000 cubic feet per second (cfs), with all other flow parameters of the current MLFF in place.
- Steady flows in September and October per the 2008 HFE Environmental Assessment (EA), with monthly volumes of approximately 500,000 to 600,000 acre feet (about 8,000 to 10,000 cfs).

Expected Resource Results: Under this scenario, at the lower release volume of 8.23 maf, accumulation of some portion of new tributary sand inputs would likely occur in both Marble and Grand Canyons (Wright and Grams, 2010), but it is less certain that any new sand inputs would accumulate at the higher 9.0 maf volume. Recreational camping beaches would be expected to continue to degrade at previously reported rates associated with MLFF, with perhaps lower erosion rates of camps in summer and winter months (Kaplinski and others, 2005). It is not expected that there would be an increase in size and distribution of camping beaches throughout the river corridor; recreational rafting safety would be unaffected. Terrestrial and river edge aquatic riparian habitats, archaeological sites and historic properties would show no improvement. With lower summer peaks associated with this scenario there may be some vegetation encroachment on sand bars and camping beaches.

Water Year Scenario #2: Above 9.0 million acre feet (maf) - Equalization

Objectives: To implement reasonable measures to minimize erosion of sandbar deposits for purposes of reducing degradation to the lower elevation ecosystem of Grand Canyon National Park, including the ecological processes and functions that affect native flora and fauna, archeological and cultural resources, recreation uses, and other values for which Grand Canyon National Park was established.

Science Principle: For any given annual volume release of water, sandbar erosion and sediment transport is minimized by reducing both daily/monthly/seasonal variations in volume releases, and by minimizing subsequent daily variations in discharges. (Rubin and others, 2002; Wright and others, 2005; Wright and others, 2008; ASCE, 1975; USDOI, 1995; Topping and others, 2006).

Proposed Operating Parameters:

- Monthly Release Volumes will be adjusted each month based on the most current forecast of the annual release required by the 2007 Interim Guidelines.
- Monthly Release Volumes will vary within a range of +/- 100,000 acre-feet from the Average Monthly Release Volume over the water year (defined in the next bullet). This operational flexibility will be used for existing power production operations under the Modified Low Fluctuating Flow (MLFF) alternative selected by the 1996 ROD and contained in the 1995 FEIS. Modifications of monthly release volumes will be made in consultation with Western Area Power Administration.
- Average Monthly Release Volumes will be the amount of remaining water to release for the water year divided by the remaining months in the water year (excluding the September/October steady flows).
- Daily peaks will be no greater than 22,000 cfs, with all other flow parameters of the current MLFF in place (including daily range in fluctuating flows up to 8,000 cfs), including the fall steady flows required in the 2008 High Flow Experiment Environmental Assessment (2008 HFE EA).
- Steady flows in September and October per the 2008 HFE Environmental Assessment (EA).

Expected Resource Results: Under this scenario, loss of recreational camping beaches would be reduced to the extent possible by minimizing sediment transport (Wright and Grams, 2010). Recreational rafting values may benefit from the more limited fluctuations. Terrestrial and aquatic river edge riparian habitats and archaeological sites may continue to degrade, but the amount of loss may be reduced under this recommended flow regime.

Supporting Research Publications

ASCE, 1975, Sedimentation Engineering, Vanoni, V.A. ed.: ASCE Manuals and Reports on Engineering Practice, no. 54, 745 p.

Gloss, Steven P., Jeffrey E. Lovich, and Theodore S. Melis, 2005. The State of the Colorado River Ecosystem in Grand Canyon: A Report of the Grand Canyon Monitoring and Research Center 1991–2004, USGS Circular 1282

Grams and others, 2010, 2008 High-Flow Experiment at Glen Canyon Dam: Morphologic Response of Eddy-Deposited Sandbars and Associated Aquatic Backwater Habitats along the Colorado River in Grand Canyon, Paul E. Grams, John C. Schmidt, Matthew E. Andersen [currently available at www.gcmrc.gov and http://www.usgs.gov/pubprod/pubs.html as U.S. Geological Survey Open File Report 2010-1032],

Hazel and others, 2010, Sandbar Response Following the 2008 High-Flow Experiment on the Colorado River in Marble and Grand Canyons, Arizona, Joe E. Hazel Jr., Paul E. Grams, John C. Schmidt and Matt Kaplinski [currently available at: www.gcmrc.gov and http://www.usgs.gov/pubprod/pubs.html as U.S. Geological Survey Scientific Research Investigations Report 2010-5015]Kaplinski, M., 2005, State of the Colorado River Ecosystem, *in* eds. Gloss and others, U.S. Geological Survey Circular 1282, Chapter 12, pp. 193-206

Melis, T.S., and several other authors, 2010, 2008 High-Flow Experiment at Glen Canyon Dam Benefits Colorado River Resources in Grand Canyon National Park, U.S. Geological Survey Fact Sheet 2010-3009, 4 p.

Melis, T.S., Topping, D.J., Rubin, D.M., Wright, S.A.
2007 Research furthers conservation of Grand Canyon sandbars: *U.S. Geological Survey Fact Sheet* 2007-3020, 4 p.

Rubin, D.M., Topping, D.J., Schmidt, J.C., Hazel, J., Kaplinski, M., and Melis, T.S.
2002 Recent sediment studies refute Glen Canyon Dam hypothesis: *Eos*, Transactions, American Geophysical Union, Vol. 83, No. 25, 18 June 2002, Pages 273, 277-278

Topping, D.J., Rubin, D.M., Schmidt, J.C., Hazel, J.E., Jr., Melis, T.S., Wright, S.A., Kaplinski, M., Draut, A.E., and Breedlove, M.J. 2006 Comparison of sediment-transport and bar-response results from the 1996 and 2004 controlled-flood experiments on the Colorado River in Grand Canyon: CD-ROM *Proceedings of the 8th Federal Inter-Agency Sedimentation Conference*, Reno, Nevada, April 2-6, 2006, ISBN 0-9779007-1-1.

U.S. Department of the Interior, 1995 Final Environmental Impact Statement on the Operation of Glen Canyon Dam. Bureau of Reclamation, U.S. Government Printing Office, Denver.

U.S. Department of the Interior, Experimental releases from Glen Canyon Dam, 2008 Coconino County, Arizona, 2008 through 2012. Bureau of Reclamation.

Wright, S.A., Melis, T.S., Topping, D.M. and Rubin, D.M., 2005, State of the Colorado River Ecosystem, *in* eds. Gloss and others, U.S. Geological Survey Circular 1282, Chapter 1, pp. 1-16

Wright, S.A., Schmidt, J.C., Melis, T.S., Topping, D.J., and Rubin, D.M. Is there enough 2008Sand? Evaluating the fate of Grand Canyon sandbars. In *GSA Today*, v. 18, no. 8, doi: 0.1130/GSATG12A.11

Wright, S.A. and Grams, P.E., in press, Evaluation of glen Canyon Dam flow release scenarios on downstream sand storage along the Colorado River, Water Year 2011, U.S. Geological Survey Open File Report 2010-xxxx, ?p.

Wright, S.A., Topping, D.J., Rubin, D.M. and Melis, T.S., 2010, An approach for modeling sediment budgets in supply-limited rivers, Water Resources Research, [available: http://www.agu.org/journals/wr/papersinpress.shtml#id2009WR008600]

Attachment 1 – Information Proposed for inclusion in the Draft 2011 Annual Operating Plan (note: Table 9 metric conversion will be compiled)

Table 8. Range of Projected Monthly Releases from Lake Powell Under Water Year 2011 Inflow Scenarios (English Units)[1]

Month	Minimum Probable Inflow Scenario Projected Monthly Release Volume 11.5 maf dropping to 9 maf in March	Most Probable Inflow Scenario Projected Monthly Release Volume at Remaining at 11.5 maf	Maximum Probable Inflow Scenario Projected Monthly Release Volume 11.5 maf increasing to 13 maf/yr in Feb/March
October 2010	492	492	492
November 2010	927	927	927
December 2010	938	938	938
January 2011	951	951	951
February 2011	965	965	965
March 2011	982	982	1065
April 2011	554	1001	1266
May 2011	579	1027	1390
June 2011	612	1060	1391
July 2011	724	1209	1391
August 2011	800	1210	1391
September 2011	476	738	833
Water Year 2011	**9 maf**	**11.5 maf**	**13 maf**

Units are in 1,000 af/month.

Most and Max Probable will likely be adjusted somewhat in August 24 Month Study based on that month's forecast. These numbers should be fairly representative of the range of possibilities.

New Text proposed to be added to June 1, 2010 Draft AOP on page 30, at ln. 4:

On December 10, 2009, Secretary of the Interior Ken Salazar announced that the Department of the Interior would initiate development of a High-Flow Experimental Protocol (Protocol) for releases from Glen Canyon Dam as part of the ongoing implementation of the Glen Canyon Dam Adaptive Management Program (AMP). High-flow experimental releases have been undertaken in the past and will be further analyzed and implemented pursuant to the direction of the Secretary to assess the ability of such releases to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established. As part of the AMP, the Department's effort to develop the Protocol is a component of its ongoing responsibility to comply with the requirements and obligations established by the Grand Canyon Protection Act of 1992 (Pub. L. 102–575) (GCPA). Further information on the Protocol may be found at 74 Fed. Reg. 69361 (Dec. 31, 2009).

The High-Flow Experimental Protocol is currently the subject of an ongoing analysis, including analysis pursuant to NEPA. The Department anticipates that the Protocol is likely to be completed during Water Year 2011. Pending completion of the ongoing NEPA process, if a high-flow release is undertaken in Water Year 2011, projected operations of Glen Canyon Dam will be modified consistent with the final experimental protocol. Implementation of an experimental high-flow release will modify the projected releases for Water Year 2011 displayed in Tables 8 and 9.