Glen Canyon Dam Adaptive Management Work Group
Agenda Item Information
February 9-10, 2011

Agenda Item

High Flow Experiment Protocol Environmental Assessment (EA)

Action Requested

✓ This is an information item.

Presenters

Dennis Kubly, Environmental Resources Division, Upper Colorado Region, Bureau of Reclamation
John Hamill, Chief, Grand Canyon Monitoring and Research Center
John Halliday, Tribal Liaison, Glen Canyon Dam Adaptive Management Program, Office of the Assistant Secretary of Water and Science

Previous Action Taken

✓ By AMWG: AMWG provided comments and recommendations on the High Flow Test Protocol EA as part of National Environmental Policy Act scoping at its February 3, 2010 meeting in Phoenix, Arizona.

✓ By AMWG: At its August 2010 meeting, AMWG approved the FY 11-12 Biennial Workplan, and with it, an earlier version of the HFE science plan. The approved work plan included the following language: "Some changes to this work plan may be needed once the Protocol is finalized pursuant to the EA process. Additional revisions may be required to address additional experimental activities that may be identified in the Long Term Experimental and Management Plan EIS (http://www.usbr.gov/uc/rm/amp/amwg/mtgs/10aug24/Attach_08b.pdf, page 204)."

Relevant Science

✓ The following describes the relevant research or monitoring on this subject:

Wright, S.A., J.C. Schmidt, D.J. Topping, 2008, Is there enough sand? Evaluating the fate of Grand Canyon sandbars: GSA Today 18(8):4-10.

U.S. Bureau of Reclamation, 2009, Notice of Development of Experimental High-Flow Releases from Glen Canyon Dam under the Authority of the Secretary of the Interior (Secretary), Development of an Environmental Assessment, and Notice of Public Meeting: Federal Register 74 (250): 69361-69362.

Wright, SA, and Grams, P.E., 2010, Evaluation of Water Year 2011 Glen Canyon Dam flow release scenarios on downstream sand storage along the Colorado River in Arizona: U.S. Geological Survey Open-File Report 2010-1133, 19 p.

Background Information

Report on Environmental Assessment – Dennis Kubly

The High Flow Experiment (HFE) Protocol is being developed to establish a set of guidelines that will enable the Glen Canyon Dam Adaptive Management Program to conduct experimental dam releases on a multi-year, multi-experiment basis, while reducing the time and expense of compliance activities. The intent of the experiments is to improve learning that will lead to improved fine sediment conservation and benefit resources that depend on sediment – sandbars, camping beaches, and nearshore habitat for native fish. The EA will also analyze the effect of conducting high flow experiments on other natural resources, hydropower production, and recreation.

The Bureau of Reclamation (Reclamation) began the process to develop an Environmental Assessment (EA) for the HFE Protocol with a Federal Register notice in December of 2009, and held a public scoping meeting at the February 3-4, 2010, AMP Adaptive Management Work Group meeting. Since that time, 10 cooperating agencies--Bureau of Indian Affairs, National Park Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, Western Area Power Administration, Arizona Game and Fish Department, Upper Colorado River Commission, Hopi Tribe, Hualapai Tribe and Pueblo of Zuni--have joined with Reclamation to develop the HFE Protocol and the EA.

In development of the EA, Reclamation conducted a cooperating agencies HFE Protocol Workshop (June 17-18, 2010) and held a series of cooperating agencies conference calls to discuss purpose and need, as well as elements of potential alternatives for the EA. Reclamation also met with each of the AMP Tribes to conduct government-to-government consultation on the proposed action. Reclamation continues to work with the cooperating agencies and tribes to develop this EA and provided a draft EA to the public on January 18, 2011.

The proposed HFE Protocol contains three major components: (1) planning and budgeting; (2) modeling and; (3) decision and implementation. The planning and budgeting component sets the stage for HFE consideration by evaluating the status of resources and assigning funding for conducting HFEs. The modeling component projects the sand mass balance during potential HFE release windows using known tributary sand inputs and forecasted hydrology. The decision and implementation process incorporates the results of the first two components in a process of technical deliberation balanced with policy considerations. If the decision is made to conduct an HFE, GCMRC and cooperating scientists would conduct the scientific investigations following a previously agreed upon science plan.

Report on Science Plan – John Hamill

The goal of this experimental project is to test the hypothesis that a series of sand-enriched high flows will be an effective strategy for rebuilding and maintaining sandbars using dam operations (Topping and others, 2006). The details of high flow triggering criteria are in the January 18, 2011 Environmental Assessment for the Development and Implementation of a Protocol for High-Flow Experimental Releases from Glen Canyon Dam, Arizona, 2011 through 2020 (hereafter referred to as the HFE EA).

The second goal will be to evaluate the effects of implementation of the High Flow Experiment Protocol on a variety of other priority AMP resources including aquatic food base, native fish, Lees Ferry trout and angler satisfaction, riparian vegetation, campsites, and archaeological sites. Special focus will be on assessing the effects of the seasonal timing of high flows on Lees Ferry rainbow

trout early life-stage survival, recruitment, downstream migration and HFE impacts on native fishes especially the endangered humpback chub (*Gila cypha).*

The general science plan outlines how ongoing monitoring and research projects will address the evaluation of the effectiveness of the HFEs. Changes to the science plan may be needed based on availability of funds and as HFEs are implemented and adjusted in an adaptive management framework (Williams and others, 2008). Additional revisions may also be required to address additional experimental activities that may be identified in the Long Term Experimental and Management Plan EIS, which will be initiated by the Department of the Interior in 2011.
The proposed approach will rely on existing quality of water, sediment, aquatic biology and other resource monitoring projects to assess the effects of HFEs. No new studies would be added, however, some existing monitoring and research efforts would be expanded or adjusted to provide information that is directly relevant to the evaluation of the HFEs.

This science plan is focused on assessing the effects of the "store and release approach" described in the HFE EA. A separate science plan could be developed to assess the effects of the "rapid response approach" described in the HFE EA, once the details of that approach are more fully described. It is expected that many of the studies described below will inform both HFE approaches, but more specific short term investigations may be needed to evaluate the efficacy of the rapid response approach.

Strategic Science Questions
Table 1 (below) identifies the specific HFE science questions associated with these resources that will be addressed with available funding included in the approved Glen Canyon Dam Adaptive Management Program Biennial Budget and Work Plan—Fiscal Years 2011-12 (BWP). These HFE science questions were developed by GCMRC based on the high flow synthesis report (Melis and others, in press), other relevant literature, and input provided by the HFE EA cooperating agencies.

Products/Reports
There is substantial uncertainty about the outcome that may result from implementation of the HFE protocol. For example, the biological responses to fall HFEs are difficult to predict. Thus, modification of the HFE protocol may be required based on knowledge gained from biological responses to future HFEs. Modification of the protocol in response to sandbar-monitoring results may also be required, and a different HFE strategy may be justified during wet and dry climatic periods. Because of these uncertainties, the annual "status check" outlined in the EA will be a critical component of an adaptive HFE strategy. This status check would involve reviewing recent monitoring data for sand budgets, sandbar size, native and nonnative fish population trends, and other resource responses. Based on the findings of these reviews, the HFE protocol may need to be adapted to address undesirable resource responses. Likewise, the HFE science plan may need to be adapted based on new knowledge and learning and to address new science questions.

Primary reporting of results of the above tasks will be performed in the context of annual reporting and publications as described in the work plans associated with each individual monitoring project (see individual project descriptions in the FY 2011-12 BWP). In addition, a summary of relevant results and findings specific to each individual HFE will be provided in USGS Open-file Reports and/or Fact Sheets in the following fiscal year. A thorough analysis and synthesis of results of the multi-year experiment will be provided at the conclusion of the HFE protocol experiment.

Budget

GCMRC anticipates that the tasks described above will be funded as part of ongoing monitoring and research projects included in the approved GCDAMP BWP, including the use of experimental funds as summarized in Table 2. Changes to the work plans included in the FY 11-12 BWP or in the allocation of experimental funds (Table 2) could adversely impact implementation of the tasks described above and the ability to address the science questions listed in Table 1. Several funding shortfalls are identified in Table 2, including:

1. No funding is currently available to collect and analyze monthly aquatic food base samples (as opposed to quarterly sampling which is now funded) ($100K in FY 11).
2. The NSE study is suited to assessing the direct and indirect effects of repeated HFEs on humpback chub. Only one field season remains in this project (FY11) and adjustments or amendments to the NSE study will be needed to specifically address issues related to the impacts of rainbow and brown trout on humpback chub or assess possible displacement of young humpback chub by a fall HFE (amount to be determined)
3. No funding is currently available for annual riparian vegetation monitoring ($50K every other year beginning in FY 12)
4. No funding is currently available for to monitor water quality in the forebay of Lake Powell and the tailwater of GCD shortly before and after an HFE ($9.3K)

Finally, additional funding would be needed to implement a yet to be developed science plan for the "rapid response HFE" described in the HFE EA.

Science Support for a Potential Spring 2011 HFE

A scaled-down version of this plan would be implemented in response to a potential March-April 2011 HFE owing to the short lead time available to plan and execute a full-scale science plan. The primary focus that plan would be to assess the rainbow trout response to a spring HFE, preferably, at a timing later than either the 1996 or the 2008 HFEs.

Table 1. HFE science questions that will be the focus the HFE EA Science Plan

Sandbars, Camping Beaches, and Archaeological Sites

1. Will multiple high flows conducted over a period of 10 years result in net increases in sandbar area and volume?
2. With the available sand supply (i.e. tributary inputs), is the approach of using repeated floods to build sandbars sustainable?
3. Will multiple high flows conducted over a period of 10 years result in net increases in campable area within the Colorado River ecosystem?
4. Will multiple high flows conducted over a period of 10 years improve archaeological site condition as reflected in increased sand deposition, increased site stability, and reduction in rates of erosion?

Aquatic Food Base and Fish

5. What is the effect of a fall HFE on the food base at Lees Ferry?
6. How does HFE timing and frequency affect Lees Ferry rainbow trout population dynamics and out-migration?
7. Is it possible to manage the Lees Ferry trout population with a spring HFE held at slightly different times?
8. What are the direct effects of a fall HFE on displacement of humpback chub?

9. What are the indirect effects of increases in rainbow trout associated with HFEs on humpback chub?

Recreation

10. How will multiple high flows conducted over a period of 10 years affect recreational experience quality in the Colorado River corridor in Glen Canyon?

Riparian Vegetation and Springs

11. How does HFE timing and frequency affect woody riparian and marsh vegetation composition?
12. How does riparian vegetation influence sandbar building, campable area, and wind-blown transport of sand?
13. How do Kanab ambersnail populations and habitat vary over a 10-year period of repeated high flows?

Water Quality

14. How do high flow experiments affect water quality (especially DO and temperature) in the forebay of Lake Powell and in the Colorado River between the Dam and Lee's Ferry?

Hydropower

15. What are the effects of repeated HFEs on hydropower production and marketable capacity at Glen Canyon Dam?

Table 2A. FY 2011 budget for research and monitoring projects related to the proposed high flow experimental protocol as included in the approved FY 2011-12 BWP. The amount of Experimental Funds that will be used in year with and without an HFE is also shown.

Task	Project Number	FY 11 Budget*	Exp Funds No HFE	Exp funds With HFE
Task 1 – SedTrend	PHY 8.M2.11-12	$464,476	$250,000	$140,000
Task 2 – Sandbar monitoring	PHY 8.M2.11-12	See task 1	50,000	50,000
Task 3 – Campable area monitoring	REC 9 R1.11-12	74,319		
Task 4 – Remote sensing of sandbars	DAS 12.D9.11-12	243,873		
Task 5 – Archeological site monitoring	CUL 11.R1.11-12	352,279		
Task 6 – Sediment flux monitoring	PHY 7.M1-11-12	984,888		110,000
Task 7 – Aquatic food base monitoring	BIO 1.M1.11-12	236.568	**a**	**a**
Task 8 – Lees Ferry trout				
• Adult and YOY trout monitoring	BIO 4.M2.11-12	215,710	22,709	22,709
• Paria to Badger Rapid Study	BIO 2.E18.11-12	432,518	195,918	195,918
Task 9 – Lees Ferry recreation experience	REC 9.R4.11	25,000	25,000	25,000
Task 10 – Native Fish				
• Mainstem fish monitoring	BIO 2.M4.11	283,090		
• LCR fish monitoring	BIO 2.M1.11	572,942		
• Nearshore Ecology Study	BIO 2.R15.11	697,039		**b**
Task 11 – Riparian vegetation				
• Veg transect ((biannual)	BIO 6.M2.11	149,883		
• Veg Mapping	BIO 6.M1.11	84,883		
Task 12 – Kanab Ambersnail Monitoring w/o mitigation	BIO 5.M1.11	20,506		
Task 13 – Lake Powell and Lee Ferry Water Quality	BIO 7.R1.11	182,002		**c**
Task 14 – Hydropower	HYD 11.WAPA	106,950		**d**
Total		$5,126,926	$543,627	$543,627

* FY 11 budget is based on the assumption that **no** HFE will be conducted. Budget amounts will be adjusted up or down depending on whether an HFE is conducted.

a. $100K needed in FY 11 to restore monthly food base sampling.
b. Additional funding would be needed to amend/extend the NSE project to address effects of HFEs on juvenile HBC (displacement and rainbow trout effects).
c. $9,300 required to monitor water quality in the forebay of Lake Powell and the tailwater of GCD shortly before and after a HFE.
d. Scope of the economic analysis will depend on ultimate scope of Goal 10 (Hydropower) activities supported in the BWP.

Report on Tribal Consultations – John Halliday
By the time of the AMWG meeting, for the purpose of formal tribal consultations, the Tribal Liaison, John Halliday, will have visited with the Hualapai Tribe, the Havasupai Tribe, the Hopi Tribe, the Navajo Nation, and the Kaibab Paiute Tribe and the Paiute Tribe of Utah, both of which are part of the Southern Paiute Consortium. In these meetings, he represented the office of the Assistant Secretary for Water and Science (ASWS) in consultation with top policy makers within the tribes, creating a connection between the ASWS and the tribal government. He explained the proposed action by federal government agency and received feedback from the tribe. In particular, he discussed any concerns about adverse impacts on the tribe due to the action, and what could be done to mitigate those impacts.

He has also visited informally with the Pueblo of Zuni, whose leadership was not yet prepared to meet in formal consultations because of a transition in leadership.

RECLAMATION

Managing Water in the West

High-Flow Experiment Protocol Environmental Assessment

Dennis Kubly
Bureau of Reclamation
Salt Lake City, UT

Adaptive Management Work Group Meeting
February 9, 2011

U.S. Department of the Interior
Bureau of Reclamation

History of HFEs

- **Setting the Stage**
  - **1995 EIS Beach/Habitat Building Flow (BHBF) and Habitat Maintenance Flow (HMF)**
    - **BHBF—scheduled high releases (40-45k cfs) of short duration designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural system**
    - **HMF—spring releases up to powerplant capacity (33,200 cfs) designed to reform backwaters and maintain sandbars**
  - **The Fit in the Mix**
    - **HMFs were an insurance policy on the negative effects of too frequent BHBFs since "frequent floodflows would likely transport more sand than could be supplied by the tributaries—resulting in long-term sandbar erosion."**
  - **Attributes of both BHBF and HMF in draft HFE Protocol**

HFE Protocol EA Chronology

- Announcement by Secretary: Dec 9, 2009
- Federal Register Notice: Dec 22, 2009
- Initiate Public Scoping, AMWG Meeting: Feb 3-4, 2010
- HFE Workshop: June 17-18, 2010
- Cooperating Agency Conference Calls: Jul-Dec 2010
- Cooperating Agency Review Draft: Nov 23-Dec 6, 2010
- Public Review Draft: Jan 14-Feb 28, 2011

Cooperating Agencies

- **Federal**
  - **Bureau of Indian Affairs; National Park Service, Intermountain Region; U.S. Fish and Wildlife Service; U.S. Geological Survey, Pacific Southwest Area; and Western Area Power Administration**
- **American Indian Tribes**
  - **Hopi Tribe, Hualapai Tribe, and Pueblo of Zuni**
- **State**
  - **Arizona Game and Fish Commission and Upper Colorado River Commission**

The Protocol

- A protocol in science and medicine, by definition, is a formal set of rules and procedures to be followed during a particular research experiment.
- This protocol is intended to be experimental in nature, and is designed to learn how to incorporate high releases into future dam operations in a manner that effectively conserves sediment and sediment-dependent resources in the long-term.
- Sandbar building potential is greatest by generating the greatest possible sand concentrations and largest possible areas of inundation, both of which are maximized by increasing flow magnitude.
- Sandbar building occurs as long as elevated sand concentrations are maintained and there is still space available to deposit sand; thus high flows should be of as long a duration as can be maintained with available sand.

Purpose and Need

- **Purpose: (1) to develop and implement a protocol that determines when and under what conditions to conduct experimental high volume releases, and (2) to evaluate the parameters of high-flow releases in conserving sediment to benefit downstream resources in Glen, Marble, and Grand Canyons.**
- **Need: This action is needed to take advantage of future sediment-enriched conditions in the Colorado River with experimental high flow tests that will improve the understanding of the relationships between high dam releases of up to 45,000 cfs and sediment conservation.**

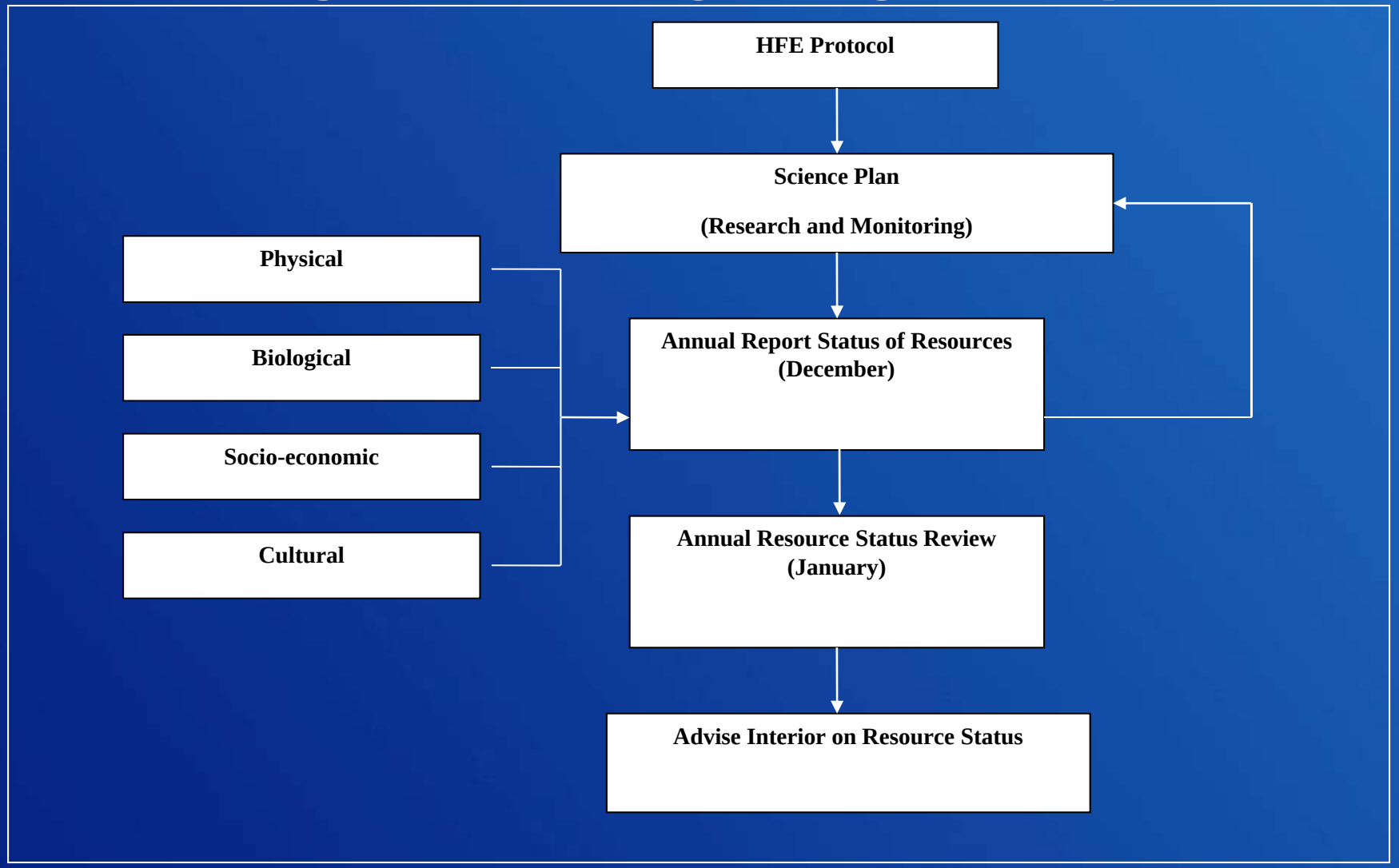
HFE Protocol Paradigms

- **Store and Release**
  - developed by USGS and was first introduced as the basis for the HFE protocol in a June 2010 modeling workshop
  - relies on accumulation of sand during periods of above-average sediment input from tributaries to achieve sediment enriched conditions called for in the development of the HFE protocol (74 FR 69361); decisions occur over months
- **Rapid Response**
  - proposed in September 2010 by Western Area Power Administration
  - requires real-time coupling of tributary sediment inputs and dam releases; decisions must occur in hours

Rapid Response

- Relies on the highly variable and short-term duration Paria River floods as the trigger
- Sediment models not yet capable of addressing fine sediment retention
- Real-time decisions must be preceded with consideration for effects on property, recreation, human safety, and dam operations
- Trigger likely to occur in Aug-Sep, months not in release window and not evaluated for effects
- Paria floods may not occur at times of sediment-enriched conditions
- Two paradigms tested in the same time frame could produce confounding results; no science plan

Planning and Budgeting Component



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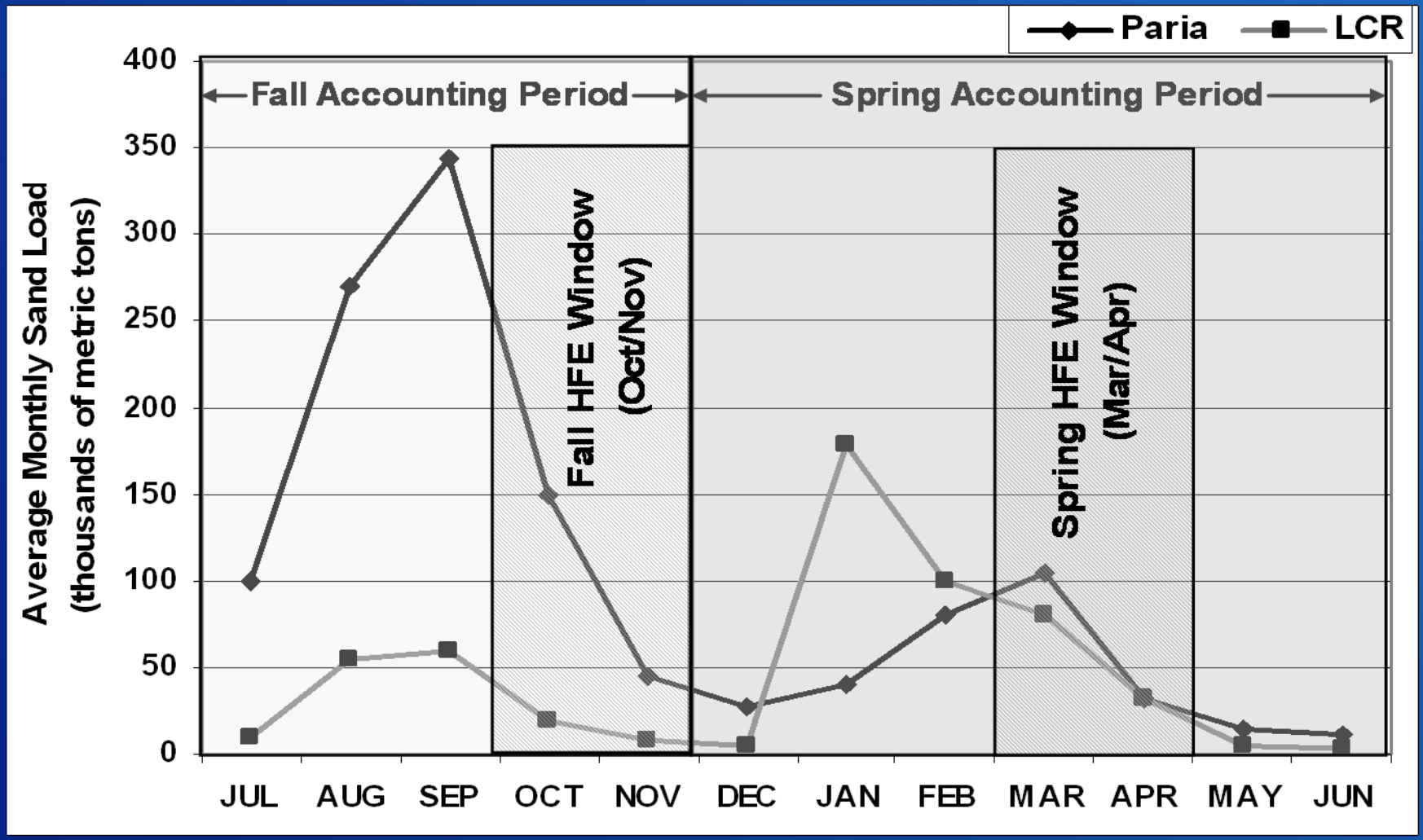
Modeling Component



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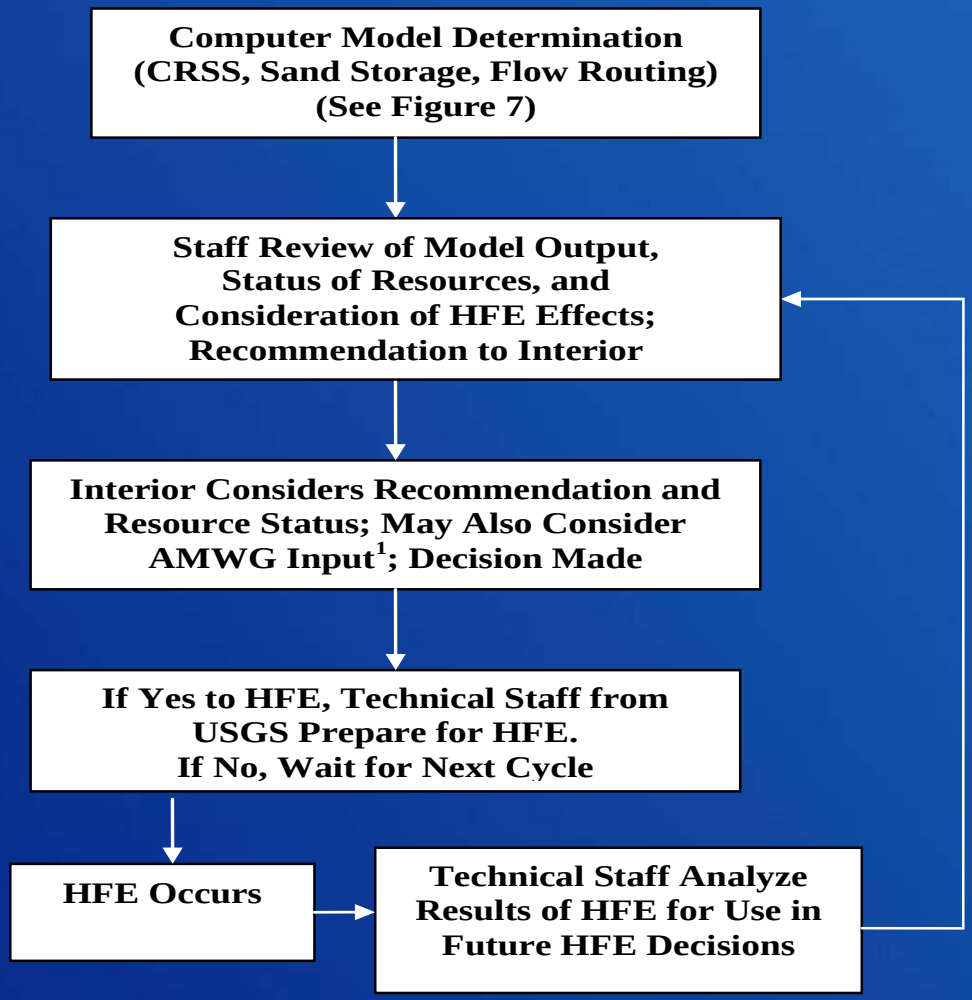
Decision and Implementation Component



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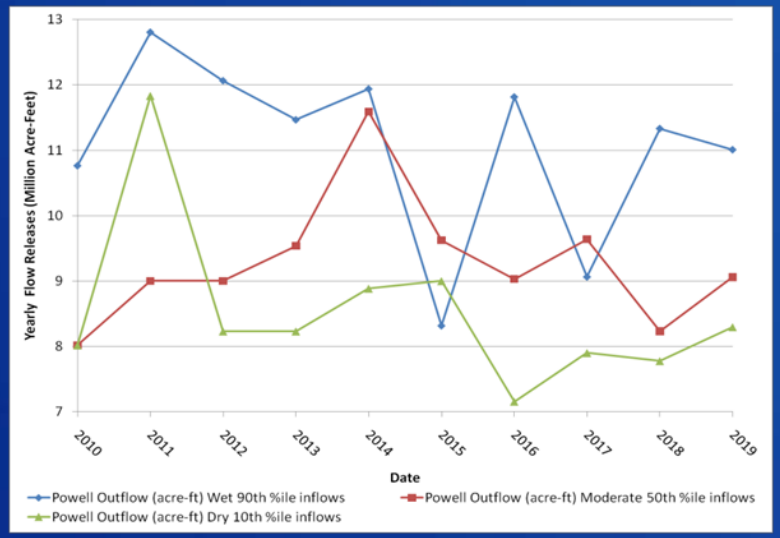
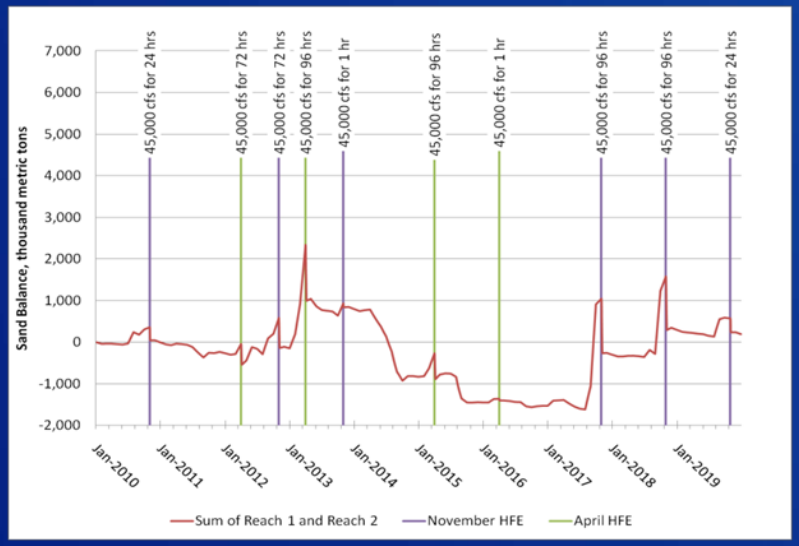
Modeling the HFE Scenarios

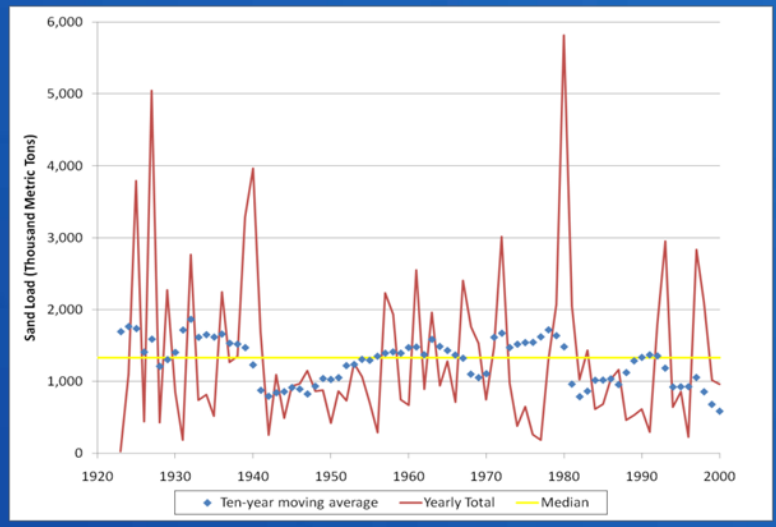


Hydrology



Model Output 10 Yr Trace

Paria River Sediment



HFE Scenarios

HFE No.	Peak Magnitude (ft^3/sec)	Peak Duration (hrs)
1	45,000	96
2	45,000	72
3	45,000	60
4	45,000	48
5	45,000	36
6	45,000	24
7	45,000	12
8	45,000	1
9	41,500	1
10	39,000	1
11	36,500	1
12	34,000	1
13	31,500	1

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Modeling Output Summary

HFE	Flow Magnitude (cfs)	Duration (hours)	Number and Percent Frequency
1	45,000	96	33
2	45,000	72	10
3	45,000	60	4
4	45,000	48	5
5	45,000	36	4
6	45,000	24	9
7	45,000	12	11
8	45,000	1	15
9	41,500	1	4
10	39,000	1	2
11	36,500	1	1
12	34,000	1	2
13	31,500	1	0

HFE Scenarios Modeling Output

Months - Year	Low, Dry	Low, Mod.	Low, Wet	Mod, Dry	Mod, Mod.	Mod, Wet	High, Dry	High, Mod.	High, Wet
Mar/Apr Yr 1	5	5					7	7	
Oct/Nov Yr 1	2	2		6	6		6	6	
Mar/Apr Yr 2									
Oct/Nov Yr 2		7							
Mar/Apr Yr 3	6	12		1	2	1	8		
Oct/Nov Yr 3	3	8	4	1	2	1	1	1	1
Mar/Apr Yr 4	10			1	1	1	2	8	3
Oct/Nov Yr 4	1	1	7	8	8		6	8	
Mar/Apr Yr 5							2	7	1
Oct/Nov Yr 5	1		4	8					
Mar/Apr Yr 6	11	8	8	5	1	1		12	9
Oct/Nov Yr 6			8				1	1	1
Mar/Apr Yr 7	8	8			8		9	10	
Oct/Nov Yr 7	7	7					1	1	1
Mar/Apr Yr 8			7	8		4	4	9	1
Oct/Nov Yr 8	4	3	3	1	1	1	6	7	8
Mar/Apr Yr 9									
Oct/Nov Yr 9	9	7		1	1	1			
Mar/Apr Yr 10	1	1	2						
Oct/Nov Yr 10	2	2	1	5	6	2	6	7	1
No. of HFEs	14	13	9	11	10	8	13	13	9

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Assessment of Effects

PHYSICAL RESOURCES	CULTURAL RESOURCES
Water Resources	Historic Properties
Water Quality	Sacred Sites
Air Quality	SOCIO-ECONOMIC RESOURCES
Sediment	Hydropower
BIOLOGICAL RESOURCES	Recreation (including Public Safety)
Vegetation	
Terrestrial Invertebrates and Herptofauna	
Aquatic Foodbase	
Fish	
• Humpback Chub	
• Razorback Sucker	
• Non-Listed Native Fishes	
• Trout	
• Other Non-native Fishes	
• Fish Habitat	
Birds	
Mammals	

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Effects Analysis

- **Four principal attributes of an HFE are identified—timing, magnitude, duration, and frequency.**
  - **Timing refers to time of year (Mar-Apr and Oct-Nov)**
  - **Magnitude is the peak flow (31,500-45,000 cfs)**
  - **Duration is the length of time for the high dam release from the start of up-ramp to the end of down-ramp (<1 hr-96 hrs)**
  - **Frequency is how often HFEs are conducted and considers the interval of time between HFEs (up to 2/yr)**
  - **The first three attributes (timing, magnitude, and duration) are analyzed for a single HFE, and the fourth (frequency) is also included in the analysis of multiple HFEs.**

Ongoing Compliance

- Draft High Flow Experimental Protocol EA was made available to the public on January 18, 2011, and the comment period closes on February 28, 2011.
- Reclamation requested formal ESA Section 7 consultation with the US Fish and Wildlife Service (FWS) on January 14, 2011, for effects to endangered humpback chub, razorback sucker, southwestern willow flycatcher, and Kanab ambersnail.
- Reclamation needs to complete consultation with FWS, complete tribal consultation and NHPA compliance, and complete NEPA compliance to implement the HFE Protocol.

Potential EA Outcomes

- A finding of no significant impact and the protocol goes forward as proposed;
- An environmental impact statement if the proposed action could result in significant impacts; or
- A decision to withdraw the proposal on the basis of environmental impacts disclosed in this document.

For Further Input

The EA is available on the Reclamation website at:

http://www.usbr.gov/uc/envdocs/ea/gc/HFEProtocol/index.html

Comments are due by February 28, 2011:

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