From: Linda Whetton

To: Albert Sr., Carleton; Alston, Joe; Barger, Mary; Beckmann, Darryl; Begay, Steven; Bell, Bob; Charley; Gold, Rick; Groseclose, Jay; Harris, Christopher; Jackson Kelly, Loretta; James, Leslie; Johnson, Rick; King, Robert; Kuharich, Rod; Kuwanwisiwma, Leigh; Lehr, Phillip; Limbaugh, Mark; O'Brien, John; Oelschlaeger, Max; Orton, Mary; Ostler, Don; Palmer, Clayton; Persons, Bill; Peterson, Randall; Potochnik, Andre; Rampton, Ted; Ramsey, Nikolai; Seaholm, Randy; Shields, John; Skrzynski, LeAnn; Spiller, Sam; Steffen, Mark; Steffen, Tim; Strong, Dennis; Taubert, Bruce; Warren, Brad; Werner, Bill; Yeatts, Michael; Zimmerman, Gerald

Date: 10/6/2006 8:56:11 AM

Subject: Two Items: TWG Meeting Date & Materials for AMWG Meeting

TWG Members:

This is to inform you the TWG Meeting Date is set for November 8-9 in Phoenix, Arizona. Attempts were made to hold it during the week of Oct 30-Nov 3 but the conference rooms at the Bureau of Indian Affairs were unavailable and the Holiday Inn Express couldn't provide a block of rooms for that week. With the elections on November 7, it was determined that the best dates to hold the meeting would be Nov 8-9. We also took into consideration the request of one stakeholder who cannot provide any representation at the meeting.

AMWG Members:

In scheduling the meeting for Nov 8-9, it will impact when pre-meeting materials can be sent to you. At this point in time, they will be sent via overnight on November 14 which should allow you 13 business days, rather than the usual 30 calendar days, to review them prior to the meeting on December 5-6.

Roles Ad Hoc Group:

Mr. Limbaugh, the Secretary's Designee, is interested in finalizing and implementing the roles report. Since the AMWG has new leadership and many new members, it would be worthwhile to get a fresh perspective of the roles report from an updated Ad Hoc Group. Mr. Limbaugh has asked that the Roles Ad Hoc Group be reconstituted to review the work of the earlier group and send him a recommendation as soon as they can.

Additional details for both meetings will be forthcoming as arrangements are finalized.

cc: Amy Heuslein / Garry Cantley (via fax @ 602-379-3833)

CC: Andersen, Matthew; Balsom, Janet; Beard, Chris; Bryant, Nora; Burke, Kelly; Burton, Gary; Christensen, Kerry; Conrad, Tara; Daly, Karen; Damp, Jonathan; Davis, William E.; Dongoske, Kurt; English, Jeff; Fairley, Helen; Garrett, L. David; Greiner, Lloyd; Hamill, John; Henderson, Norm; Hower, Jonne; Jessop, Shirla; Kaplinski, Matt; Kite, John; Knowles, Glen W.; Kubly, Dennis; Maul, Susan; McMullen, Ken; Melis, Ted; Powell, Linda; Rogers, Roland; Stevens, Larry

United States

August 17, 2006

To: Rick Gold, Director, Upper Colorado Bureau of Reclamation
Mark Limbaugh, Assistant Secretary, Water and Science, Department of Interior

From: John Hamill, Chief, GCMRC
Dave Garrett, Science Advisors, Executive Director

Subject: Request to Delay AMWG Fall Meeting Until Early November

This is a request to delay the fall AMWG meeting from October, 2006, to early November, 2006. The request is presented to provide more time for Glen Canyon Dam Adaptive Management Program (AMP) stakeholders to review and discuss the potential resource impact assessments related to several long experimental options that are being evaluated.

The GCMRC, in collaboration with the AMP Science Planning Group (SPG), has evaluated six different experimental options, and recently reduced these to three options. Their potential impacts to various resources in the Colorado River ecosystem are being contrasted to the impacts from the current baseline flow regime (MLFF), as well as against each other. Information on potential resource impacts, while limited and constrained by uncertainties, is critical to AMWG in its evaluation and selection of an experimental alternative for the FY 2008-2011 period.

The SPG and GCMRC have completed specification of the proposed experimental options and have contracts established for development and review of the assessments for each option. These assessments can be completed by September 30, 2006, but this does not leave sufficient time for TWG or AMWG review and briefings on the assessments prior to a mid-October AMWG meeting. The request to delay the AMWG meeting to early November will provide sufficient time.

Please let us know in the earliest time frame if this request is approved.

From: Linda Whetton
To: Albert Sr., Carleton; Alston, Joe; Beckmann, Darryl; Begay, Steven; Bulletts, Charley; Dongoske, Kurt; Gold, Rick; Groseclose, Jay; Jackson Kelly, Loretta; James, Leslie; Kuharich, Rod; Kuwanwisiwma, Leigh; Lehr, Phillip; Oelschlaeger, Max; Potochnik, Andre; Rampton, Ted; Ramsey, Nikolai; Shields, John; Spiller, Sam; Steffen, Mark; Strong, Dennis; Taubert, Bruce; Warren, Brad; Werner, Bill; Zimmerman, Gerald
Date: 10/16/2006 11:28:03 AM
Subject: AMWG Meeting Details & Request for Review of POAHG website

This is to inform you the next meeting of the Glen Canyon Dam Adaptive Management Work Group will be held:

Date: Tue., December 5, 2006 (9:30 AM - 5 PM)
Wed., December 6, 2006 (8 AM - 3 PM)

Location: Fiesta Inn Resort (Encantada Ballroom)
2100 S. Priest Drive
Tempe, Arizona 85282
Tel: 800-528-6481
Rate: $103 + tax (12.07%)
BLOCK CLOSES: November 13, 2006
ROOM BLOCK under: Bureau of Reclamation
CANCELLATION POLICY = 48 hours prior to arrival date or incur first night's lodging rate
AIRPORT SHUTTLE SERVICE = 24 hours (go to baggage claim area at Sky Harbor Airport)

NOTE: You will be expected to leave a valid credit card or cash deposit in the amount of $50 with the hotel at the time of check in. This is an "incidentals" charge to cover food/beverage purchases, laundry needs, etc.

There is a restaurant located in the hotel and other restaurants (5-minute walk to Denny's) and some located near the Arizona Mills Mall (5-10 minute drive). If you want more details on the hotel, please visit the website at:
http://www.fiestainnresort.com

As indicated in my 10/6/06 e-mail message, meeting packets will be sent via overnight mail on Tuesday, Nov. 14, which will give you 13 business days to review the documents. However, documents that may be revised following the TWG meeting (Core Monitoring Plan, Strategic Science Plan) will be available in their original format on the TWG website should you desire to get a "head start" on reading some of them. Once the documents are posted to the AMWG meeting page, the URL will provided to you. We are in the process of preparing a draft agenda and will send that out once it has been approved.

REQUEST FOR REVIEW OF PUBLIC OUTREACH AHG (POAHG) WEBSITE:

The new POAHG is in its final draft form and ready to be reviewed by the AMWG and TWG. Please read the following guidelines prior to going to the website.

The URL to the site is: http://www.gcdamp.gov

Review Guidelines for AMWG/TWG:

1) Please review this site with an understanding that it has been extensively reviewed and approved by the Public Outreach Ad Hoc Group. Therefore, any suggested modifications should only be to correct information errors, typos, broken links, or other problems. Stylistic or editorial suggestions are not being sought.

2) Please review this site from the perspective of the intended broad public audience.

3) Please note the "Alert" message that comes up when going to the new site's home page. It is important that the URL to the site NOT be distributed to anyone OR linked to from any agency web site until the review period is over and the site is officially approved and made public. (The "Alert" message will be removed after the final AMWG and TWG review period.)

4) **Please provide all feedback for necessary modifications by November 27th to Mike Yeatts and Jeff Humphrey. (Mike = michael.yeatts@nau.edu) (Jeff Humphrey = jeff_humphrey@fws.gov)**

5) The look and feel and functionality of the web site was approved at the March 2006 AMWG meeting. Please review the web site's content carefully by November 27th so it can be approved at the December 5&6 AMWG meeting.

6) This web site can accommodate future expansion/additional information as appropriate.

Thank you.

cc: Amy Heuslein / Garry Cantley (via fax @ 602-379-3833)

CC: Andersen, Matthew; Balsom, Janet; Barajas, Federico; Barger, Mary; Baron, Jill; Beard, Chris; Bryant, Nora; Burke, Kelly; Burton, Gary; Carroll, Stacey; Christensen, Kerry; Conrad, Tara; Daly, Karen; Damp, Jonathan; Davis, William E.; Fairley, Helen; George, Roxane; Gonzales, Catherine; Greiner, Lloyd; Hamill, John; Harris, Christopher; Henderson, Norm; Hendrix, Doug; Hower, Jonne; Iams, Lisa; Jessop, Shirla; Johnson, Rick; Kaplinski, Matt; Kincaid, Chris; King, Robert; Kite, John; Knowles, Glen W.; Kubly, Dennis; Luckey, April; McMullen, Ken; Melis, Ted; O'Brien, John; Orton, Mary; Ostler, Don; Palmer, Clayton; Persons, Bill; Peterson, Randall; Powell, Linda; Rogers, Roland; Seaholm, Randy; Skrzynski, LeAnn; Steffen, Tim; Stevens, Larry; Wirth, Barry; Yeatts, Michael

From: Linda Whetton

To: Barajas, Federico; Beckmann, Darryl; Conrad, Tara; Dongoske, Kurt; Gold, Rick; Hamill, John; Hower, Jonne; Kubly, Dennis; Melis, Ted; Orton, Mary; Peterson, Randall

Date: 10/25/2006 9:44:42 AM

Subject: PLEASE READ: Change in AMWG Pre Mtg Conf Call

The Glen Canyon Dam Adaptive Management Pre-Meeting Conference Call has been changed to:

Date: Friday, November 17

Time: 1 PM (Washington DC time)
11 AM (AZ, UT time) -> Daylight savings ends Oct. 29
10 AM (NV time)

Duration: approximately 2 hours

Phone Numbers: 1-801-524-3885 or toll free 1-888-420-6860

For UC Regional Staff: Please meet in Conference Room 7103

CC: Bryant, Nora; Daly, Karen; Hendrix, Doug; Wirth, Barry

From: Linda Whetton
To: Albert Sr., Carleton; Alston, Joe; Beckmann, Darryl; Begay, Steven; Bulletts, Charley; Dongoske, Kurt; Gold, Rick; Groseclose, Jay; Jackson Kelly, Loretta; James, Leslie; Kuharich, Rod; Kuwanwisiwma, Leigh; Lehr, Phillip; Mershon, laurie; Oelschlaeger, Max; Orton, Mary; Potochnik, Andre; Rampton, Ted; Ramsey, Nikolai; Shields, John; Spiller, Sam; Steffen, Mark; Strong, Dennis; Taubert, Bruce; Warren, Brad; Werner, Bill; Zimmerman, Gerald
Date: 11/30/2006 1:03:58 PM
Subject: Revision to Exp Options Assessment Report

John Hamill asked me to send the following e-mail message to you. Copies will be provided at the AMWG meeting for inclusion in your meeting binder:

- - - - - - - - -

From: <jhamill@usgs.gov>
To: <lwhetton@uc.usbr.gov>, <dkubly@uc.usbr.gov>, <kdongoske@cableone.net>
Date: 11/30/2006 12:15:49 PM
Subject: Fw: changes to the experimental option report

Linda, Dennis and Kurt: Please distribute this to the TWG and AMWG as appropriate.

The experimental option assessment report that was distributed to the AMWG and is posted on the AMWG website includes several changes from the version that was provided to the TWG. There was one substantive change to the experimental options document in response to address a typographical error. The change appears in chapter 3, part 4 (Recreation and Cultural Resources) under the section entitled Angling Opportunity, Quality, and Access. The edit involved changing 25,000 cfs to 15,000 cfs in the first sentence below and breaking a longer sentence in the original into two
shorter sentences. The new paragraph now reads:

Under the 8.23 MAF annual release scenario, flows at or above 15,000 cfs are more frequent under Option A
than under MLFF. This situation also holds true for the most probable and wet hydrologic scenarios; although, the differences between frequency of high flows eventually disappears in the wettest of the wet years, when steady high flows at or above 25,000 cfs are required under all the options.

Other than that change, table 3 in appendix E was reformatted so that the tables would not be broken between two pages (page 173 in the original) and the entire document was repaginated to account for several poorly placed page breaks.

I apologize for any confusion this may have caused.

John Hamill, Chief
Grand Canyon Monitoring and Research Center
U. S. Geological Survey
2255 N Gemini Dr. MS 9394
Flagstaff, AZ 86001
voice: 928-556-7364
fax: 928-556-7092
cell: 928-607-5253

cc: Amy Heuslein / Garry Cantley (via fax @ 602-379-3833)

CC: Alberts, Jason; Andersen, Matthew; Balsom, Janet; Barger, Mary; Beard, Chris; Bryant, Nora; Burke, Kelly; Burton, Gary; Christensen, Kerry; Conrad, Tara; Crist, Dena; Damp, Jonathan; Davis, William E.; Fairley, Helen; Garrett, L. David; Greiner, Lloyd; Hamill, John; Hamilton, Lynn; Harris,

Christopher; Henderson, Norm; Jessop, Shirla; Johnson, Rick; Kaplinski, Matt; Kincaid, Chris; King, Robert; Kite, John; Knowles, Glen W.; Kubly, Dennis; McMullen, Ken; Melis, Ted; O'Brien, John; Ostler, Don; Palmer, S. Clayton; Persons, Bill; Peterson, Randall; Powell, Linda; Rogers, Roland; Ryan, Tom; Seaholm, Randy; Skrzynski, LeAnn; smankiller; Steffen, Tim; Stevens, Larry; Yeatts, Michael

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Date: 12/15/2006 12:32:26 PM
Subject: AMWG Action Items & Motions

The following action items and motions were captured from the AMWG meeting held on Dec. 5-6, 2006:

ACTION ITEMS

1. Members should send their comments on the AMP Strategic Plan to Mary Orton by March 1, 2007. Four documents are attached that chronicle the dates that AMWG either internally approved the Strategic Plan, or recommended it to the Secretary of the Interior:

a. The motion that the AMWG passed on January 17, 2002, recommending the strategic plan to the Secretary of the Interior: <2002-01 Action taken on the SP by AMWG.doc>. This included the vision, mission, principles, goals, management objectives, qualitative targets, and narrative sections.

b. The text of the strategic plan that AMWG recommended to the Secretary on January 17, 2002: <_Strategic Plan as recommended to SOTI 2002-01-17.PDF>.

c. Amendments to the strategic plan approved by AMWG in January 2003, along with some agreements on process to complete the strategic plan: <2003-01 Action taken on the SP by AMWG.doc>. AMWG did not recommend these amendments to the Secretary.

d. Amendments to the strategic plan, including Information Needs in sequence order, approved "as a working document" by AMWG (not recommended to the Secretary): <2003-08 Action taken on the SP by AMWG.doc>.

2. The Roles Ad Hoc Group (Randy Peterson, USBR; John Hamill, GCMRC; Dave Garrett, SAs; and Kurt Dongoske, TWG Chair) will review the Roles Ad Hoc Group Report (attached: <roles report final 2006-01.doc>), and will address the Science Advisors' functional recommendations from the Executive Summary of the SPG Report (attached: <roles report final 2006-01>).

3. Members should provide feedback to Dennis Kubly on the following FY08 budget development questions by December 31, 2006. For more information, see the FY08 Budget Development Agenda Information Form from the December 2006 AMWG meeting packet (attached: < FY08 budget final .doc >).

MOTIONS to be forwarded to the Secretary of the Interior:

• Recommend to the Secretary of the Interior to accept the GCMRC Strategic Science Plan dated October 27, 2006.

• AMWG approves the Monitoring and Research Plan (MRP) as a working document to help guide preparation of the FY08-09 workplan and budget; and recommends to the Secretary of the Interior the GCMRC be charged with (1) addressing the concerns listed in the TWG Minority report in a final FY07-11 document, and (2) bringing that document to the AMWG for further consideration in summer 2007.

• AMWG recommends that the Secretary of the Interior consider the following scope in developing the Long Term Experimental Plan EIS:

The alternatives should maintain the balance of benefits to all resources as described in the ROD of the Glen Canyon Dam EIS, while focusing on humpback chub and sediment resources. Insofar as they are consistent with this balance and focus, the elements of the alternatives should:
- include a range of flow events, patterns, and timing
- include non-flow experiments
- be based on credible science planning
- maximize hydropower capacity and flexibility to the extent possible
- address tribal and cultural resources.

The experiments in the plan should be of adequate (but not excessive) duration to allow the determination of actions needed to sustain and, where possible, improve key resources and the balance of benefits to all resources.

The AMWG also forwards to the Secretary for consideration, four options1 and the Modified Low Fluctuating Flow regime from the Glen Canyon Dam EIS ROD, as examples of mixtures of flow and non-flow experiments that have been rigorously debated within the Glen Canyon Dam Adaptive Management Program.

1 GCMRC, 2006, Assessment of the Estimated Effects of Four Experimental Options on Resources below Glen Canyon Dam, table E.1, page 3. USGS, Flagstaff.

• AMWG recommends to the Secretary of the Interior to charge GCMRC to develop a science plan for a BHBF that addresses the concerns raised at the AMWG meeting on Dec. 6, 2006, and AMWG further charges the TWG to work with GCMRC to review the Draft Science Plan and make a recommendation to the AMWG.

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1. Lees Ferry Trout Fishery
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• The AMWG recommends that the Secretary of the Interior support development of refuges to assist in the conservation of the Grand Canyon population of humpback chub. Developing these refuges needs to be a collaborative effort, among the actions taken for this conservation. Further development and operation of refuges should be led under the auspices of a lower Colorado River fish recovery implementation program when this program is underway.

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Date: 11/2/2006 2:42:36 PM

Subject: Memo from AS-WS Limbaugh to AMWG

Please see attached memo from Mr. Mark Limbaugh.

cc: Amy Heuslein /Garry Cantley (via fax @ 602-379-3833)

CC: Alberts, Jason; Andersen, Matthew; Barajas, Federico; Barger, Mary; Conrad, Tara; Fairley, Helen; Garrett, L. David; George, Roxane; Gonzales, Catherine; Hamill, John; Harris, Christopher; Hower, Jonne; Jessop, Shirla; Johnson, Rick; King, Robert; Kubly, Dennis; Lee, Leona; Melis, Ted; Mershon, laurie; O'Brien, John; Orton, Mary; Ostler, Don; Palmer, Clayton; Persons, Bill; Peterson, Randall; Powell, Linda; Seaholm, Randy; Skrzynski, LeAnn; Steffen, Tim; Stevens, Larry; Yeatts, Michael

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Strategic Plan

Glen Canyon Dam
Adaptive Management Program

Approved January 17, 2002

by the Glen Canyon Dam Adaptive Management Work Group

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REFERENCES CITED ..... References Cited–1 to References Cited–3

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FOREWORD

This strategic plan is a guidance document for the Glen Canyon Dam Adaptive Management Program and was developed by program members. Elements of this plan include the Glen Canyon Dam Adaptive Management Work Group's vision and mission statements, as well as principles, goals, and management objectives. One of the primary objectives of the program is to meet the environmental and monitoring commitments of the Glen Canyon Dam Final Environmental Impact Statement and Record of Decision, and comply with the Grand Canyon Protection Act of 1992. The Grand Canyon Protection Act mandated the preparation of the Final Environmental Impact Statement and Record of Decision to direct operations of Glen Canyon Dam and use other authorities 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. Recognizing the complexity of this task, the Record of Decision for the Operation of Glen Canyon Dam Final Environmental Impact Statement directed the Bureau of Reclamation and other interested agencies, tribes, organizations, and individuals to use an adaptive management approach for implementing the preferred alternative. This approach is described in this strategic plan.

It is anticipated that this strategic plan is a long-term plan; however, it is recommended that the Adaptive Management Work Group review this plan at the beginning of every other federal fiscal year. The review process should be completed within six months of the beginning of the fiscal year in which the review takes place. If any of the stakeholders or the interested public identify changes that are needed to the strategic plan, including changes to any of the goals, management objectives, or information needs, these recommendations will be made to the Adaptive Management Work Group for approval and incorporation in a revised plan.

1 INTRODUCTION

This strategic plan describes the adaptive management approach that the Glen Canyon Dam Adaptive Management Program uses in making recommendations to the Secretary of the Interior regarding management of the Colorado River ecosystem (see Glossary). This strategic plan presents the vision, mission, principles, goals, management objectives, information needs, and management actions of the Glen Canyon Dam Adaptive Management Program. As the main planning document of the Adaptive Management Program, this plan has been prepared based on consultation and coordination among those organizations, institutions, and individuals with interests in the operation of Glen Canyon Dam and its effects on the Colorado River ecosystem.

The plan presents the background and history of the Glen Canyon Dam Adaptive Management Program, the scope of the program, the program members or stakeholders, the statutory and organizational framework, and the details of how the Adaptive Management Program operates. The plan details the specific management objectives needed to realize the vision and goals of the program, and whether they are achieved through the Adaptive Management Program or supplemented by funds outside the Program. Supporting documents are provided in a series of appendices.

ADAPTIVE MANAGEMENT PROGRAM ORGANIZATIONAL FRAMEWORK

What is Adaptive Management?

Adaptive management has gained widespread acceptance in resource management since Holling (1978) developed the concept. Lee (1993:9) defines adaptive management with a simple imperative: "policies are experiments; *learn from them*." Other characteristics (as described by Nyberg 1998; Walters 1986; Taylor et al. 1997) include:

- A focus on ecosystems;
- Experimentation and manipulation of managed ecosystems;
- A time scale based on the biological generation or longer;
- Acknowledgement of uncertainty about what policy or practice is best for a particular management issue;
- Careful implementation of a plan of action designed to reveal the critical knowledge;
- Monitoring of key response indicators;
- Analysis of outcomes in consideration of original objectives; and
- Incorporation of results into future decisions.

Glen Canyon Dam Adaptive Management Program Defined

Due to the significant levels of uncertainty surrounding the resources of the Colorado River ecosystem and the effects of dam operations on those resources, the Glen Canyon Dam Environmental Impact Statement stipulated an adaptive management approach. This approach allows for scientific experimentation that adds to the knowledge base of effects of the operation

of Glen Canyon Dam, primarily on downstream resources, and results in the development of recommendations to the Secretary of the Interior regarding additional operational changes.

The adaptive management approach being taken to manage Glen Canyon Dam operations and the resources affected by dam operations is as follows:

- The Adaptive Management Program focus is on the Colorado River ecosystem;
- The AMP evaluates how well the preferred alternative of the EIS/ROD and other management actions meet the goals of the GCPA and the mix of resources benefits in the EIS/ROD;
- Models are developed to reveal the potential effects of policies, activities, or practices that are being considered for implementation;
- Questions are formulated as testable hypotheses regarding the expected responses or linkages of the Colorado River ecosystem to dam operations and other management actions;
- Questions are formulated as testable hypotheses;
- Experiments are conducted to test hypotheses and answer questions;
- Management activities reveal, through monitoring and evaluation of results, the accuracy or completeness of the earlier predictions; and
- New knowledge and information produced through experimentation are incorporated into management discussions and recommendations to the Secretary of the Interior.

Organizations and Positions Within the Glen Canyon Dam Adaptive Management Program

With the signing of the Record of Decision for the Glen Canyon Dam Environmental Impact Statement (Reclamation 1996), the Glen Canyon Dam Adaptive Management Program was established, along with the following positions or organizations:

- Secretary of the Interior's Designee
- Adaptive Management Work Group
- Technical Work Group
- Independent review panels
- Grand Canyon Monitoring and Research Center

The roles, functions, and relationships of these positions and organizations are graphically depicted in Fig. 1 and are described in detail below based on the descriptions in the Glen Canyon Dam Environmental Impact Statement (Reclamation 1995) and Record of Decision (Reclamation 1996).

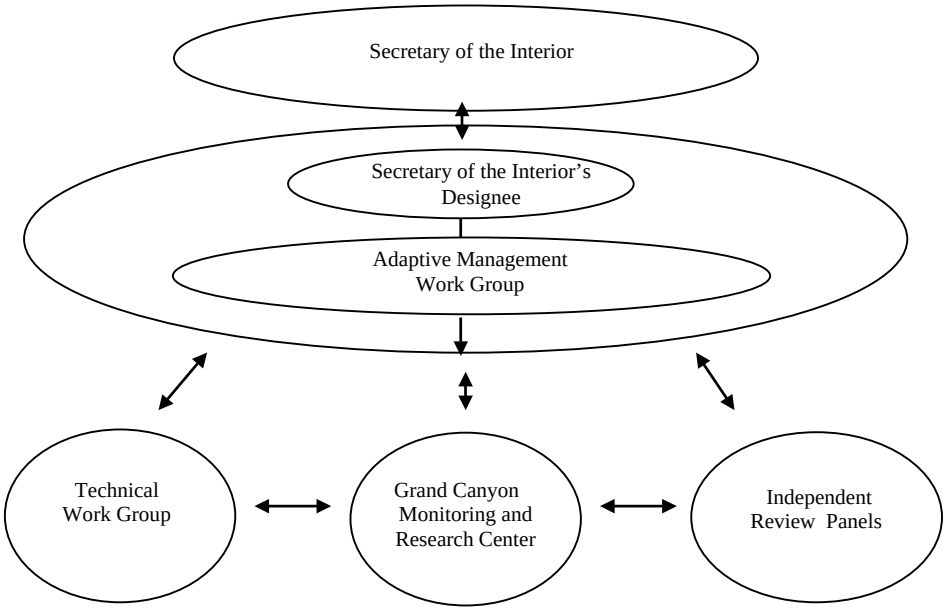

Figure 1. Organizational components of the Glen Canyon Dam Adaptive Management Program.

Secretary of the Interior's Designee

The Secretary of the Interior's Designee serves as the principal contact for the Glen Canyon Dam Adaptive Management Program and as the focal point for issues and decisions associated with the program. Responsibilities of the position include:

- Chairs the Adaptive Management Work Group;
- Ensures that the Department of the Interior complies with its obligations under the Grand Canyon Protection Act and Record of Decision for the Glen Canyon Dam Environmental Impact Statement;
- Ensures that the Department of the Interior fulfills its trust responsibilities to American Indian tribes with interests or assets affected by the program; and
- Reviews, modifies, accepts, or remands recommendations from the Adaptive Management Work Group in making decisions about any changes in dam operation and other management actions and forwards the approved recommendations to the Secretary of the Interior.

Adaptive Management Work Group

The Adaptive Management Work Group is a Federal Advisory Committee that includes representatives from the stakeholder tribes, organizations, and institutions listed below. The Secretary of the Interior appoints the Adaptive Management Work Group members. Responsibilities of the Adaptive Management Work Group as delineated in the Glen Canyon Dam Environmental Impact Statement (Reclamation 1995:36) are:

- Provides the framework for Glen Canyon Dam Adaptive Management Program policy, goals, direction, and priorities;
- Develops recommendations to the Secretary of the Interior for modifying operating criteria and other resource management actions, policies, or procedures;
- Facilitates coordination and input from interested parties;
- Reviews and forwards the annual report to the Secretary of the Interior and his/her designee on current and projected year operations;
- Reviews and forwards annual budget proposals; and
- Ensures coordination of operating criteria changes in the Annual Operating Plan for Colorado River Reservoirs and other ongoing activities.

Note that "dam operations" refers to the operation of the power plant and other release structures, such as bypass structures, spillways, and, potentially, a temperature control device, among others. Their uses conform to applicable law. The Adaptive Management Work Group develops recommendations for all of the dam's structures to further the purposes of the Grand Canyon Protection Act, the Glen Canyon Dam Environmental Impact Statement, and Record of Decision. This is done within the limits of the Record of Decision and through experimentation.

Representatives from the following tribes, organizations, or interest groups are presently included in the Adaptive Management Work Group:

- Arizona Department of Water Resources
- Arizona Game and Fish Department
- Bureau of Reclamation
- Bureau of Indian Affairs
- Colorado River Board of California
- Colorado River Commission of Nevada
- Colorado River Energy Distributors Association
- Colorado Water Conservation Board
- Grand Canyon River Guides
- Grand Canyon Trust
- Hopi Tribe
- Hualapai Tribe
- National Park Service
- Navajo Nation
- New Mexico State Engineer's Office
- Pueblo of Zuni
- Southern Paiute Consortium
- Southwest Rivers
- Trout Unlimited
- U. S. Fish and Wildlife Service
- Utah Associated Municipal Power Systems
- Utah Division of Water Resources
- Western Area Power Administration
- Wyoming State Engineer's Office

Technical Work Group

The Technical Work Group is comprised of technical representatives of Adaptive Management Work Group members and operates at the direction of the Adaptive Management Work Group. The Technical Work Group's main function is to provide technical assistance to the Adaptive Management Work Group. Technical Work Group functions may include (Reclamation 1995:37):

- Developing, with the Grand Canyon Monitoring and Research Center, criteria and standards for monitoring and research programs and providing periodic reviews and updates of these;
- Developing, with the Grand Canyon Monitoring and Research Center, resource management questions (i.e., information needs);
- Reviewing and commenting on the scientific studies conducted or proposed by the program;
- Provide a forum for discussion by Technical Work Group members, external scientists, the public, and other interested persons;
- Providing information as necessary for preparing annual resource reports and other reports as required by the Adaptive Management Work Group; and
- Reviewing strategic plans, annual work plans, long-term and annual budgets, and other assignments from the Adaptive Management Work Group.

Grand Canyon Monitoring and Research Center

The Grand Canyon Monitoring and Research Center was created to fulfill the mandate in the Grand Canyon Protection Act for the "establishment and implementation of a long-term monitoring and research program to ensure that Glen Canyon Dam is operated in a manner that protects the values for which the Grand Canyon National Park and the Glen Canyon National Recreation Area were created." The Grand Canyon Monitoring and Research Center serves as the science center for the Glen Canyon Dam Adaptive Management Program. The Grand Canyon Monitoring and Research Center leads the monitoring and research of the Colorado River ecosystem and facilitates communication and information exchange between scientists and members of the Technical Work Group and Adaptive Management Work Group. Other functions of the Grand Canyon Monitoring and Research Center are:

- Advocate quality, objective science, and the use of that science in the adaptive management decision process;
- Provide scientific information about resources in the Colorado River ecosystem;
- Support the Secretary of the Interior's Designee and the Adaptive Management Work Group in a technical advisory role;
- Develop research designs and proposals for implementing (by the Grand Canyon Monitoring and Research Center or its contractors) monitoring and research activities in support of information needs;
- Coordinate review of the monitoring and research program with independent review panels;
- Coordinate, prepare, and distribute technical reports and documentation for review and as final products;
- Prepare and forward technical management recommendations and annual reports, as specified in Section 1804 of the Grand Canyon Protect Act, to the Technical Work Group;
- Manage data collected as part of the Adaptive Management Program and serve as a repository for other information about the Colorado River ecosystem;
- Administer research proposals through a competitive contract process, as appropriate;

- Develop, with the Technical Work Group, criteria and standards for monitoring and research programs; and
- Develop, with the Technical Work Group, resource management questions (i.e., information needs).
- Produce the State of the Colorado River Ecosystem Report.

Independent Review Panels

Independent Review Panels, as called for in the Glen Canyon Dam Environmental Impact Statement (Reclamation 1995:38), are comprised of qualified individuals not otherwise participating in the long-term monitoring and research studies. The panels include peer reviewers, science advisors, and protocol evaluation panels whose primary responsibility is to assess the quality of research, monitoring, or science being conducted by the Adaptive Management Program and to make recommendations to improve it. Responsibilities of the panels include:

- Reviewing Glen Canyon Dam Adaptive Management Program monitoring and research programs and protocols;
- Providing reports based on their review to the Grand Canyon Monitoring and Research Center, Technical Work Group, and Adaptive Management Work Group;
- Making recommendations and providing advice to the Adaptive Management Work Group, Technical Work Group, and Grand Canyon Monitoring and Research Center regarding science activities;
- Assessing proposed research plans and programs, technical reports and publications, and other program accomplishments; and
- Conducting five-year reviews of Grand Canyon Monitoring and Research Center monitoring and research protocols.

History of the Glen Canyon Dam Adaptive Management Program

This strategic plan and the Glen Canyon Dam Adaptive Management Program cannot be understood without referencing key events since completion of Glen Canyon Dam in 1963. The plan and program arose from the Bureau of Reclamation's proposal to install additional generators on the bypass tubes and to rewind and uprate the existing generators at Glen Canyon Dam. This proposal resulted in the establishment of the Glen Canyon Environmental Studies that existed from 1982 through 1996**.**

Glen Canyon Environmental Studies

While the National Park Service, Native Americans, river runners, and scientists had noticed that some beaches were disappearing and that plant and animal life along the Colorado River were changing since Glen Canyon Dam was completed in 1963, the Glen Canyon Environmental Studies program of the Bureau of Reclamation was the first systematic effort to investigate the effects of dam operations on downstream resources. The program began in 1982 and lasted through 1996. The Glen Canyon Environmental Studies did identify a mix of positive and negative consequences of dam operations on the downstream environment. In response to substantial public concern over the findings of the Glen Canyon Environmental Studies, in 1989 the Secretary of the Interior announced that an environmental impact statement would be completed to evaluate the operation of Glen Canyon Dam. With this announcement, the Glen

Canyon Environmental Studies focused on providing specific data for use in the Glen Canyon Dam Environmental Impact Statement (Reclamation 1995).

Grand Canyon Protection Act

The Grand Canyon Protection Act (Appendix A) was enacted on October 30, 1992. Section 1802 states:

> (a) IN GENERAL.–The Secretary shall operate Glen Canyon Dam in accordance with the additional criteria and operating plans specified in Section 1804 and exercise other authorities under existing law 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.
>
> (b) COMPLIANCE WITH EXISTING LAW.–The Secretary shall implement this section in a manner fully consistent with and subject to the Colorado River Compact, the Upper Colorado River Basin Compact, the Water Treaty of 1944 with Mexico, the decree of the Supreme Court in Arizona vs. California, and the provisions of the Colorado River Storage Project Act of 1956 and the Colorado River Basin Project Act of 1968 that govern allocation, appropriation, development, and exportation of the waters of the Colorado River Basin.
>
> (c) RULE OF CONSTRUCTION.–Nothing in this title alters the purposes for which the Grand Canyon National Park or the Glen Canyon National Recreation Area were established or affects the authority and responsibility of the Secretary with respect to the management and administration of the Grand Canyon National Park and Glen Canyon National Recreation Area, including natural and cultural resources and visitor use, under laws applicable to those areas, including, but not limited to, the Act of August 25, 1916 (39 Stat. 535) as amended and supplemented.

The Secretary of the Interior was also directed to establish and implement long-term monitoring programs and activities to ensure that Glen Canyon Dam is operated in a manner consistent with the Grand Canyon Protection Act. These programs include necessary research and studies to determine the effect of management of the dam on the natural, recreational, and cultural downstream resources. These actions will also be undertaken in consultation with other federal agencies, the Governors of the Basin States, Indian Tribes, and the general public, including representatives of academic and scientific communities, environmental organizations, the recreation industry, and contractors for the purchase of federal power produced at Glen Canyon Dam. To accomplish these requirements, the Glen Canyon Dam Adaptive Management Program was established.

Glen Canyon Dam Environmental Impact Statement

The Glen Canyon Dam Environmental Impact Statement (Reclamation 1995) was completed in March 1995. Its purpose was to "determine specific options that could be implemented to minimize—consistent with law—adverse impacts on the downstream environmental and cultural resources and Native American interests in Glen and Grand Canyons." The Glen Canyon Dam

Environmental Impact Statement analyzed nine alternatives to allow the Secretary of the Interior to balance competing interests and to meet statutory responsibilities for protecting downstream resources and producing hydropower, and to protect affected Native American interests. The preferred alternative was the Modified Low Fluctuating Flow Alternative.

Record of Decision on the Operation of Glen Canyon Dam

On October 9, 1996, the Secretary of the Interior signed the Record of Decision that presented the rationale for choosing the Modified Low Fluctuating Flow Alternative. As noted in the Record of Decision:

> The goal of selecting a preferred alternative was not to maximize benefits for the most resources, but rather to find an alternative dam operating plan that would permit recovery and long-term sustainability of downstream resources while limiting hydropower capability and flexibility only to the extent necessary to achieve recovery and long-term sustainability. [Reclamation 1996:10]

The Record of Decision (Appendix G) included seven environmental and monitoring commitments:

- Adaptive Management
- Monitoring and Protection of Cultural Resources
- Flood Frequency Reduction Measures
- Beach/Habitat-Building Flows
- New Population of Humpback Chub
- Further Study of Selective Withdrawal
- Emergency Exception Criteria

The commitments are explained in detail in the Record of Decision (Reclamation 1996; Appendix G) and in the Glen Canyon Dam Environmental Impact Statement (Reclamation 1995:33-34); however, it should be noted that subsequent work of the Technical Work Group and Adaptive Management Work Group have altered some commitments (Technical Work Group 1998) with Endangered Species Act and National Environmental Policy Act compliance.

Statutes, Policies, and Resolutions

The Colorado River is managed and operated under numerous compacts, federal and state laws, court decisions and decrees (including Native American water claim settlements), contracts, treaties, and regulatory guidelines collectively known as the Law of the River. This collection of documents apportions the water among the seven Basin States and Mexico, and regulates and manages the river flows of the Colorado River. Some of the statutes included within the Law of the River that have a major impact on dam operations are the Colorado River Compact of 1922, the Upper Colorado River Basin Compact of 1948, the Colorado River Storage Project Act of 1956, the Colorado River Basin Project Act of 1968, and the Grand Canyon Protection Act of 1992. In addition to Colorado River specific legislation, the Endangered Species Act of 1973 and court decrees including Arizona v. California affect the extent to which water developments

and diversions can be utilized in the Colorado River Basin. The Law of the River and this additional legislation control and influence the Adaptive Management Program.

Additional laws, Acts of Congress, executive orders, policies, tribal resolutions, etc., that control or influence the Adaptive Management Program include the National Park Service Organic Act, enabling legislation for Grand Canyon National Park and Glen Canyon National Recreation Area, and Executive Orders that established reservation boundaries for the Navajo Nation and the Hualapai Tribe. In addition, Section 204 of Title II of Public Law 106-377 controls the level of funding of Adaptive Management Program activities from Colorado River Storage Project power revenues. The Federal Advisory Committee Act controls operation of the Adaptive Management Work Group and the Technical Work Group.

Environmental laws and regulations are important to the Adaptive Management Program. These include, but are not limited to, the Endangered Species Act, National Historic Preservation Act of 1966, and National Environmental Policy Act of 1969. Adaptive Management Program compliance with these statutes, regulations, policies, directives, etc., is described in a later section.

Guidance Document for the Adaptive Management Program

Since the Adaptive Management Program became fully operational in 1997, questions and uncertainties have arisen over the relationships of program elements, compliance priorities, and other legal matters. Answers were sought from a Department of the Interior Solicitor. The questions posed and answers received from the Department of the Interior's Solicitor (Loveless 2000) are called the "Guidance Document for the Adaptive Management Program." This document is provided as Appendix B.

Summary of the Glen Canyon Dam Adaptive Management Program

The Adaptive Management Program was developed and designed to provide an organization and process for a collaborative, science-based integration of monitoring and research information to make formal recommendations to the Secretary of the Interior. These recommendations must recognize the environmental commitments of the Glen Canyon Dam Environmental Impact Statement and Record of Decision, and comply with the Grand Canyon Protection Act. The Adaptive Management Program must also remain in compliance with the Law of the River and relevant environmental statutes, regulations, and policies. With all these demands, the Adaptive Management Work Group devised a vision and mission statement and principles to guide its activities and decision making.

2 DESIRED RESOURCE CONDITIONS

VISION AND MISSION

The combined Vision and Mission statement reads as follows:

> The Grand Canyon is a homeland for some, sacred to many, and a national treasure for all. In honor of past generations, and on behalf of those of the present and future, we envision an ecosystem where the resources and natural processes are in harmony under a stewardship worthy of the Grand Canyon.
>
> We advise the Secretary of the Interior on how best to protect, mitigate adverse impacts to, and improve the integrity of the Colorado River ecosystem affected by Glen Canyon Dam, including natural biological diversity (emphasizing native biodiversity), traditional cultural properties' spiritual values, and cultural, physical, and recreational resources through the operation of Glen Canyon Dam and other means.
>
> We do so in keeping with the federal trust responsibilities to Indian tribes, in compliance with applicable federal, state, and tribal laws, including the water delivery obligations of the Law of the River, and with due consideration to the economic value of power resources.
>
> This will be accomplished through our long-term partnership utilizing the best available scientific and other information through an adaptive ecosystem management process.

PRINCIPLES

The nine principles of the Glen Canyon Dam Adaptive Management Program are:

1. The goals represent a set of desired outcomes that together will accomplish our vision and achieve the purpose of the Grand Canyon Protection Act. Some of the objectives and actions that fall under these goals may not be the responsibility of the Adaptive Management Program, and may be funded by other sources, but are included here for completeness.
2. The construction of Glen Canyon Dam and the introduction of non-native species have irreversibly changed the Colorado River ecosystem.
3. Much remains unknown about the Colorado River ecosystem below Glen Canyon Dam and how to achieve the Adaptive Management Program goals.
4. The Colorado River ecosystem is a managed ecosystem. An ecosystem management approach, in lieu of an issues, species, or resources approach, will guide our efforts. Management efforts will prevent any further human-induced extirpation or extinction of native species.
5. An adaptive management approach will be used to achieve Adaptive Management Program goals, through experimentation and monitoring, to meet the intent of the Grand Canyon Protection Act, Glen Canyon Dam Environmental Impact Statement, and the Record of Decision.

6. Dam operations and management actions will be tried that attempt to return ecosystem patterns and processes to their range of natural variability. When this is not appropriate, experiments will be conducted to test other approaches.
7. Because management actions to achieve a goal may benefit one resource or value and adversely affect another, those action alternatives that benefit all resources and values will be pursued first. When this is not possible, actions that have a neutral impact, or as a last resort, actions that minimize negative impacts on other resources, will be pursued consistent with the Glen Canyon Dam Environmental Impact Statement and the Record of Decision.
8. If the target of a management objective proves to be inappropriate, unrealistic, or unattainable, the Adaptive Management Program will reevaluate that target and the methods used to attain it.
9. Recognizing the diverse perspectives and spiritual values of the stakeholders, the unique aesthetic value of the Grand Canyon will be respected and enhanced.

GOALS

The 12 goals of the Adaptive Management Program are:

1. Protect or improve the aquatic foodbase so that it will support viable populations of desired species at higher trophic levels.
2. Maintain or attain viable populations of existing native fish, remove jeopardy from humpback chub and razorback sucker, and prevent adverse modification to their critical habitat.
3. Restore populations of extirpated species, as feasible and advisable.
4. Maintain a naturally reproducing population of rainbow trout above the Paria River, to the extent practicable and consistent with the maintenance of viable populations of native fish.
5. Maintain or attain viable populations of Kanab ambersnail.
6. Protect or improve the biotic riparian and spring communities, including threatened and endangered species and their critical habitat.
7. Establish water temperature, quality, and flow dynamics to achieve the Adaptive Management Program ecosystem goals.
8. Maintain or attain levels of sediment storage within the main channel and along shorelines to achieve the Adaptive Management Program ecosystem goals.
9. Maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of the Adaptive Management Program ecosystem goals.
10. Maintain power production capacity and energy generation, and increase where feasible and advisable, within the framework of the Adaptive Management ecosystem goals.
11. Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of past, present, and future generations.
12. Maintain a high quality monitoring, research, and adaptive management program.

MANAGEMENT OBJECTIVES

Goal 1. Protect or improve the aquatic foodbase so that it will support viable populations of desired species at higher trophic levels.

The target for all the Management Objectives in Goal 1 is adequate food availability to support trout and native fish above the Paria River and native fish below the Paria River. Linkages: See the number of fish desired under Goals 2, 3, and 4.									
1.1	Maintain or attain	Primary producers: algae on hard substrates, rooted macrophytes on soft substrates, and diatoms	Biomass	Mainstem from Glen Canyon Dam to the Paria River in both pools and on cobble bars identified by specific sampling sites	$x \pm y$ g/m^2 (cobble)[0] $a \pm b$ g/m^2 (pool) (To be provided from Shannon.)			$x \pm y$ g/m^2 (cobble) $a \pm b$ g/m^2 (pool) (Need to resolve differences between data from Shannon et al. and AGFD.)	See McKinney et al. 1999[22] The small group suggested the target should be the average of 1996 and 1997 data which they believe represents the best biomass estimates for the period in which data are available, and because they appeared to be good years to support the desired species.
			Composition		River Mile	% Algae	% Macro-phytes	Information Need	Given the change in composition, the idea of Cladophora as a keystone species has been called into question. Scientists have said composition is an Information Need and should not be broken down below algae and macrophytes at this point in time.
					Pools				
						IN	IN		
						IN	IN		
						IN	IN		
					Cobbles				
						IN	IN		
						IN	IN		
						IN	IN		

Goal 1. Protect or improve the aquatic foodbase so that it will support viable populations of desired species at higher trophic levels.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
1.2	Maintain or attain	Benthic invertebrates	Biomass	Mainstem from Glen Canyon Dam to Paria River	x ± y g/m^2 (cobble) a ±- b g/m^2 (pool)	x ± y g/m^2 (cobble) a ± b g/m^2 (pool)	See McKinney *et al.* 1999[22]
			Composition		<u>Cobble</u>: __ % Tubificids __ % *Gammarus* __ % Chironomids __ % Gastropods __ % Other <u>Pool</u>: __ % Tubificids __ % *Gammarus* __ % Chironomids __ % Gastropods __ % Other (per Shannon and AGFD.)	Information Need	Metric is relative % of species.
1.3	Maintain or attain	Primary producers: algae on hard substrates, rooted macrophytes on soft substrates, and diatoms	Biomass	Mainstem below the Paria River on cobble bars identified by specific sampling sites	River Mile / g/m^2 Cobble 2 61 68 127 205	50 g/m^2[27]	
			Composition		River Mile / % Algae / % Macro-phytes Pools 2 61 68 127 205 Cobble 2 61 68 127 205	Information Need	Metric is relative % of algal species. MAMB is for miscellaneous algae, macrophytes, and bryophytes

Goal 1. Protect or improve the aquatic foodbase so that it will support viable populations of desired species at higher trophic levels.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
1.4	Maintain or attain	Benthic invertebrates	Biomass	Mainstem below the Paria River	0.960 g/m^2 (cobble)[27] 0.054 g/m^2 (pool)[27]	To be provided based on 1996-97 data.	
			Composition		Cobble: __ % Tubificids __ % *Gammarus* __ % Chironomids __ % Gastropods __ % Other Pool: __ % Tubificids __ % *Gammarus* __ % Chironomids __ % Gastropods __ % Other	Obtain from literature	Metric is relative % of species.
1.5	Maintain or attain	Foodbase drift: Diptera *Gammarus* Other Bugs CPOM FPOM DOC	Abundance	Mainstem below GCD	River Mile / AFDW 2 61 68 127 205	To be provided based on 1996-1997 data	

Goal 2. Maintain or attain viable populations of existing native fish, remove jeopardy from humpback chub and razorback sucker, and prevent adverse modification to their critical habitat.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
2.1	Maintain or attain	Humpback chub (150 mm and larger) (Length is based on the size at which a HBC is able to be pit-tagged.)	Abundance	LCR aggregation (The definition of the LCR aggregation will be resolved following completion of the stock assessment workshop and the PEP review.)	4330-4811 individuals[3] with a mean of 4508 individuals	Information Need	The target is viable populations and removal of jeopardy. Target to be based on 91-96 population estimate, PVA, & N_e.
				Eight mainstem aggregations	Information Need Confidence interval with a mean of 225 individuals?	Information Need	
2.2	Maintain or attain	Humpback chub (51 mm to 150 mm)	Year class strength	LCR aggregation	Information Need. Consider using a CPUE index for different year classes, at some place in the LCR at some time during the year.	Information Need. Intended to be an index that will indicate spawning success.	The target is viable populations and removal of jeopardy. Metric is catch per unit effort (CPUE). See Gorman and Bramblett.[9] See synthesis by Coggins.
				Eight mainstem aggregations	Information Need	Information Need	
2.3	Maintain or attain	Humpback chub (> 200 mm) (This is the length at which 50% of the fish are thought to be sexually mature.)	Recruitment	LCR aggregation	Information Need	Information Need	The target is viable populations and removal of jeopardy.
				8 mainstem aggregations	Information Need	Information Need	
2.4	Establish	Humpback chub	Spawning aggregation	CRE below GCD	One spawning aggregation in the LCR	A second spawning aggregation	The target is removal of jeopardy.
2.5	Attain	Humpback chub	Condition	LCR aggregation	Information Need	Information Need. There should be a minimum threshold.	The target is viable populations and removal of jeopardy. PEP should be asked to evaluate the method that would be used to calculate condition and
				8 mainstem aggregations	Information Need	Information Need	
			Disease and other	LCR aggregation	Information Need	Information Need	

Goal 2. Maintain or attain viable populations of existing native fish, remove jeopardy from humpback chub and razorback sucker, and prevent adverse modification to their critical habitat.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
			parasites	8 mainstem aggregations	Information Need	Information Need	the value to be established as the threshold.
2.6	Reduce	Native fish	Mortality due to non-native fish predation as a % of overall mortality	LCR	Information Need	Information Need	The target is reduction of non-native fish predation so it does not impinge on native fish viability. Linkages: The native fish MOs in Goal 2 and Goal 3.
				Mainstem	Information Need	Information Need	
2.7	Attain	Razorback sucker	Abundance	CRE below GCD	0 individuals[9]	Information Need	The target is derived from the capability of the habitat to support the species, and includes the removal of jeopardy.
2.8	Maintain	Flannelmouth sucker	Abundance	CRE below GCD	AGFD to provide [9]	Information Need	Appropriate metric to be determined. The target is viable populations.
			Distribution		AGFD to provide [9]	Information Need	
		Bluehead sucker	Abundance		AGFD to provide [9]	Information Need	
			Distribution		AGFD to provide [9]	Information Need	
		Speckled dace	Abundance		AGFD to provide [9]	Information Need	
			Distribution		AGFD to provide [9]	Information Need	

Goal 3. Restore populations of extirpated species, as feasible and advisable.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
3.1	Restore	Colorado pikeminnow	Abundance	CRE downstream of GCD	0 individuals[9]	Information Need	
		Bonytail			0 individuals[9]	Information Need	
		Roundtail Chub			0 individuals[9]	Information Need	
		River otter			0 individuals[10]	Information Need	

Goal 4. Maintain a naturally reproducing population of rainbow trout above the Paria River, to the extent practicable and consistent with the maintenance of viable populations of native fish.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
Linkages: See Issue Paper B (trout).							
4.1	Maintain or attain	Rainbow trout (RBT)	Abundance	Mainstem from Glen Canyon Dam to Paria River	260,000 ± 30,000 Age II+ individuals[23]	100,000 Age II+ individuals	The target is adequate abundance of wild-reproducing Rainbow trout to maintain a quality recreational fishery, while not adversely affecting native fish population viability.
					Electrofishing CPUE	Information Need	
			Proportional stock density (see below)		15%	Information Need	Might replace measure of "length at age" in the future. Value of metric needs to be assessed.
			Length at age		15" by Age III[23]	15 – 18" by Age III	
			Condition		$W_r = 0.82$[23]	$W_r = 0.90$	
			Whirling disease and other parasitic infections		Absence	Absence	
			Spawning habitat		Information Need	Information Need	Metric is quality and abundance of habitat.
			Natural recruitment		100%	100%	This MO restates and measures the goal.
4.2	Limit	Lees Ferry RBT	Distribution	CRE below the Paria River	Information Need	Information Need. Need research and data that demonstrate predator-prey and competitive effect.	The target is minimal competitive or predator-prey effect on downstream native fish.

Proportional Stock Density is the ratio that results by dividing the number of fish great than 16 inches by the number of all fish greater than 12 inches. This provides a measure of the abundance of fish at a certain size, which should translate into a target for both abundance and length at age.

Goal 5. Maintain or attain viable populations of Kanab ambersnail.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
5.1	Attain and maintain	Kanab ambersnail	Population	Vasey's Paradise	7100 (April 1999) 6400 (May 1999) 20,000 (July 1999) 35,000 (Sept/Oct 1999) (Individuals below 70,000 cfs stage)[24]	Information Need (to be measured in the spring and before any Management Action that may affect the population)	The metric is the population parameter(s) that indicate viability. The target is a viable population. "Viable" includes the entire population, not just those below 70,000 cfs. Management Action: monitor the KAS populations at Keyhole, Elves, and Deer Creek
5.2	Maintain	Kanab ambersnail	Habitat	Vasey's Paradise	82-99 m^2 monkeyflower and 36.6 m^2 watercress below 70,000 cfs stage. Information Need (for above new stage level when it is determined)	Information Need. An x-year running average greater than or equal to y% of the total area of occupied habitat measured at Vasey's in March 1996, with a minimal level TBD.	The target is the level needed to sustain a viable population. Purpose is to limit human impact, by intentional flooding or other actions, to habitats occupied by Kanab ambersnail.

Goal 6. Protect or improve the biotic riparian and spring communities, including threatened and endangered species and their critical habitat.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
The target is an achievable and appropriate mix of four types of communities: marsh, open sand beach, old high water zone (OHWZ), and new high water zone (NHWZ). All four communities are important for maintaining the diversity of wildlife, visitor use, and cultural resources. See the Riparian Issue Paper for more information.							
6.1	Maintain	Marsh community	Abundance	CRE below GCD, and above Lake Mead's water level as it fluctuates due to Hoover Dam operations	1215 patches (4.6 ha)[7]	For an x-year running average of y or more marsh patches >/= 10 m^2, as determined by standard criteria for wetland species, soil type, and wetted area.	See Kearsley[15] and Stevens *et al.* [29].
			Composition		Information Need	No loss of native species. Species are assumed still to be present when they have been detected by monitoring within the last 10 years.	
			Area		Information Need	For an x-year running average area equal to ± y% of the area defined by aerial imaging in 2000.	
6.2	Maintain	New high water zone community	Patch number and distribution	CRE below GCD, and above Lake Mead's water level as it fluctuates due to Hoover Dam operations	Information Need	Information Need	The target is to allow for scouring of NHWZ vegetation to 1984 levels for patch number and distribution, and then allow its return through successional processes
			Composition		Information Need	Species are assumed still to be present when they have been detected by monitoring within the last 10 years.	The target is to allow no loss of native plant or animal species.

Goal 6. Protect or improve the biotic riparian and spring communities, including threatened and endangered species and their critical habitat.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
			Area		Information Need	For an x-year running average area equal to ±- y% of the area defined by aerial imaging in 2000.	NHWZ vegetation & sand beaches occur in the same strip of land. An increase to NHWZ vegetation will reduce the amount of open sand, and vice versa. These objectives are therefore closely linked to each other, as well as to the beach-building effects of BHBFs.
6.3	Maintain	Old high water zone community	Abundance	CRE below GCD, and above Lake Mead's water level as it fluctuates due to Hoover Dam operations	In 1992, there was an estimated 1,870 acres of OHWZ vegetation (Stevens 1992).	Information Need	The target is no significant loss of area.
			Composition		Information Need	Information Need	The target is no loss of native plant or animal species.
			Distribution		Information Need	Information Need	
6.4	Maintain	Sand Beach community	Abundance	CRE below GCD, and above Lake Mead's water level as it fluctuates due to Hoover Dam operations	Information Need	Information Need	See Kearsley [15] and Stevens *et al.* [29]
			Composition		Information Need	Information Need	
			Distribution		Information Need	Information Need	
6.5	Reduce	Invasive non-native species	Abundance (Abundance refers to number of individuals within the species. These species should be limited to invasive ones, not just non-natives.)	CRE below GCD, and above Lake Mead's water level as it fluctuates due to Hoover Dam operations	95+ species (plants)[28] 3 species (birds)[28]	No new non-native species. Invasive non-native species cover </= x% of total riparian area. The targets are species-specific. (Information Need)	The target for abundance is the level at which these species do not impinge on biological, recreational, and cultural resources.

Goal 6. Protect or improve the biotic riparian and spring communities, including threatened and endangered species and their critical habitat.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
			Distribution		Information Need	Information Need	The target for distribution is no spreading of invasive non-native species to areas where they do not already occur.
6.6	Maintain	Spring and wetland	Habitat occupied by rare and endemic species	CRE below GCD, and above Lake Mead's water level as it fluctuates due to Hoover Dam operations	Information Need	Information Need	The target is to maintain the capability of these habitats to support the rare and endemic species known to live there. The targets should recognize the dynamic nature of these habitats as influenced by flow events.
6.7	Maintain	Southwest willow flycatcher	Riparian habitat	CRE below GCD, and above Lake Mead's water level as it fluctuates due to Hoover Dam operations	Information Need	Information Need	The target is the capability of the habitat to support the species. The target is a dynamic mosaic of NHWZ, OHWZ, and marsh vegetation. The definition of critical habitat will change as we learn more about the species' needs.

Goal 7. Establish water temperature, quality, and flow dynamics to achieve GCDAMP ecosystem goals.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
7.1	Attain	Water	Temperature range	Mainstem	6.93-18.56 °C[17]	Information Need	The target may include several stations in the mainstem.
			Seasonal variability of temperature		Information Need	Information Need	
The target for MO 7.1 is a temperature range and pattern of seasonal variability based on the range of natural variability, the physical capacity of the dam, and the range that optimizes conditions for the targeted resources. Targeted resources may include foodbase, native fish, trout, and people (human health and safety – microorganisms and hypothermia). Temperature patterns should have as their first priority the improvement of conditions for native biological resources, including native fish, and including foodbase and trout interactions. This is based on the special status of native fish. Linkages: MO 13; Principles 4, 6, and 7; and the Vision-Mission statement.							
7.2	Maintain	Water	Quality	Mainstem	Information Need (for the specific water quality parameters to use).	Information Need	Parameters may include nutrients, salinity, pH, DO, nitrogen, phosphorus, microbes, and others. Data available from NASQWAN.[35]
The target for MO 7.2 is water quality based on the range of natural variability, the physical capacity of the dam, the legally defined state water quality standards, and the range that optimizes conditions for the targeted resources. The targeted resources may include foodbase, native fish, trout, Southwestern willow flycatcher, riparian and spring communities, the recreational experience, and cultural resources. Linkages: Goals 1-3, 8-10, and 12.							
7.3	Maintain	Flow dynamics	Power plant operations	Mainstem	ROD operating criteria	Dam operating criteria then in effect	See MO 50 for experimental flows.
			BHBF flows		Maximum 45,000 cfs (March to April)	Dam operating criteria then in effect	
			Habitat maintenance flows		ROD operating criteria	Dam operating criteria then in effect	

Goal 8. Maintain or attain levels of sediment storage within the main channel and along shorelines to achieve GCDAMP ecosystem goals.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
The target for Goal 8 is enough sediment to achieve the biological, recreational, and cultural goals. Given limited sediment inputs, we need to retain enough sediment in the system to achieve ecosystem patterns in these goals). For the biological goals, the purposes are habitat and nutrient storage. For the cultural goal, the purposes are enhancing plant habitat and preserving historical properties. For recreational goals, the purposes are camping beaches and trout spawning habitat. Linkages: Recreational, biological, and cultural goals: 1-4, 7-10, and 12.							
8.1	Maintain or attain	Sediment	Abundance	Main channel below 5,000 cfs	Information Need	Current volumes or higher (trend), including some timeframe based on tributary inputs and high flows timing (Information Need).	Metric is volume (m^3) as a rolling average.
			Grain-size		Information Need	Current level or finer (trend), including some timeframe based on reach, tributary inputs and high flows timing (Information Need).	Metric is D50 (median) grain size. Also, see Kondolf.[16]
			Distribution		Information Need Current level to be obtained from side scan sonar and video (Anima) and/or multi-beam.	Current level or more areally extensive (trend), including some timeframe based on tributary inputs and high flows timing (Information Need).	Metric is patchiness and area (m^2) of sand on channel bottom.
8.2	Maintain or attain	Sediment	Abundance	Channel margins (not eddies) from 5,000 to 25,000 cfs	Information Need	Information Need, including some timeframe based on tributary inputs and high flows timing.	Metric is area (m^2) and volume (m^3) as a rolling average.
			Grain-size		Information Need	Information Need, including some timeframe based on tributary inputs and high flows timing.	See Kondolf.
			Distribution		Information Need	Information Need, including some timeframe based on tributary inputs and high flows timing.	Metric is number of sandbars by reach.

Goal 8. Maintain or attain levels of sediment storage within the main channel and along shorelines to achieve GCDAMP ecosystem goals.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
8.3	Maintain or attain	Sediment	Abundance	Eddies below 5,000 cfs	Information Need	Information Need, including some timeframe based on tributary inputs and high flows timing.	Metric is area (m^2) and volume (m^3) as a rolling average
			Grain-size		Information Need	Information Need, including some timeframe based on tributary inputs and high flows timing	
			Distribution		Information Need	Information Need, including some timeframe based on tributary inputs and high flows timing.	Metric is # of sandbars by reach
8.4	Maintain or attain	Sediment	Abundance	Eddies between 5,000 and 25,000 cfs	Information Need	Information Need, including some timeframe based on tributary inputs and high flows timing.	Metric is area (m^2) and volume (m^3) as a rolling average The target level should consider spawning habitat for trout in Glen Canyon and sediment needed for BHBFs.
			Grain-size		Information Need	Information Need, including some timeframe based on tributary inputs and high flows timing	The target level should consider spawning habitat for trout in Glen Canyon and sediment needed for BHBFs.
			Distribution		Information Need	Information Need, including some timeframe based on tributary inputs and high flows timing.	Metric is number of sandbars by reach The target level should consider spawning habitat for trout in Glen Canyon and sediment needed for BHBFs.

Goal 8. Maintain or attain levels of sediment storage within the main channel and along shorelines to achieve GCDAMP ecosystem goals.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
8.5*	Maintain or attain	Sediment	Abundance	Shorelines above 25,000 cfs	Information Need	Information Need	Metric is area (m^2) and volume (m^3) as a rolling average
			Grain-size		Information Need	Information Need	
			Distribution		Information Need	Information Need	Metric is number of sandbars by reach

*This Management Objective is intended to include all shorelines (eddies and channel margins) between 25,000 cfs and the highest level of potential dam effects on pre-dam sand bars (about 125,000 cfs or pre-dam alluvium (pda) terrace of Hereford *et al*. 1998). The highest level will be determined through discussions with sedimentological, cultural, recreational, and riparian workers on how best to constrain this boundary and in how many areas it should be monitored.

NOTE: Coarse sediment is important to the ecosystem, as is fine sediment. There is a Management Objective on rapids navigability under the recreation goal that indirectly addresses debris flows, as well as an MO on trout spawning habitat under the trout goal.

Information Need: consult with various researchers to determine how best to break out sub-reaches from the three broader fine sediment reaches as described above. The riparian group suggested developing a table that has various resource concerns on the *X*-axis and various processes on the *Y*-axis. The recreation group suggested developing a table that has river miles (-15 to 278) on the *X*-axis and various resources on the *Y*-axis (those resource areas impacted by sedimentological processes).

Goal 9. Maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of GCDAMP ecosystem goals.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
9.1	Maintain	Visitor	Physical access	Mainstem	Information Need. Obtain from current GLCA and GRCA management plans. Use 10-year average distributed by season of user-days, number of people, and distribution.	Information Need	The target level should be within the capacity of the CRE to absorb visitor impacts. The target level should consider GLCA and GRCA Management Plans
			Physical safety (other than whitewater boating)		Information Need. Use average of NPS incident reports from Myers et al. for period 1988-92.[25] Include data and conclusions from other reports re: accident rates during interim and experimental flows and BHBF. Brown and Hahn (1987) did the baseline study in 1985-6 for GCES I, and collected data at medium and high flows. Jalbert and Mitchell (1992) collected data in 90-91 during the "experimental flows," primarily at low flows; and Jalbert (1997) again in 1996 during the BHBF. Also Underhill and Borkan (1987).	Metric is river-related deaths or injuries. The target is to minimize river-related injuries and deaths. Information Need: To correlate flows, equipment type, and guide experience to NPS river incident reports related to wading anglers, river travel in the flatwater reaches above the Paria River and below Separation Canyon, and trails to and along the river, to determine flow-related risk. The stage of Lake Mead should be included in the correlation for the reach below Separation Canyon.	
9.2	Maintain or improve	Recreational opportunities	Quality and quantity	Glen Canyon	Information Need GLCA data: number and variety of recreational activities.	Information Need	NPS studies underway. The target level should be within the capacity of the CRE to absorb visitor impacts. The target level should consider GLCA and GRCA Management Plans. Management action: a non-native fishing policy for concessions contracts needs to be developed.
				Grand Canyon	Information Need. GRCA data: number and variety of recreational activities.	Information Need	

Goal 9. Maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of GCDAMP ecosystem goals.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
9.3	Increase	Camping beaches	Size	Mainstem	Information Need From Kaplinski et al. in prep.	800 m^2 (Stewart *et al.* 2000)	The target level should be within the capacity of the CRE to absorb visitor impacts. The target level should consider GLCA and GRCA Management Plans. Metric for Quality includes parameters for vegetation, sanitation, and shade. Metric for Distribution is number of campsites required per identified reach.
			Quality	Mainstem	Information Need	Information Need Metric needs to be a "quality index." That includes parameters for open sand area, < 8 degrees slope, mooring, wind protection, ant colonies, degree of human impact (fire rings, trail erosion, litter, sanitation), vegetation encroachment, and shade. Also, need to assess and quantify the processes causing changes in beach quality and size (e.g., river flows, wind, tributary runoff, vegetation encroachment, human, other.)	
			Distribution	Critical reaches	Information Need	Minimum 21 ± 5 beaches per critical reach above maximum ROD flows (25,000 cfs) capable of accommodating 16-36 people. Also, consider NPS river travel model.	
				Non-critical reaches	Information Need	Information Need: Suggest an average of one beach capable of accommodating 16-36 people every 2.0 river miles.	

Goal 9. Maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of GCDAMP ecosystem goals.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
9.4	Improve	Rapids	Navigability	Mainstem	Information Need	Information Need See incident rates/flow level during the late 1980s and Interim Flow period.	The target level to be developed from NPS on-river accident rates. See Myers et al.[25] The target should address navigability across the range of flows allowed within the ROD. The metric is the number of accidents per rapid at each flow. See Brown and Hahn (1987), and Jalbert and Mitchell (1992).
			Whitewater boating safety		Information Need	Metric is river-related deaths or injuries. The target is to minimize river-related injuries and deaths. IN: To correlate flows, equipment type, and guide experience to NPS river incident reports, to determine flow-related risk.	
9.5	Maintain or enhance	Experience	Wilderness	CRE in Grand Canyon National Park	Information Need	Information Need See GRCA data on use levels and distribution.	See Bishop, *et al.* (1986) for flow-related wilderness. The target level should consider GRCA and GLCA Management Plans (in progress).
				CRE below GCD in Glen Canyon NRA	Information Need	Information Need See GLCA data on use levels and distribution.	

Goal 10. Maintain power production capacity and energy generation, and increase where feasible and advisable, within the framework of GCDAMP ecosystem goals.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
10.1	Maintain or increase	Power	Marketable capacity and energy	GCD	Available hydropower allocations are made seasonally and vary with hydrology	Information Need	Constrained by the ROD
10.2	Maintain	Power	Existing emergency criteria for WAPA system	GCD	Emergency exception criteria	Information Need	Constrained by the ROD
10.3	Maintain	Power	Existing emergency criteria for WSCC system	GCD	Emergency exception criteria	Information Need	Constrained by the ROD
10.4	Maintain	Power	Regulation	GCD	GCD provides a share of regulation to the WALC and WACM control areas	Information Need Determine if the current regulation scheme, or additional regulation schemes, will cause problems for the ecosystem.	

Goal 11. Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of past, present and future generations.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
11.1	Preserve	Historic properties	National Register integrity	Area of Potential Effect	Information Need (at least 264 properties)	100% of historic properties	The target is to preserve National Register-eligible properties (e.g., TCPs, prehistoric, and historic sites) via protection, management, and/or treatment (e.g., data recovery) for the purpose of federal agency compliance with NHPA, as well as AMP and AMWG compliance with GCPA.
11.2	Manage	Traditionally important resources	Resource integrity	CRE	Information Need (obtained through ethnographic studies, polls, interviews, surveys, and literature)	Information Need Long-term trend indicates stable or improving for each identified resource.	The target is to manage (based on current cultural values) other traditionally important resources that are not sufficiently addressed under other MOs. Specifically, this MO addresses resources not considered Register-eligible.
11.3	Protect and maintain	Traditional cultural resources	Physical access	CRE	Information Need	Information Need	See USBR[34] The target is to provide meaningful tribal consultation on AMP activities that might restrict or block physical access by Native American traditional practitioners. See AIRFA and EO 13007.

MANAGEMENT OBJECTIVES

Goal 1. Protect or improve the aquatic foodbase so that it will support viable populations of desired species at higher trophic levels.

12.1	Maintain or attain	Socio-economic data	Hydropower	N/A	EIS	Information Need	The target level is adequate socioeconomic data for making recommendations to the Secretary.
			Air quality	N/A	EIS	Information Need	
			Wilderness	N/A	EIS	Information Need	
			Recreation	N/A	EIS and Stewart (1999)	Information Need	
			Non-use values	N/A	Non-use study accompanying the EIS.	Information Need	
			Tribal & spiritual values	N/A	EIS	Information Need	
12.2	Integrate and synthesize	Cultural and environmental data	Interdisciplinary information	CRE	Not readily available and not completely synthesized or integrated	Readily accessible by georeferencing using GIS, databases, etc.	The target is adequate cultural and environmental data for making recommendations to the Secretary.
12.3	Attain and maintain	Monitoring and research program	Natural, cultural, and recreational resources	CRE	GCMRC Strategic Plan 1998-2002	Updated GCMRC Strategic Plan	The target is implementation of a GCMRC Strategic Plan that has been agreed to by the AMWG after review by the SAB, the PA signatories, and the TWG, and that will subsequently be reviewed on a periodic basis.

Goal 11. Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of past, present and future generations.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
12.4	Attain and maintain	AMP composed of all stakeholders	That acknowledges uncertainty and uses experimentation, monitoring & research	N/A	An ongoing AMP program with a Strategic Plan in development	Updated AMP Strategic Plan	The target is implementation of an AMP Strategic Plan that describes the processes for science-based collaborative resources management.
			Participation		<u>For calendar year 2000:</u> Average TWG attendance = 92 % Average AMWG attendance = 95 % Participation on TWG and AMWG ad hoc groups = 35 % This last number was the number of TWG or AMWG members who volunteered to be on ad hoc groups divided by the total number of TWG and AMWG members.	100% attendance by all representatives at AMWG and TWG meetings plus active participation in Ad Hoc Committees.	The target is to have all AMWG and TWG members actively involved with AMP deliberations and activities, and their input recognized and valued.

Goal 11. Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of past, present and future generations.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
12.5	Attain and maintain	AMP	Effective tribal consultation (i.e., inclusion of tribal values and perspectives into the AMP)	CRE	Current participation at TWG, AMWG, and PA meetings	Effective dialogue between tribes and AMWG members on all AMP actions	See USBR[32] The target is to achieve, at a minimum, effective, legally mandated government-to–government consultation. To achieve this MO it is important to provide adequate funding, but funding alone is not a sufficient indicator of successful achievement.
12.6	Attain and maintain	Management activities, research, and long-term monitoring activities	Tribal participation	AMP	Information Need	Information need	The target is a set of activities that provides meaningful tribal participation and meets each tribe's interests to ensure that tribal values are incorporated in the scientific activities of the adaptive management program, and that tribal interpretations of monitoring and research data are considered. Linkage: Vision/Mission statement, particularly the mention of federal trust responsibilities.

Goal 11. Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of past, present and future generations.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
12.7	Conduct	Experimental flows	Flow dynamics	Mainstem	1996 BHBF 1997 HMF 2000 LSSF test	Information Need To be proposed by the Experimental Flows Ad Hoc Group.	See GCMRC,[6] Webb et al.[37] and Topping et al.[31] The target level is the experiments needed to gain critical understanding of ecosystem function under different dam operations, e.g., BHBFs, HMFs, biological opinion flows, and financial exception criteria flows.
12.8	Conduct	Management experiments	Other management actions	CRE	Check dams Translocation of KAS Fishing regulations	Information Need At a minimum, one management action to address native v. non-native fish interaction and one to address vegetation encroachment on beaches in the next five years.	The target level is the experiments needed to gain critical understanding of ecosystem function under different management alternatives outside of dam operations.
12.9	Build	AMP	Public support	N/A	Information Need	Information Need A public outreach plan adopted by the AMWG. Propose to have BOR, NPS, and USGS public affairs people develop the plan.	Metric should include GCMRC and BOR web pages; GCD programs and tours; AMWG Outreach Committee; publications; various AMWG member activities. The purpose is adequate public support for AMP experiments and adaptive management, and a diverse funding base.

Goal 11. Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of past, present and future generations.

MO #	Perform some action	On some element	On some attribute	At some place	From the current level	To the target level	Comments
12.10	Maintain or attain	Funding	Foundation and Corporate	N/A	$0	Information Need	The target is adequate funding to meet the goal. Develop a plan identifying sources for obtaining foundation and corporate funding.
			Appropriated		$75,000 (FY 2000)	$1,010,000 USGS $475,000 Tribal participation	
			State Agency		Information Need (obtain from AGFD)	Information Need	
			Power revenues		$6.22M (for GCMRC) $1.443M (for BOR)	$7,850,000 indexed for CPI	
12.11	Maintain or attain	Participation	Externally-funded investigators	CRE	Information Need (obtain from NPS)	Information Need MAs: 1. Develop a brochure that indicates support that would be provided by GCMRC and NPS to researchers who bring their own funding to address issues related to AMP MOs and INs. 2. Get outside researchers engaged and obtain their data.	Current and target levels should include small and cost-shared projects in NPS, AGFD, etc. The target is contributions to meeting Information Needs by externally funded investigators. Note: Incentives could include donated office space, partial funding, letters of support, facilitated access, and logistical support.

INFORMATION NEEDS

To be completed.

MANAGEMENT ACTIONS

To be completed.

3 SUPPLEMENTAL INFORMATION

PROGRAMMATIC AND GEOGRAPHIC SCOPE

The programmatic scope of the Adaptive Management Program is to provide advice and recommendations to the Secretary of the Interior on whether the environmental commitments and constraints of the Record of Decision are being met, and to ensure that the intent of the Record of Decision and Grand Canyon Protection Act are being met. If not, the Adaptive Management Program recommends changes in dam operations and implementation of other management actions.

With respect to dam operations, the Guidance Document for the Adaptive Management Program states:

> Long-term monitoring and research, including test flows within the current range of authorized operations, are intended to enable finer and finer tuning of operations over time, as additional knowledge and experience are gained, to better achieve the target mix of resource benefits, as outlined in the Glen Canyon Dam Environmental Impact Statement, pages 54-65. [Loveless 2000]

However, the Grand Canyon Protection Act authorizes other management actions to accomplish its intent of protecting the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established. Examples could include water temperature modification, stabilization of historic properties, non-native fish control, and removal of exotic vegetation.

The programmatic scope of the Adaptive Management Program is limited by the range of dam operations and other management actions available to achieve a desired resource effect. This is complicated by the fact that the dam and immediate downstream areas are located at approximately the mid-point between the origin of the Colorado River in the Rocky Mountains and its terminus in the Gulf of California. Many activities, facilities, and conditions on the river occur both upstream and downstream of the geographic area covered by the Adaptive Management Program. The Adaptive Management Program has little or no control over these other areas.

In addition, the Adaptive Management Work Group may coordinate with other organizations and programs and offer recommendations to the Secretary of the Interior regarding actions that may be undertaken by other agencies. As stated in the Adaptive Management Work Group Charter (Appendix C), activities outside the scope of the Adaptive Management Program will be funded separately and do not deter from the focus of the Grand Canyon Protection Act.

The geographic scope of the Adaptive Management Program is the Colorado River mainstem corridor and interacting resources in associated riparian and terrace zones, located primarily from the forebay of Glen Canyon Dam to the western boundary of Grand Canyon National Park. It includes the area where dam operations impact physical, biological, recreational, cultural, and other resources. The scope of Adaptive Management Program activities may include limited investigations into some tributaries (e.g., the Little Colorado and Paria Rivers). The lateral scope is an issue of ongoing research and investigation to determine where the effects of dam operations are located along the floodplain.

The Adaptive Management Program may do research outside the geographic scope defined above to obtain needed information. Such linkages with other areas "should be made on a case-by-case basis, considering ecosystem processes, management alternatives, funding sources, and stakeholder interests." (National Research Council 1999:43; Loveless 2000)

INSTITUTIONAL SCOPE — WHAT THE PROGRAM INFLUENCES OR IS INFLUENCED BY

Annual Operating Plan Process

The Annual Operating Plan process enables Reclamation to plan and project future Colorado River system reservoir contents and downstream releases for the upcoming water year. The planning process allows the Secretary of the Interior to determine and meet Colorado River Basin water delivery obligations. This process is conducted with input from the Colorado River Management Work Group and other members of the public in accordance with the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs, and Sections 1802(b) and 1804(c) of the Grand Canyon Protection Act.

Individual reservoir operations in the Colorado River reservoir system are based on appropriate consideration of uses of the reservoirs for all purposes, as required by the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs. Because hydrologic conditions will vary from any assumptions utilized in the Annual Operating Plan process, projected reservoir operations and dam releases are subject to monthly revision during the year to accommodate changing hydrologic conditions. However, releases must be governed in accordance with the Law of the River.

As a part of this Annual Operating Plan process, the decision on releases to the Lower Division states must be made in accordance with a "surplus," "normal," or "shortage" determination. Releases must also meet treaty delivery obligations to Mexico.

The Grand Canyon Protection Act requires criteria, operating plans, and reports "separate from and in addition to" those mandated by the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs, noting that the Grand Canyon Protection Act is implemented fully consistent with and subject to the water allocation and development provisions of previous compacts and statutes contained in the Law of the River. As noted in the Grand Canyon Protection Act report language, these criteria primarily affect the Glen Canyon Dam powerplant operations and do not affect any delivery obligations to the Lower Basin or Mexico.

Tribal Interests Within the Colorado River Ecosystem

The Navajo Nation, Hualapai Tribe, and Havasupai Tribe have reservation lands, resources, and ownership concerns that may be affected by Adaptive Management Program activities, projects, or proposals. As discussed under the Tribal Consultation section of this plan, government-to-government consultation with these tribes must take place. On tribal land, special tribal permits or permissions must be obtained for activities of the Adaptive Management Program to remain in compliance with tribal laws, codes, resolutions, policies, or executive orders. Other tribes, including the Hopi Tribe, the Pueblo of Zuni, and various bands among the Southern Paiute Consortium, have interests and concerns with resources or places that may be affected by the operation of Glen Canyon Dam or with the management actions or recommendations of the Adaptive Management Program.

National Park Service Management Policies and Activities

As manager of Grand Canyon National Park and Glen Canyon National Recreation Area, the National Park Service is the steward of the downstream natural and cultural resources affected by Glen Canyon Dam operations. The National Park Service's authority for resource management activities derives from a variety of laws, including the National Park Service Organic Act of 1916, the General Authorities Act of 1970, and the 1978 amendments to this Act (the Redwoods Amendment). Although the Organic Act and the Redwoods Amendment use different language, they define a single standard for the management of the national park system. The basic principles governing management of all units of the National Park Service system are first to conserve park resources and values and second to provide for the enjoyment of park resources and values by the people of the United States.

The National Park Service has three levels of guidance documents: (1) National Park Service Management Policies (National Park Service 2001) that is the basic policy document of the National Park Service, (2) interim updates or amendments accomplished through Director's Orders, and (3) detailed and comprehensive handbooks or reference

manuals issued by associate directors. These documents provide National Park Service field employees with guidance to carry out Management Policies and Director's Orders.

The primary responsibility of National Park Service managers is to preserve park resources and values without impairment. Impairment is defined as a loss or harm to the integrity of park resources or values. The National Park Service cannot conduct or allow activities in parks that would impair park resources and values unless provided for by legislation or by the proclamation establishing the park. In cases of doubt as to the impact of activities on park resources, the National Park Service will decide in favor of protecting the resources.

Whether an impact constitutes impairment depends on the specific resources or values affected; the severity, duration, and timing of the influence; the direct and indirect effects of the influence; and the values and purposes for which a particular park unit was established. However, the laws do give the National Park Service the management discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park, so long as the impact does not constitute impairment.

The National Park Service has established a tiered planning process with General Management Plans as the highest tier. The General Management Plans for Grand Canyon National Park and Glen Canyon National Recreation Area reflect the service-wide guidance that applies to all National Park Service areas, as well as the specific authorizing legislation that established these areas. They focus on what management should be achieved and maintained over time to provide a foundation from which to protect park resources while providing for meaningful visitor experiences.

The next tier of park planning is implementation plans. These deal with complex, technical, and sometimes controversial issues with a level of detail and analysis beyond that appropriate at the General Management Plan or strategic plan level. The Grand Canyon National Park General Management Plan (National Park Service 1995) builds upon several implementation plans relevant to the Adaptive Management Program, including the 1988 Backcountry Management Plan, 1989 Colorado River Management Plan, and 1994 Resource Management Plan. Other relevant implementation plans subsequent to the Grand Canyon National Park General Management Plan include the 1997 Resource Management Plan and the 1998 Draft Wilderness Management Plan.

Operation of the Colorado River Storage Project Power System

The Glen Canyon Dam powerplant is tied to a vast system of generators, transmission lines, and delivery points in the western United States, Canada, and Mexico. It is legally obligated to provide electricity to wholesale electrical customers and others in the West. The Bureau of Reclamation operates Glen Canyon Dam in close coordination with the Western Area Power Administration. The Western Area Power Administration markets the electrical power produced by the Colorado River Storage Project dams and owns and operates the federal transmission system that delivers the electricity.

Long-Term Firm Electrical Power

Under the authorizing legislation for the Colorado River Storage Project, federal dam operators are required to produce "the greatest practicable" amount of long-term firm power at Glen Canyon Dam, integrating the operation of Glen Canyon Dam with the other Colorado River Storage Project powerplants and other federally-owned electrical powerplants.

The Western Area Power Administration's long-term contracts for electricity are with small municipalities, other political subdivisions, rural electrical cooperatives, federal defense facilities and other federal and state institutions, and Indian tribes. This power is sold strictly in the Colorado River Storage Project market area that includes Colorado, Wyoming, Utah, Arizona, New Mexico, and Nevada. Revenues from these sales are placed into the Basin Fund, a fund that repays the United States Treasury the capital costs of the Colorado River Storage Project mainstem dams and the irrigation assistance portion of the Upper Basin participating projects. Revenues from the sale of power also fund much of the cost of the Adaptive Management Program.

Long-term firm electrical power has been sold according to a marketing plan established by the Western Area Power Administration. The contracts for electricity made possible under this plan end in 2024. The Western Area Power Administration is obligated to deliver electricity in the amounts specified in these contracts. This can be supplied by the Colorado River Storage Project generators or the Western Area Power Administration may purchase some of this power from other generators. The contract amount can be adjusted every five years to take into account changing circumstances or resources.

Operation for a Federal Load Control Area

The Western Area Power Administration operates two load control areas that are electrically tied to Glen Canyon Dam. A load control area is a geographical area assigned to a controller to monitor electrical demand and generation and make sure that they "match" on a moment-by-moment basis. This is referred to as "regulating." Currently, Glen Canyon Dam generation can change by up to 1,000 cubic feet per second to adjust to these "swings" in demand. The contribution by Glen Canyon Dam to these two load control areas is evenly divided. The Western Area Power Administration's Operation Center in Phoenix, Arizona, sends a "regulation" signal every few seconds directly to Glen Canyon Dam.

Reserve Sharing Groups

Reserves are required by electrical production and distribution companies to serve as a "back-up" in case of unforeseen electrical system problems. The existence of reserves minimizes the possibility of interruption of electrical service. The Western Area Power Administration has contractual agreements with two reserve sharing groups. Reserve sharing groups are formed to share the "damage" caused by generator and transmission outages, transmission overloads and other emergencies, or unplanned events.

For the two reserve sharing groups, the Western Area Power Administration is obligated to provide up to 70 megawatts of power from one or more of the Colorado River Storage Project powerplants. Typically, Glen Canyon Dam has provided the bulk of this service.

Emergency Service

The Western Area Power Administration calls upon Glen Canyon Dam and other Colorado River Storage Project dams to respond to a variety of electrical system emergencies. These emergencies and the responses to them by the Western Area Power Administration and Bureau of Reclamation are a requirement of all participating members of the Western Systems Coordinating Council. These are described in the Glen Canyon Dam Environmental Impact Statement and are authorized in the Record of Decision. Further details on the emergency exception criteria are contained in the Operating Agreement Associated with Glen Canyon Dam Operating Criteria between the Bureau of Reclamation and the Western Area Power Administration dated July 7, 1997. Generally, these emergencies are related to transmission line and generation outages. During these emergencies, the operating limitations on Glen Canyon Dam contained in the Record of Decision may be exceeded.

PROTOCOLS AND PROCEDURES — HOW THE ADAPTIVE MANAGEMENT PROGRAM WORKS

Charter

The Charter of the Adaptive Management Program (Appendix C) was recently renewed as a formal Federal Advisory Committee Act committee for an additional two years.

Operating Procedures of the Adaptive Management Work Group and Technical Work Group

Current operating procedures of the Adaptive Management Work Group and Technical Work Group are in Appendices D and E, respectively. These procedures have been formally recommended by these two groups and are consistent with the Adaptive Management Work Group Charter (Appendix C). The procedures serve to give formal structure to Glen Canyon Dam Adaptive Management Work Group and Technical Work Group meetings.

Science Within the Glen Canyon Dam Adaptive Management Program

The goal of scientific inquiry within the Adaptive Management Program is to discover facts about the Colorado River ecosystem using a rigorous program of monitoring, research, and adaptive management. While significant knowledge of the ecosystem has been gained since the Glen Canyon Environmental Studies, the ecosystem is extraordinarily complex. Much is still unknown.

Research and monitoring activities are designed to enhance our understanding of ecosystem functions, processes, and patterns. Long-term monitoring is critical to understanding the status and trends of important resources, as well as the effects of the Secretary of the Interior's actions in operating the dam on those resources of special concern, such as endangered species or resources of tribal interest. Long-term monitoring also informs on the success or failure of management actions and produces data for long-term research hypotheses about the functioning of the Colorado River ecosystem. A stable monitoring program allows repetitive measurements on a consistent time scale, which allows short- and long-term comparison with previous measurements. Methods range from traditional field sampling techniques to multispectral remote sensing designed to identify stability or trends in key resources or indicator species.

Research activities often require experimental comparisons of an alternative treatment against a controlled or baseline environment. The experiments attempt to separate the cause of a particular effect from the suite of possible confounding factors. Understanding of ecological patterns and processes has changed substantially as a result of these monitoring and research activities. The resulting answers to questions and hypotheses thus add to the knowledge base available to the Adaptive Management Work Group as it makes recommendations to the Secretary of the Interior.

Management Within the Glen Canyon Dam Adaptive Management Program

The Adaptive Management Program does not derogate any agency or tribal authority or responsibility for management or stewardship of resources. Instead, the Adaptive Management Program makes formal recommendations through the Adaptive Management Work Group to the Secretary of the Interior regarding dam operations and other management actions to meet the environmental and monitoring commitments of the Environmental Impact Statement and Record of Decision, comply with the Grand Canyon Protection Act, and remain in compliance with the Law of the River and relevant environmental statutes, regulations, and policies. These recommendations are made by consensus where possible, but as stated in the Adaptive Management Work Group Charter (Appendix C): "…in the event that consensus is not possible, a vote should be taken." Whether achieved through consensus or by majority vote, recommendations are transmitted to the Secretary of the Interior through the Secretary of the Interior's Designee.

The Secretary of the Interior, as the final decision maker, responds to these recommendations either directly or through actions of the agencies with delegated authority. In the latter case, implementation of these recommendations by a federal agency often depends on internal discussions between the management agency and the Secretary of the Interior.

How Science and Management are Integrated into the Adaptive Management Program

The Grand Canyon Monitoring and Research Center provides scientific data and syntheses to the Adaptive Management Program. In general, the Grand Canyon Monitoring and Research Center provides scientific data and syntheses to the Technical Work Group, which then uses this information to create management recommendations for consideration by the Adaptive Management Work Group. The Grand Canyon Monitoring and Research Center may also bring scientific information directly to the Adaptive Management Work Group. Any of the organizational components within the Adaptive Management Program may call upon the independent review panels for advice (Fig. 1).

After approval by the Adaptive Management Work Group, the Secretary of the Interior's Designee forwards recommendations to the Secretary of the Interior. Secretarial decisions are communicated back to the members of the Adaptive Management Program.

How Management of One Resource Affects Other Resources

The Adaptive Management Program recognizes that the Colorado River below Glen Canyon Dam is part of a large and complex ecosystem. Management actions proposed to benefit one resource might adversely impact another due to the interrelationships within the system. For example, a river flow designed to benefit a threatened or endangered native fish might result in reduced recreational opportunities or limits on the access of Native Americans to a sacred sites.

When the benefit to one resource is proposed as part of a legal compliance responsibility, it is particularly important to maintain an ecosystem perspective. One example comes from the planning of the experimental Beach/Habitat-Building Flow in 1996. This experimental flow was designed to test the hypothesis that Colorado River flows greater than powerplant capacity would mobilize sediment stored in the river channel and deposit it on the river banks. However, while designing and scheduling the experimental flow for sediment conservation, the effects of the higher flow on the aquatic food base, Kanab ambersnail, Southwestern willow flycatcher, and tamarisk had to be considered. Similarly, tribes needed to be consulted on impacts to resources of tribal concern or access to sacred sites. Impacts to recreational users and power generation also had to be factored into the experiment.

Tribal Consultation and Coordination Within the Adaptive Management Program

Federally-recognized Indian tribes are domestic sovereign nations, and the legal relationship between the federal government and tribes is one set forth in the United States Constitution, treaties, statutes, executive orders, secretarial orders, and court decisions. Indian tribes have a guaranteed right to self-govern and to exercise inherent sovereign powers over their members and reservations. The federal government works with Indian tribes on a government-to-government basis to address issues concerning Indian tribal self-governance, trust resources, and Indian tribal treaty and other rights. Tribal trust resources include land and natural resources either on or off Indian reservations, and other assets retained by or reserved by or for Indian tribes, held by the federal government in trust and protected by a fiduciary obligation on the part of the United States.

To ensure meaningful consultation and collaboration with Indian tribal governments, various executive orders, secretarial orders, and memoranda have been issued recently, e.g. Executive Order 13084, Executive Order 13007, Secretarial Order 3175, Secretarial Order 3206, and *Federal Register* 94-10877.

To ensure fulfillment of the federal Indian trust responsibility, the Department of the Interior has established policies and procedures for government-to-government consultation with federally-recognized Indian tribes and tribal members for the identification, conservation, and protection of American Indian trust resources, trust assets, or tribal health and safety. Indian trust assets are values derived from land resources including surface water and groundwater, natural vegetation and wildlife, and air quality. Any potential impacts from federal actions or activities to tribal trust assets must be properly addressed between the affected tribe and the appropriate federal agency prior to any disturbance to such resources.

Tribal Trust Responsibilities and the Adaptive Management Program

Within the Adaptive Management Program, the federal government's trust responsibility to the interested Native American tribes (Havasupai, Hopi, Hualapai, Kaibab Band of Paiute Indians, Navajo Nation, San Juan Southern Paiute Tribe, Paiute Indian Tribe of Utah, and the Pueblo of Zuni) is realized through treaties, Executive Orders, and various levels of consultation. Section 1805(c)(3) of the Grand Canyon Protection Act requires the Secretary of the Interior to consult with Indian tribes regarding the implementation of the long-term monitoring program and activities to ensure that Glen Canyon Dam is operated in a manner consistent with that of Section 1802 of the Grand Canyon Protection Act.

Tribal participation and representation at the Adaptive Management Work Group and Technical Work Group levels is one aspect of the Secretary of the Interior's consultative requirement under the Grand Canyon Protection Act. However, given the nature and management of Native American traditional knowledge and concerns, it may be necessary for the Grand Canyon Monitoring and Research Center, Bureau of

Reclamation, National Park Service, and any other federal agency involved in long-term monitoring, research, or other associated activities to engage in more specific consultation with each of the identified Native American tribes. This is especially true for those tribes (Havasupai and San Juan Southern Paiute) that are not actively engaged in the Adaptive Management Program. This more specific form of consultation may require the Grand Canyon Monitoring and Research Center, Bureau of Reclamation, and National Park Service to engage in a face-to-face consultation with each tribe, their tribal representatives, and identified traditional leaders regarding monitoring and research activities, proposed management actions, and any other related Adaptive Management Program activities. The result of this consultation effort is to fully and meaningfully engage the appropriate tribes in the decision-making process regarding activities that may affect resources of tribal concern.

HOW COMPLIANCE IS INTEGRATED INTO THE ADAPTIVE MANAGEMENT PROGRAM

Compliance with the Endangered Species Act, National Environmental Policy Act, and National Historic Preservation Act, has particular impact on the Adaptive Management Program and is described below:

Endangered Species Act

The Adaptive Management Program is highly focused on compliance with Section 7(a)(2) of the Endangered Species Act of 1973, as amended, and its implementing regulations (50 Code of Federal Regulations [CFR] 402). This section addresses consultation between the action agency (usually the Bureau of Reclamation) and the U.S. Fish and Wildlife Service on the effects of a proposed action on federally-listed species. This section requires that any action a federal agency authorizes, funds, or carries out must not jeopardize the continued existence of any listed species or adversely modify designated critical habitat (see Appendix F). The process utilized by the federal agencies in the Adaptive Management Program for Endangered Species Act consultation is illustrated in Figs. 2, 3, and 4.

Biological opinions contain the U.S. Fish and Wildlife Service's recommendations to the action agency. Consultation is concluded when the action agency responds to the U.S. Fish and Wildlife Service by accepting the biological opinion as written, or describing if and how they will implement the biological opinion. Once this commitment has been made, the action agency is responsible for implementation.

The Endangered Species Act primarily affects the Adaptive Management Program through: (1) the requirement to consult with the U.S. Fish and Wildlife Service on any discretionary action which may affect listed species or adversely modify designated critical habitat prior to taking the action; and (2) through commitments an action agency makes to conserve species in response to Reasonable and Prudent Alternatives in biological opinions. The Regional Director of the Bureau of Reclamation sent a

memorandum to the Regional Director of the U.S. Fish and Wildlife Service identifying the elements of the Reasonable and Prudent Alternative for the operation of Glen Canyon Dam that will be implemented (Calhoun 1995). These elements include:

- Formulation of an Adaptive Management Program.
- Experimental flows to benefit endangered fish.
- Determine the feasibility and expected results of installing and operating a selective withdrawal structure (temperature control device) on Glen Canyon Dam.
- Studies of the response of native fish to various temperature regimes and river flows.
- Coordinate preparation of a Little Colorado River management plan.
- Conduct a Razorback sucker workshop.
- Establish a second spawning aggregation of humpback chub in the mainstem or tributaries.
- Evaluate the over-winter survival of young-of-year humpback chub.
- Study Kanab ambersnail life cycle and distribution.

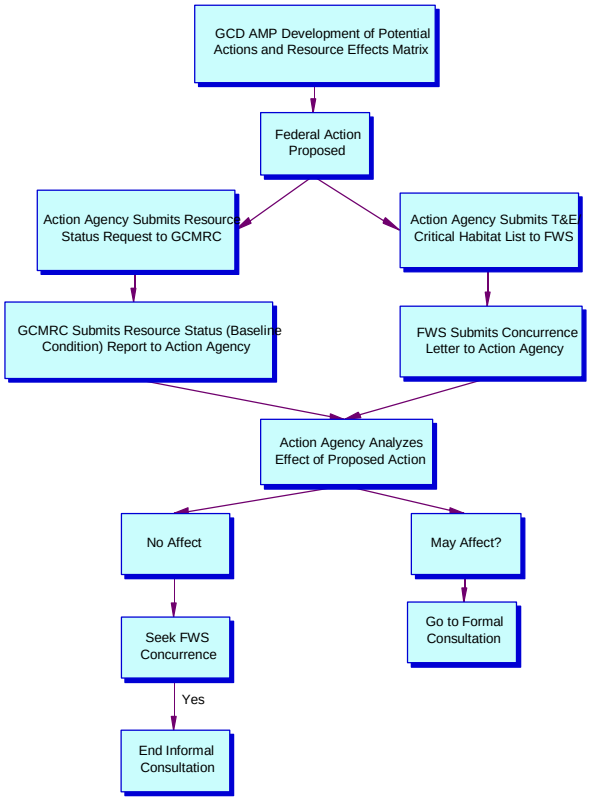

Figure 2. Glen Canyon Dam Adaptive Management Program Section 7 Informal Consultation Process.

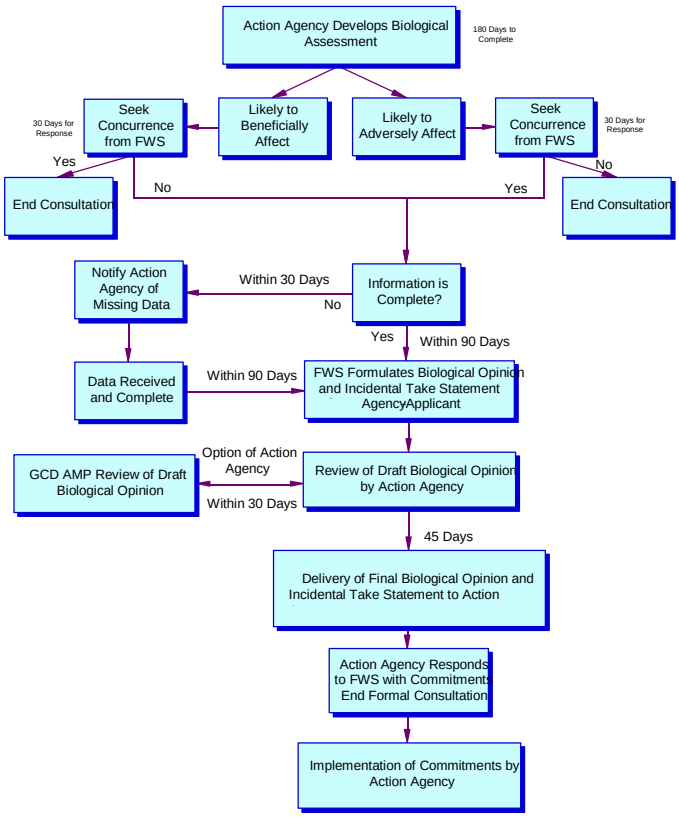

Figure 3. Glen Canyon Dam Adaptive Management Program Section 7 Formal Consultation Process.

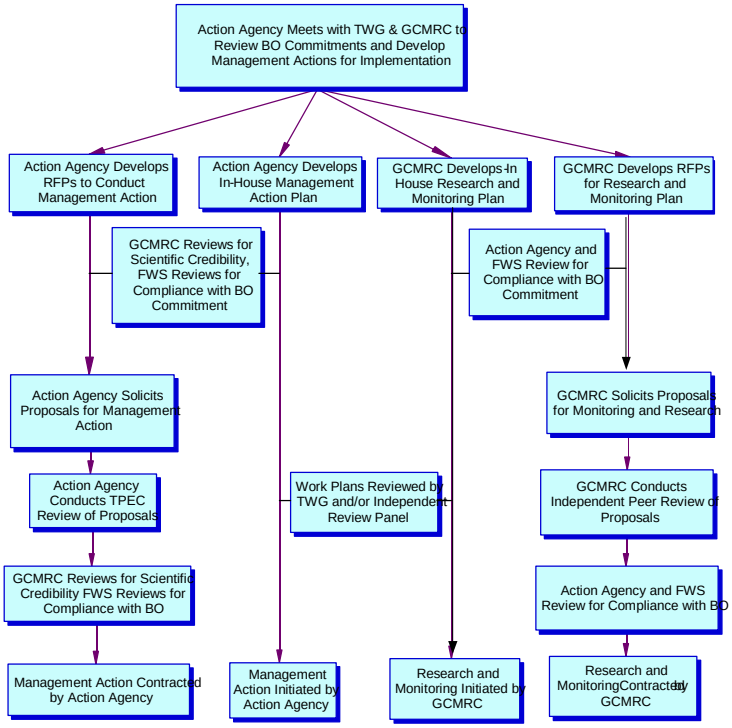

Figure 4. Glen Canyon Dam Adaptive Management Program Section 7 Consultation Process: Implementation of Biological Opinion.

The Superintendent of Grand Canyon National Park sent a memorandum to the Regional Director of the U.S. Fish and Wildlife Service identifying additional elements they would implement (Arnberger 1998). These elements include:

- Conduct translocation of Kanab ambersnails subject to flows below 45,000 cubic feet per second from Glen Canyon Dam.
- Complete monitoring of the status of the translocated population.
- Evaluate, and where appropriate, utilize augmentation opportunities.

National Environmental Policy Act

The National Environmental Policy Act has five basic mandates that the Adaptive Management Program must continue to follow:

- Supplemental mandate: adds to the existing authority and responsibility of every federal agency to protect the environment when carrying out the agency mission.
- Affirmative mandate: agencies must make decisions that restore and enhance the environment.

- Substantive mandate: agencies must recognize that each person should have a healthful environment and must contribute to the protection of that environment for present and future generations.
- Procedural mandate: agencies must use their planning and decision-making process to give appropriate consideration to environmental value and amenities.
- Balancing mandate: agencies, to the fullest extent possible and consist with other essential policy considerations, must make decisions to achieve productive harmony between people and nature.

As long as the Adaptive Management Program meets the commitments made in the Record of Decision, no additional National Environmental Policy Act compliance is needed. However, if the Adaptive Management Program makes a recommendation to the Secretary of the Interior that deviates from the Record of Decision (Reclamation 1996), then the National Environmental Policy Act requires further compliance.

National Historic Preservation Act

The Glen Canyon Dam Environmental Impact Statement included the Programmatic Agreement for Cultural Resources that represents alternate procedures by which the Bureau of Reclamation will achieve compliance with Section 106 of the National Historic Preservation Act for the continued operation of Glen Canyon Dam. The Programmatic Agreement is a legally binding document among the Advisory Council on Historic Preservation, Arizona State Historic Preservation Officer, National Park Service, Bureau of Reclamation, Hopi Tribe, Hualapai Tribe, Paiute Indian Tribe of Utah, Kaibab Band of Paiute Indians, Pueblo of Zuni, and Navajo Nation. With proposed amendments to the Programmatic Agreement, the Western Area Power Administration, the Bureau of Indian Affairs, and possibly the Havasupai Tribe and San Juan Southern Paiute Tribe, may become signatories.

The Programmatic Agreement is a process whereby all the signatories agree to specific actions relative to management of National Register eligible historic properties affected by Glen Canyon Dam. The Programmatic Agreement has stipulations which include: (1) identification and evaluation of all historic properties within the area of potential effects of dam operations; (2) development of a plan for monitoring the effects of Glen Canyon Dam operations on historic properties and for carrying out remedial actions to address the effects of ongoing damage to historic properties; and (3) preparation of an historic preservation plan.

In the Adaptive Management Program, Programmatic Agreement signatories, Grand Canyon Monitoring and Research Center staff, and associated scientists provide input to Adaptive Management Work Group and Technical Work Group members on cultural resource issues. The Technical Work Group and Adaptive Management Work Group are considered interested parties to the Section 106 compliance process. Since the Programmatic Agreement is a component of the Adaptive Management Program, the Technical Work Group and Adaptive Management Work Group have input to the Programmatic Agreement program through their review and recommendations to the Secretary of the Interior. As the lead agency, the Bureau of Reclamation has primary

responsibility for ensuring that the stipulations of the Programmatic Agreement are implemented.

ANNUAL ADAPTIVE MANAGEMENT PROGRAM CYCLE

Budget Development Process

The budget development process is detailed in Appendix H.

Annual Report to Congress

As authorized by the Grand Canyon Protection Act, each year the Adaptive Management Program prepares a report to be transmitted to Congress. The report describes the long-term operations and other reasonable mitigation measures taken to protect, mitigate adverse impacts to, and improve the condition of the natural, recreational, and cultural resources of the Colorado River ecosystem.

The report also serves to provide an update on the status of the resources addressed by the Grand Canyon Protection Act. The annual State of the Colorado River Ecosystem report prepared by the Grand Canyon Monitoring and Research Center provides valuable input to the Annual Report to Congress.

State of the Colorado River Ecosystem Report

Communication between scientists and managers is vital in the Adaptive Management Program. The State of the Colorado River Ecosystem report serves the critical purpose of assessing the condition of the ecosystem, including a comprehensive reporting of status and trends among Colorado River ecosystem resources. Through the use of qualitative and quantitative targets, it also provides a mechanism for determining if the management objectives are being met. This crucial feedback loop guides adaptive management decisions, and incorporates results into recommendations of the Adaptive Management Work Group. It helps the Adaptive Management Work Group to learn from implementation of its policies, thereby refining and improving results and achieving its goals.

Results of annual monitoring and research activities should be made available to the Technical Work Group and Adaptive Management Work Group by April of each year. Results of the science program, both data and synthesis reports, are available at the Grand Canyon Monitoring and Research Center. The Grand Canyon Monitoring and Research Center provides many of the reports on the Internet. Copies are also provided to the National Archives in compliance with the Federal Records Act.

Annual Science Plan

Each year the Grand Canyon Monitoring and Research Center prepares a detailed science plan describing the monitoring and research activities proposed for the upcoming year. The plan is discussed with the Technical Work Group and the Technical Work Group budget ad hoc group in an effort to identify both important monitoring and research questions and relative priorities among the scientific activities. The Grand Canyon Monitoring and Research Center also consults with the Programmatic Agreement signatories to determine if there are any potential effects from the proposed monitoring or research activities delineated in the annual science plan. Final recommendation to the Secretary of the Interior rests with the Adaptive Management Work Group.

The annual science plan is critical to the evaluation of the effectiveness of actions taken to protect downstream resources. The plan must have a stable and long-term monitoring component to address long-term trends. It must also have a research component to address new questions that arise through scientific investigations. Finally, it must have the statistical rigor required to substantiate its conclusions. The annual work plan will include a report on the prior year's activities.

Request for Proposal Process

The Grand Canyon Monitoring and Research Center utilizes a competitive proposal solicitation process open to government employees, public sector contractors, and universities through an open Request for Proposals process. All Adaptive Management Program monitoring and research projects are selected on the basis of their support of scientific capability and merit, submission timeliness on previous work (as evaluated through an independent, objective, and unbiased peer review process), management objectives and information needs, demonstrated capabilities of proposers, and cost effectiveness. Following the selection of proposals, appropriate procurement mechanisms (i.e., grants, contracts, and cooperative agreements) are utilized for supporting selected projects.

The Grand Canyon Monitoring and Research Center is committed to the use of peer review and has peer review guidelines that describe the processes it follows in reviewing all Grand Canyon Monitoring and Research Center proposals, programs, publications, and other products or deliverables. The guidelines will convey the unambiguous standard of scientific objectivity and credibility followed by the Adaptive Management Program.

In general, following approval by the Adaptive Management Work Group of the long-term monitoring and research strategic plan, an annual monitoring and research program will be completed and approved each year in April. After approval of the annual monitoring and research plan, Request for Proposals will be issued. Proposals will be screened by the program managers for their responsiveness to the Request for Proposals, and all qualified proposals will undergo an independent and objective scientific peer review. Awards will be made based on the results of peer review, the program manager's evaluation of project relevance, and technical contracting requirements.

APPENDICES

Appendix A

GRAND CANYON PROTECTION ACT

SEC. 1801. SHORT TITLE.

This Act may be cited as the “Grand Canyon Protection Act of 1992.”

SEC. 1802. PROTECTION OF GRAND CANYON NATIONAL PARK

(a) IN GENERAL.-The Secretary shall operate Glen Canyon Dam in accordance with the additional criteria and operating plans specified in section 1804 and exercise other authorities under existing law 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.

(b) COMPLIANCE WITH EXISTING LAW.-The Secretary shall implement this section in a manner fully consistent with and subject to the Colorado River Compact, the Upper Colorado River Basin Compact, the Water Treaty of 1944 with Mexico, the decree of the Supreme Court in Arizona vs. California, and the provisions of the Colorado River Storage Project Act of 1956 and the Colorado River Basin Project Act of 1968 that govern allocation, appropriation, development, and exportation of the waters of the Colorado River Basin.

(c) RULE OF CONSTRUCTION.-Nothing in this title alters the purposes for which the Grand Canyon National Park or the Glen Canyon National Recreation Area were established or affects the authority and responsibility of the Secretary with respect to the management and administration of the Grand Canyon National Park and Glen Canyon National Recreation Area, including natural and cultural resources and visitor use, under laws applicable to those areas, including, but not limited to, the Act of August 25, 1916 (39 Stat. 535) as amended and supplemented.

SEC. 1803. INTERIM PROTECTION OF GRAND CANYON NATIONAL PARK

(a) INTERIM OPERATIONS.-Pending compliance by the Secretary with section 1804, the Secretary shall, on an interim basis, continue to operate Glen Canyon Dam under the Secretary's announced interim operating criteria and the Interagency Agreement between the Bureau of Reclamation and the Western Area Power Administration executed October 2, 1991 and exercise other authorities under existing law, in accordance with the standards set forth in section 1802, utilizing the best and most recent scientific data available.

(b) CONSULTATION.-The Secretary shall continue to implement Interim Operations in consultation with-

(1) Appropriate agencies of the Department of the Interior, including the Bureau of Reclamation, United States Fish and Wildlife Service, and the National Park Service;

(2) The Secretary of Energy;

(3) The Governors of the States of Arizona, California, Colorado, Nevada, New Mexico,

Utah, and Wyoming;

(4) Indian Tribes; and

(5) The general public, including representatives of the academic and scientific communities, environmental organizations, the recreation industry, and contractors for the purchase of Federal power produced at Glen Canyon Dam.

(c) DEVIATION FROM INTERIM OPERATIONS.-The Secretary may deviate from Interim Operations upon a finding that deviation is necessary and in the public interest to-

(1) comply with the requirements of Section 1804(a);

(2) respond to hydrologic extremes or power system operation emergencies;

(3) comply with the standards set forth in Section 1802;

(4) respond to advances in scientific data; or

(5) comply with the terms of the Interagency Agreement.

(d) TERMINATION OF INTERIM OPERATIONS.-Interim operations described in this section shall terminate upon compliance by the Secretary with section 1804.

SEC. 1804. GLEN CANYON DAM ENVIRONMENTAL IMPACT STATEMENT; LONG-TERM

OPERATION OF GLEN CANYON DAM.

(a) FINAL ENVIRONMENTAL IMPACT STATEMENT.-Not later than 2 years after the date of enactment of this Act, the Secretary shall complete a final Glen Canyon Dam environmental impact statement, in accordance with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.).

(b) AUDIT.-The Comptroller General shall-

(1) audit the cost and benefits to water and power users and to natural, recreational, and cultural resources resulting from management policies and dam operations identified pursuant to the environmental impact statement described in subsection (a); and

(2) report the results of the audit to the Secretary and the Congress.

(c) ADOPTION OF CRITERIA AND PLANS.-(1) Based on the findings, conclusions, and recommendations made in the environmental impact statement prepared pursuant to subsection (a) and the audit performed pursuant to subsection (b), the Secretary shall-

(A) adopt criteria and operating plans separate from and in addition to those specified in section 602(b) of the Colorado River Basin Project Act of 1968; and

(B) exercise other authorities under existing law, so as to ensure that Glen Canyon Dam is operated in a manner consistent with section 1802.

(2) Each year after the date of the adoption of criteria and operating plans pursuant to paragraph (1), the Secretary shall transmit to the Congress and to the Governors of the Colorado River Basin States a report, separate from and in addition to the report specified in section 602(b) of the Colorado River Basin Project Act of 1968 on the preceding year and the projected year operations undertaken pursuant to this Act.

(3) In preparing the criteria and operating plans described in section 602(b) of the Colorado River Basin Project Act of 1968 and in this subsection, the Secretary shall consult with the Governors of the Colorado River Basin States and with the general public, including-

(A) representatives of academic and scientific communities;

(B) environmental organizations;

(C) the recreation industry; and

(D) contractors for the purpose of Federal power produced at Glen Canyon Dam.

(d) REPORT TO CONGRESS.-Upon implementation of long-term operations under subsection (c), the Secretary shall submit to the Congress the environmental impact statement described in subsection (a) and a report describing the long-term operations and other reasonable mitigation measures taken to protect, mitigate adverse impacts to, and improve the condition of the natural, recreational, and cultural resources of the Colorado River downstream of Glen Canyon Dam.

(e) ALLOCATION OF COSTS.-The Secretary of the Interior, in consultation with the Secretary of Energy, is directed to reallocate the costs of construction, operation, maintenance, replacement and emergency expenditures for Glen Canyon Dam among the purposes directed in section 1802 of this Act and the purposes established in the Colorado River Storage Project Act of April 11, 1956 (70 Stat. 170). Costs allocated to section 1802 purposes shall be nonreimbursable. Except that in fiscal year 1993 through 1997 such costs shall be nonreimbursable only to the extent to which the Secretary finds the effect of all provisions of this Act is to increase net offsetting receipts; Provided, That if the Secretary finds in any such year that the enactment of this Act does cause a reduction in net offsetting receipts generated by all provisions of this Act, the costs allocated to section 1802 purposes shall remain reimbursable. The Secretary shall determine the effect of all the provisions of this Act and submit a report to the appropriate House and Senate committees by January 31 of each fiscal year, and such report shall contain for that fiscal year a detailed accounting of expenditures incurred pursuant to this Act, offsetting receipts generated by this Act, and any increase or reduction in net offsetting receipts generated by this Act.

SEC. 1805. LONG-TERM MONITORING.

(a) IN GENERAL.-The Secretary shall establish and implement long-term monitoring programs and activities that will ensure that Glen Canyon Dam is operated in a manner consistent with that of section 1802.

(b) RESEARCH.-Long-term monitoring of Glen Canyon Dam shall include any necessary research and studies to determine the effect of the Secretary's actions under section 1804(c) on the natural, recreational, and cultural resources of Grand Canyon National Park and Glen Canyon National Recreation Area.

(c) CONSULTATION.-The monitoring programs and activities conducted under subsection (a) shall be established and implemented in consultation with-

(1) the Secretary of Energy;

(2) the Governors of the States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming;

(3) Indian tribes; and

(4) the general public, including representatives of academic and scientific communities, environmental organizations, the recreation industry, and contractors for the purchase of Federal power produced at Glen Canyon Dam.

SEC. 1806. RULES OF CONSTRUCTION.

Nothing in this title is intended to affect in any way-

(1) the allocations of water secured to the Colorado Basin States by any compact, law, or decree; or

(2) any Federal environmental law, including the Endangered Species Act (16 U.S.C. 1531 et seq.).

SEC. 1807. STUDIES NONREIMBURSABLE.

All costs of preparing the environmental impact statement described in section 1804, including supporting studies, and the long-term monitoring programs and activities described in section 1805 shall be nonreimbursable. The Secretary is authorized to use funds received from the sale of electric power and energy from the Colorado River Storage Project to prepare the environmental impact statement described in section 1804, including supporting studies, and the long-term monitoring programs and activities described in section 1805, except that such funds will be treated as having been repaid and returned to the general fund of the Treasury as costs assigned to power for repayment under section 5 of the Act of April 11, 1956 (70 Stat. 170). Except that in fiscal year 1993 through 1997 such provisions shall take effect only to the extent to which the Secretary finds the effect of all the provisions of this Act is to increase net offsetting receipts; Provided, That if the Secretary finds in any such year that the enactment of this Act does cause a reduction in net offsetting receipts generated by all provisions of this Act, all costs described in this section shall remain reimbursable. The Secretary shall determine the effect of all the provisions of this Act and submit a report to the appropriate House and Senate committees by January 31 of each fiscal year, and such report shall contain for that fiscal year a detailed accounting of expenditures incurred pursuant to this Act, offsetting receipts generated by this Act, and any increase or reduction in net offsetting receipts generated by this Act.

SEC. 1808. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated such sums as are necessary to carry out this title.

SEC. 1809. REPLACEMENT POWER.

The Secretary of Energy in consultation with the Secretary of the Interior and with representatives of the Colorado River Storage Project power customers, environmental

organizations and the States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming shall identify economically and technically feasible methods of replacing any power generation that is lost through adoption of long-term operational criteria for Glen Canyon Dam as required by section 1804 of this title. The Secretary shall present a report of the findings, and implementing draft legislation, if necessary, not later than two years after adoption of long-term operating criteria. The Secretary shall include an investigation of the feasibility of adjusting operations at Hoover Dam to replace all or part of such lost generation. The Secretary shall include an investigation of the modifications or additions to the transmission system that may be required to acquire and deliver replacement power.

Appendix B

GLEN CANYON DAM ADAPTIVE MANAGEMENT PROGRAM
AMWG FACA COMMITTEE GUIDANCE

Purpose of this Document

During the first two years of implementing the Glen Canyon Dam Adaptive Management Program, it has become apparent that several aspects of the program, specifically relating to the Record of Decision, the Glen Canyon Dam EIS and the Grand Canyon Protection Act need to be clarified in order to facilitate and focus the activities of both the Adaptive Management Work Group Committee (AMWG) and its subcommittee, the Technical Work Group (TWG). It is the purpose of this document to provide that direction. The following guidance represents the Department=s understanding and intent concerning the purpose and role of the AMWG Committee and the scope of work given to the Committee in its Charter, pursuant to all relevant law and Departmental policy. This guidance has been assembled with the assistance and legal guidance of the Office of the Solicitor and has been shared with all members of the AMWG prior to finalization.

Background

During the past century, there have been numerous developments affecting the Colorado River that have led to the present juncture. On November 24, 1922, the Colorado River Compact was signed at Santa Fe, New Mexico, allocating the water of the river between the Upper and Lower Basins, as defined therein, as well as establishing the rules, rights, and obligations governing the use of that water among the seven respective states within the Colorado River Basin. The United States also has a treaty with the United Mexican States (Mexico) guaranteeing Mexico 1.5 million acre feet annually from the Colorado River. Among the other obligations established in the Compact was that of the Upper Basin not to deplete the flow of the river at Lee Ferry “below an aggregate of 75,000,000 acre-feet for any period of 10 consecutive years.”

Earlier, in 1908, Congress set aside the Grand Canyon as a national monument and in 1919 expanded the reservation and redesignated it as a national park. There are only about fifteen river miles separating the outlet works of Glen Canyon Dam and the upstream boundary (on the northerly side of the river) of Grand Canyon National Park. Later, Congress also established the area surrounding Lake Powell and extending down river to the Park boundary (except for the area within the pre-existing Navajo Reservation) as the Glen Canyon National Recreation Area, also managed by the National Park Service.

In large part in order to assure that the rights and obligations in the Colorado River Compact and the Upper Colorado River Basin Compact could be met without jeopardizing the water uses of the Upper Basin states in the future, Congress passed the Colorado River Storage Project Act on April 11, 1956, which provided the authority for the construction of the four “initial units” of CRSPA, namely Flaming Gorge, Aspinall, Navajo, and Glen Canyon dams. Glen Canyon Dam, storing more than 26 million acre feet, over 24 million of which represent

active capacity, is situated immediately above Lee Ferry, the delivery point to the Lower Basin. In 1968 Congress passed the Colorado River Basin Project Act which among other things provided for coordinated operations of Colorado River Basin reservoirs. Until recently, Glen Canyon Dam has been operated with essentially two functions in mind: compact deliveries to the Lower Basin, and hydropower generation. Compact deliveries from Glen Canyon assure that the Upper Basin can meet its delivery obligations to the Lower Basin states and effectively manage other Upper Basin reservoirs to meet Upper Basin water supply needs. Hydropower generation provides the revenues necessary to cover operation and maintenance costs as well as the revenues needed to assure repayment of CRSP projects.

During the 1980s, it became apparent that the existing pattern of dam operations was adversely affecting some of the riparian resources in the Park and the Recreation Area below the dam. The Department began studying the situation, initiated the preparation of an EIS, and then Congress passed the Grand Canyon Protection Act of 1992 to attempt to address this problem.

Authority (Questions 1a, 1b, 1c, 2a, 3, 4c, 5a, 5c, 5e, 6a, 6b, 7a, 7c, 8, 12c, 13a, 14)

Grand Canyon Protection Act, Legislative History, and Law of the River

It is quite clear that when Congress enacted the Grand Canyon Protection Act of 1992, 106 Stat. 4669 (GCPA), it intended to maintain all that had gone before B the Compacts, the Park units, and Glen Canyon Dam B and to find a way to operate the dam so as to "protect [sic], mitigate adverse impacts to and improve"[1] downstream NPS resources without interfering with the "Law of the River," including compact and treaty obligations for water delivery (GCPA, section 1802(a) and (b)). The Senate Report on the bill puts it quite simply: AThe primary purpose of this title is to authorize changes in the operation of Glen Canyon Dam to prevent damage to downstream resources, principally the dam=s power operations.@ The Secretary's responsibilities for water storage, allocation and delivery act as limits on the Secretary's discretion in implementing the GCPA. It is also clear that Congress understood that these objectives would have certain costs in the form of lost incremental hydropower generating opportunity (GCPA, section 1809) and that the existence of the dam was to be taken as a given.

The basic question Congress was addressing was how Glen Canyon Dam operations might be modified within the provisions of existing law so as to improve conditions for downstream NPS resources (with similar benefits certainly occurring on other similarly situated lands). The GCPA itself does not direct consideration of cultural resources within the boundaries of Native American reservations, only "the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established," although all federal agencies have similar obligations under other law. The entire adaptive management program (AMP), including the Grand Canyon Monitoring and Research Center and the Adaptive Management Work Group, must be understood within this context. In accordance with section 1804 of the GCPA, the EIS was conducted to attempt to find an answer to that question, and the 1996 ROD was the Department=s best first answer. Recognizing that more experience and knowledge with

[1] The GCPA as printed contains a typographical error, using "project" instead of "protect." The legislative history makes clear that "protect" is what was intended; that word will be used throughout this document.

operations might enable further refinements in operations and might further improve downstream resource conditions, however, Congress added section 1805 to the GCPA. This section required the Secretary to “establish and implement long-term monitoring programs and activities that will ensure that Glen Canyon Dam is operated in a manner consistent with section 1802,” namely, “to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established,” within the parameters of other applicable law and the physical constraints of the dam. Accordingly, the Department included in the EIS and in the ROD the provisions setting up the AMP, thereby allowing for further refinement of and changes to dam operations to better meet the GCPA objectives.

The charge given to the AMWG in its Charter is to “facilitate the AMP, recommend suitable monitoring and research programs, and make recommendations to the Secretary as required to meet the requirements of the Act.@ The scope of the AMWG responsibility, therefore, is to identify aspects of dam operations that can be modified to beneficially affect the downstream resources identified as the focus of study (i.e. “the target”) in the EIS. This covers flow rates, ramping rates, periodicity of peak flows, monitoring sediment input rates and the relation of sediment movement to water release and ramping rates, chemical content and temperature of releases, among possible others -- any aspect of dam operations, in other words, which has a reasonably demonstrable effect on the downstream resources sought to be improved by the GCPA. The key to the scope of AMWG=s responsibilities is whether a specific desired resource effect downstream of the dam can be achieved through some manipulation of dam operations. Under the ROD, the upper limit of planned release level is 45,000 cfs. Long-term monitoring and research, including test flows within the current range of authorized operations, are intended to enable finer and finer tuning of operations over time, as additional knowledge and experience are gained, to better achieve the target mix of resource benefits, as outlined in the EIS, pages 54-65.

Without losing track of this primary focus on improving conditions for downstream resources, the Charter also specifies that the AAMWG may recommend research and monitoring proposals outside the Act which complement the AMP process, but such proposals will be funded separately, and do not deter from the focus of the Act.@ This would include anything the AMWG committee considers relevant but tangential or attenuated in its effects on riparian resources downstream of the dam, as identified above. The relevant Senate Report language says, after the discussion of the primary purpose of the Act, that: Aother reasonable remedial measures may be available to the Secretary. The phrase >exercise other authorities under existing law= means that the Secretary should consider and may implement non-operational measures to address downstream effects of Glen Canyon Dam if such other remedial measures meet this title=s goal of protecting, mitigating damage to, and improving the resources downstream of the dam.@ Again, as emphasized in the Senate Report, “the water storage, allocation and delivery requirements of the Law of the River place substantial limits on the Secretary’s ability to change other elements of GCD operations. All measures undertaken pursuant to the authority of this Act have as their focus the improvement of conditions for downstream resources within the two Park
Service units.” The TWG=s responsibility is similarly limited, but even more so; it is to carry out only specific assignments within the scope of the AMWG=s responsibility, as directed by the AMWG.

The AMWG was set up pursuant to the Federal Advisory Committee Act (FACA) and must comply with FACA=s requirements for notice and public meetings, etc., as laid out in the GSA regulations at 41 CFR Subpart 101-6.10. The AMWG and TWG may establish their own internal operating procedures as they wish, so long as they comply with the specific requirements of FACA and its implementing regulations.

One area that has been a source of recent discussion has been the question of planned high releases from Glen Canyon Dam for such purposes as "beach habitat building flows." The Department expects the AMWG to work and provide its recommendations within the following context. Since the GCPA is clear that it was not intended to modify the compacts or "the provisions of the Colorado River Storage Project Act of 1956 and the Colorado River Basin Project Act of 1968 that govern allocation, appropriation, development, and exportation of the waters of the Colorado River Basin" (GCPA, section 1802(b)), any operational changes under the auspices of the GCPA are clearly subordinate to and must fit within the constraints of those provisions. Historically, there have been differences of legal opinion over some related issues, such as whether releases of water above powerplant capacity, if made for authorized purposes, can be considered as not constituting "spills" within the meaning of section 602(a) of the Colorado River Basin Project Act of 1968 and the Operating Criteria implemented pursuant to section 602, and more recently over whether the GCPA "amends" existing law by adding additional authorized purposes for the operation of Glen Canyon Dam. These legal issues have not been finally resolved, but given the limitations provided in the ROD, the Glen Canyon Dam operating criteria, and the 1996 agreement between the Department and the Basin States, it is believed that they have been adequately addressed. Clearly, section 7 of the CRSPA, which directs the Secretary "to produce the greatest practicable amount of power and energy that can be sold at firm power and energy rates" provided that the primary purposes of compact deliveries and state compact allocation development are not precluded or impaired, remains in effect, even though the GCPA (section 1809) authorized, and the EIS/ROD implemented, an incremental reduction in the value of the hydropower resource. Under the conditions of those documents (the ROD, the operating criteria, and the 1996 agreement), flows above powerplant capacity would be conducted utilizing reservoir releases required for dam safety purposes. The Department is currently focusing on operational modifications at release levels below 45,000 cfs. Modifications to the operating criteria involving flows above 45,000 cfs would require additional NEPA compliance.

EIS/ROD (Questions 1b, 4c, 5a, 5c, 7b, 7c, 12a, 12b, 12c, 13a, 13b, 13c, 13d, 13e, 13f, 15)

As mentioned above, the EIS conducted on Glen Canyon Dam operations contains the Department=s selection of a mix of targeted resource benefits and its attempt to balance these benefits against costs to hydropower generation. As stated in the ROD:

> The goal of selecting a preferred alternative was not to maximize benefits for the most resources, but rather to find an alternative dam operating plan that would permit recovery and long-term sustainability of downstream resources while limiting

hydropower capability and flexibility only to the extent necessary to achieve recovery and long-term sustainability.

The ROD represents the Department's "first cut" on providing an answer as to how that target might be achieved. The EIS and ROD are relevant to the AMP process in several respects. First of all, the EIS identifies the specific downstream resources sought to be benefitted (i.e. Aprotected, mitigated for, or enhanced@) by changes in dam operations (see EIS, pp. 54-57 and Table II-7). Secondly, its discussions and analyses of various alternatives provide a starting point for the state of the science at the time the decision was made to implement the Amodified low fluctuating flow@ pattern of operations with a commitment for long-term modifications in response to further research. In the language of the ROD, "the Modified Low Fluctuating Flow Alternative was selected as the preferred alternative because it would provide the most benefits with respect to the original selection criteria, given existing information."

The monitoring, research and experimental programs are intended to develop additional information, working with the AMWG recommendations, "which could result in some additional operational changes." The selection criteria against which such changes are to be measured, however, remain unchanged. Elsewhere the ROD amplifies that this alternative was selected because it "meets the critical requirements of the sediment resource by restoring some of the pre-dam variability through floods and by providing a long-term balance between the supply of sand from Grand Canyon tributaries and the sand-transport capacity of the river" with corresponding benefits to habitat. The ROD, in part in conjunction with the EIS, also describes in detail the decision made, including modifications to the selected alternative, specific environmental and monitoring commitments, the scope and objectives of the AMP, the role and function of the Grand Canyon Monitoring and Research Center (GCMRC), and the role expected for the AMWG and TWG. It is important to understand that before either the targeted resource blend or the operational pattern in the Glen Canyon Dam operating criteria can be changed materially, additional NEPA work would have to be done.

Among the environmental commitments made in the ROD was the commitment to restrict Glen Canyon Dam release upramp rates to 4,000 cfs per hour and downramp rates to 1,500 cfs per hour. Consistently with interagency agreements between BOR and the Western Area Power Administration (WAPA) both prior and subsequent to the 1996 ROD, these figures should be understood to represent a firm limit on changes in release rates integrated over each hourly interval, to be enforced by the Secretary, subject to being exceeded only in times of emergency unless and until changed by subsequent decision of the Secretary.

As part of the adaptive management process, studies and information needs specified in the EIS/ROD are expected to be completed and to result in the identification of new information needs or definitions of effects, impacts and mitigation requirements.

All applicable federal laws must be complied with, including NEPA, NHPA, ESA, FACA, and the APA, in addition to the federal laws considered part of the ALaw of the River.@ It is not expected that the Adaptive Management Program will result in additional required NEPA compliance unless additional resources (i.e. "management objectives") are identified and targeted for inclusion in the revised dam operations beyond those identified in the existing EIS.

Organization (Questions 8, 9, 10, and 11)

Prior to the EIS and ROD various Federal Agencies (i.e., BIA, WAPA, BOR, NPS, FWS) had various statutory responsibilities for compliance with laws involving such areas as the environment, historical and cultural resources, and threatened and endangered species. These agencies have frequently entered into agreements among themselves to take specific actions to meet those statutory requirements. It was assumed when the AMP was adopted by the Secretary that it would include all studies necessary to determine the effects of GCD operations on the designated resources selected in the ROD. Some of these studies meet scientific needs and also meet statutory requirements under NEPA, ESA and NHPA. In fact the EIS identified some specific studies that would be a part of the AMP, such as the study of low steady flows.

The Secretary of the Interior established the AMP with four key elements: AMWG, TWG, GCMRC, and the IRP (Independent Review Panel). The four have distinct roles, but ultimately the Secretary of the Interior is responsible for seeing that the monitoring and necessary research is done to evaluate the impacts of adjustments made to dam operations. The EIS document prepared by the Secretary envisioned the AMP program to be a somewhat all-encompassing investigation of impacts, while still respecting the statutory obligations of each of the Departmental agencies. One of the mechanisms chosen by the Secretary to receive feedback through the AMP is the AMWG, which is to provide recommendations on the content of the various budgeting and planning documents. The AMWG can *recommend* studies and priorities for implementing individual studies during those reviews, preferably by consensus. In doing so, all members of the AMWG are assumed to be equal in importance when voting on recommendations, including federal agencies. However, final decisions as to the management of Interior facilities and resources, what studies to implement, when, and using funds from which sources remain, by statute, with the Secretary of the Interior and the appropriate Interior agencies.

Funding (Questions 2b, 4a, 4b, 5b, 5d, 6a, 7a, 17, 18, 19, 20, and 21)

Funding for any federal effort comes from the statutory authorities provided by enacted laws. In the case of the AMP, several funding authorities can come into play -- the most visible being the Grand Canyon Protection Act (GCPA) of 1992. The GCPA makes several statements with regard to potential sources of funds and also imposes some restrictions. With regard to the use of revenues generated from the sale of electric power, section 1807 is specific and restrictive. The hydropower revenues may be used for preparation of the EIS, including supporting studies, and the long-term monitoring programs and activities described in section 1805. Both hydropower revenues and appropriated funds can be used for administrative expenses to implement the specified work. However, the use of such funds to pay expenses of non-government employees may be covered under FACA and other fiscal regulations and must be treated on a case by case basis. The GCPA also authorizes such sums to be appropriated as are necessary and encourages use of other authorities under existing law to determine the effect of the Secretary's actions under section 1804 (c) and 1805 (b) on the natural, recreational, and cultural resources of Grand Canyon National Park and Glen Canyon National Recreation Area.

The activity and its authorization determine the funding. To date, hydropower revenues have been the source of funding for almost all AMP activities because they meet the definition above. Research and monitoring proposals outside the Act which complement the AMP process are to be separately funded.

As stated in the authorities section above, the focus of the GCPA is downstream of the dam and primarily on the operations of the powerplant. The existence or construction of the dam and its associated impacts is not a focus. This is clear in both the EIS and ROD, i.e. in the EIS at page 2, top of page, right hand column ASince the dam has long been completed, alternatives to the dam itself have been excluded from the scope of the analysis.@

To illustrate the range of activities and associated funding, some examples are provided below:

- Studies of control sites in Cataract Canyon or on reservation lands, for example, may be supported by revenues, if the studies are determined through scientific peer review to be necessary for determining the effects of the Secretary's actions downstream within the park units under 1804(c).

- Studies of water quality in Lake Powell are allowable if necessary to determine the effects on downstream resources. Studies of the effects on cultural resources around the rim of Lake Powell are not allowable under AMP (GCPA) funding.

- It is reasonable to assume that while the primary focus is on powerplant releases the releases from the bypass tubes and spillway outlet works also fall into the operational category and funding could be used to conduct experiments and study impacts from their operation. In fact, this has already occurred to a degree during the 1996 beach habitat building test flow when the bypass tubes were used.

All Federal agencies have a special responsibility to Native Americans by law, including statutes, treaties, and executive orders. With the Secretary of the Interior being trustee, Department of the Interior agencies have a special role. Certainly the direct impacts of the dam operations on the Native American trust resources within the park units can and should be funded from hydropower revenues, but such impacts outside the boundaries of the river corridor in the park units must be studied using other appropriated funds. Participation in the AMP or education activities should be funded from appropriate sources. For instance education activities may come under self-governance and self-determination programs and be funded from BIA funds, activities surrounding general NPS requirements may be funded from NPS funds, and participation in AMP work group activities may be specific enough to be funded by revenues or appropriations from BOR. Funding of Native American activities should be a shared responsibility.

Other Compliance and Consultations (Questions 11, 16, and 21)

Prior to passage of GCPA and formation of the AMP, federal agencies had many responsibilities embodied in existing law. Those responsibilities remain today. The GCPA,

EIS/ROD, and AMP did not take over responsibility for nor remove the legal obligations of the agencies to fulfill existing legal mandates. The GCPA states as much in several places. The AMP is a process by which the Secretary of the Interior has chosen to include all studies and other compliance activities necessary to determine the effects of GCD operations on designated resources and to modify operations to meet the purposes of the GCPA.

It is possible that some of the studies recommended and performed under the AMP and the AMP budget will coincide with and help to satisfy obligations of the federal agencies under other laws, such as the Endangered Species Act. The obligations imposed by other laws must be complied with by the responsible agencies, whether they are funded as part of the AMP process or separately. The AMP budget does not imply that these compliance functions will automatically be assumed or raised to a higher priority through the AMP process, although where reasonable, the AMP process may assist or even satisfy such functions in a given instance -- "two birds with one stone," so to speak.

While the AMWG and TWG should be aware that the involved federal agencies face these responsibilities, those factors should not detract from the committee's focus as described in the GCPA, EIS, ROD, and Charter. The committee's recommendations for studies and their relative priorities should remain on the effects of dam operations on downstream resources within the park units. The implementation of such studies, their timing and funding and the like remain the decision of the Secretary and the federal agencies, as noted earlier.

Embodied in the NEPA process is the requirement to comply with ESA and cultural laws in order to discuss and present the impacts on all resources and eventually arrive at a preferred alternative. For example, the AMWG is not chartered to be a formal participant in ESA consultation processes. However, the AMP does not prevent AMWG members from participating as members of the public or in their other official capacities. In this regard, AMWG should focus on helping Reclamation determine how to apply the reasonable and prudent alternatives within the area of concern of the GCPA. In regards to the consultation requirements under NHPA, the action federal agencies and affected tribes have signed a programmatic agreement (PA) document and hold periodic meetings. Parties not signatory to the PA are welcome to attend and comment. Here too, however, the ultimate decision on how to proceed rests with the Secretary of the Interior and the federal agencies delegated the responsibility for management of the resources.

Other Program Relationships

While programs in other areas of the Colorado River do not require direct input from the work performed for the GCPA, it is certainly envisioned that information will be shared and that participants will keep abreast of other relevant basin activities. The GCPA requires compliance with existing laws and consultations with a variety of groups. To meet that requirement it is important that all members share knowledge obtained from activities arising from i.e., the upper basin recovery program, the salinity control program, and the lower Colorado multi-species conservation program.

APPENDICES:

QUESTIONS

Scott Loveless has responded to and the TWG has discussed a list of questions which was prepared by Bob Winfree on December 15, 1998, and which was attached to Steve Magnussen's memo of December 29, 1998. Those discussions generated the following additional questions for Scott from TWG. The following numbered list embodies the questions that led to the above guidance document.

1. **(a)** What is the scope of the AMWG Charter?

(b) How do the EIS, the ROD, and the Act impact the scope?

(c) Can the AMWG charter expand upon the scope and authorities in the Act? (EIS & ROD)

2. **(a)** Is the AMP limited by section 1804? Can AMWG recommend changes in the operating criteria?

(b) Can the program expend funds to study (research) impacts of proposed (recommended) changes that are clearly beyond the limitations of Sec. 1804(c)?

3. What constitutes the target?

4. **(a)** Can funds as designated in 1807 be used to fund studies outside the effects of dam operations (outside the operational confines of the dam)?

(b) How direct must the impacts be to allow funding under 1807?

(c) Where does the burden of proof lie for determining the effects of dam operations?

5. **(a)** Is the AMP limited to powerplant operations when hydrologic triggering criteria are not met? (paraphrase, Can you do an experimental flood when not required for dam safety purposes)

(b) Does the GCPA authorize funding to be used for mitigation of powerplant operations, or is it broader; i.e., mitigate for spillways, bypass tubes, dam existence (Furnace Flats)? (i.e., Can AMP funding be used to mitigate sediment reduction, temperature averaging effects due to the existence of GCD.)

(c) Does NHPA require mitigation for damage to properties eligible for listing on the National Register of Historic Sites as a result of the dam's existence?

(d) Does the law allow for funding mitigation activities related to construction [existence] of the dam versus operations of the dam?

(e) Were powerplant spills other than those hydrologically induced authorized by the Act?

6. **(a)** Does the monitoring program allow for research and monitoring of potential effects of releases up to 256,000 cfs?

(b) What is the legal boundary for lateral extent for all resources?

7. **(a)** When is it appropriate to propose experiments outside the preferred alternative?

(b) Can experiments be performed which are outside of the ROD?

(c) What are the limitations when performing an experiment outside the ROD?

8. What are the TWG responsibilities relative to review and editing of the monitoring and research plans prepared by GCMRC?

9. What organization is responsible for developing needed AMP planning documents and reports other than science program reporting?

10. Do recommendations of all stakeholders represented in TWG and AMWG carry equal weight in [TWG/AMWG] decisions?

11. The AMP has only been in place for a few years. Before the AMP, the various Federal Agencies involved had certain statutory responsibilities for environmental, historical and ESA compliance and they entered into agreements to take specific actions. Does the existence of an AMP budget automatically assume these compliance responsibilities for the agencies; and if so, do the agencies compliance responsibilities automatically become the dominant focus of the program? (i.e., Biological Opinion, Cultural Resources, etc.)

12. **(a)** Can the management objectives as outlined in the EIS be changed and, if so, how much can they be changed?

(b) Are the management objectives as outlined in the EIS different from the expected changes in management goals adopted by the Secretary when he selected the preferred alternative?

(c) Were the recommended changes in powerplant operating criteria made to

achieve the desired changes in management goals?

13. **(a)** What is the force and effect of the ROD? .
(b) What limits does it put on our actions?

(c) Are there any parts of the paper, prepared by Reclamation and WAPA and distributed at AMWG, which are illegal?

(d) Are the numbers in the ROD hard and fast?

(e) Is it possible to exceed them?

(f) What is the penalty for exceeding limits specified in the ROD?

14. Does the GCPA authorize activities on Native American reservation lands (for example, above 124,000 cfs outside Grand Canyon National Park on Hualapai land)?

15. When is it appropriate to propose experiments outside the ROD?

16. Are there any prohibitions about AMWG contributing to the formal consultation on BO for Kanab Ambersnail?

17. What are the limits of the use of GCPA funds on other areas outside those specified in the GCPA, Grand Canyon National Park and the Glen Canyon National Recreation Area? For example, what is the restriction on the use of funds on tribal lands? Further, what about the effects that are caused by the action but do not have a resultant influence downstream? For, example what if there were effects of dam operations in Lake Mead? Could GCPA funds be used to study impacts to Lake Mead caused by operational impacts of Glen Canyon Dam? I'm thinking here of whether these funds could be used to study the effects of operations on an endangered bird species in delta area of Lake Mead.

18. Can GCPA funds (nonreimbursable power revenues) be used for agency compliance responsibilities related only to the operation of Glen Canyon Dam? Specifically, can they be used to pay for continuing activities related to BOR or NPS NHPA, Endangered Species Act Biological Opinion requirements, NEPA compliance etc. The BOR has made a very strong argument in the past that these activities are strictly an agency responsibility and outside the purview of the AMP (The AMWG makes no recommendations to the secretary on these issues). If so, and because they are not related directly to section 1804 or 1805 of the GCPA how can GCPA funds be used to support them?

19. Can GCPA funds be used to support salaries, travel, per diem etc. not directly related to Section 1804 and 1805 activities? For example, it would seem that there is a fundamental question related to the legitimacy of the use of GCPA funds for agency or stakeholder salary costs related to administration of the AMP. Sections 1804 and 1805 make no

mention of administration costs for an AMP, and AMP is not directly related to research, studies, or the preparation of the EIS

20. Can GCPA funds be used to assist tribes to attend and participate in the AMP process?

21. If the BOR has legal obligations as a result of the Biological Opinion, are these obligations automatically the obligation of the AMWG?

AMWG OPERATIONS

FACA Overview

AMWG Member List and statement of their constituency and mission, including potential conflicts

AMWG Charter

Proposal for Renewal of AMWG Charter

AMWG Operating Procedures

Appropriations Committee language re: budget

Budget (current)

Issues papers and AMWG Guidance Document

Other issues yet to be resolved

TWG OPERATIONS

TWG Member List

TWG Operating Procedures, Proposal to Modify OP, Ground Rules, Consensus Definition

Recommendations regarding travel payments to TWG members

Ground rules for meetings

Code of conduct

Definition of consensus

GCMRC OPERATIONS

Letter Establishing GCMRC

GCMRC Monitoring and Research Center Guidelines

Center Protocols

RFP's and AMWG input
Peer Review
Administrative review (focus on priority information needs, permitting, and compliance responsibilities)
Awarding contracts, competition
Information transfer (reports, workshops, etc.)

Annual Plan (current)

Strategic Plan (current)

LAWS, AGREEMENTS

Law of the River synopsis

Colorado River Compact, November 24, 1922

Colorado River Storage Project Act, April 11, 1956

Colorado River Basin Project Act, September 30, 1968

Long-Range Operating Criteria, 1970

Long-Range Operating Criteria, October 30, 1992

National Environmental Policy Act (Section 7 consultation)

Grand Canyon Protection Act, October 30, 1992 and Legislative History

National Historic Preservation Act (Sections 106 and 110)

Programmatic Agreement on Cultural Resources, August 30, 1994

Historic Preservation Plan

Endangered Species Act

36 CFR 2.5 (research and specimen collection in National Park Service areas)

Record of Decision, Glen Canyon Dam Final Environmental Impact Statement. 10/25/96

BOR-WAPA Operating Agreement

Biological Opinions

Final GCD EIS (included by reference)

Rebecca Tsosie article on trust responsibility

GLEN CANYON DAM OPERATING CRITERIA

Operating Criteria for Glen Canyon Dam In Accordance with the GCPA, 2/24/97

Operating Guidelines Associated with Glen Canyon Dam Operating Criteria 7/7/97

Operating Criteria and other Operating Parameters (C. Palmer 7/97)

Annual Operating Plans

AMP REPORTS AND RECOMMENDATIONS

TWG Position Paper - Glen Canyon Dam Spillway Gate Extensions

Integration of Programmatic Agreement with AMP, Federal/Tribal Trust Responsibilities

BHBF Triggering Criteria

Spill avoidance

Glen Canyon Dam release issues recommended for further study, and GCMRC reply

Report of the NEPA/ESA Issues Subgroup

Recommendations to the TWG for expediting environmental compliance and improving coordination on Biological Opinion Issues

Letter to Secretary Babbitt from non-federal members

Management Objectives (current)

Information Needs (current)

Resource Criteria (current)

Report to Congress (current)

State of Natural and Cultural Resources in the Colorado River Ecosystem (current)

Lake Powell Assessment

BHBF Flow alternatives

TWG, TWG, AND AMWG
MEETING AGENDA AND MINUTES
1995, 1996, 1997

TWG, TWG, AND AMWG
MEETING AGENDA AND MINUTES
1998

Appendix C

Glen Canyon Dam Adaptive Management Work Group
Federal Advisory Committee

CHARTER

Official Designation: Glen Canyon Dam Adaptive Management Work Group.

Scope and Objectives: The Committee will provide advice and recommendations to the Secretary of the Interior relative to the operation of Glen Canyon Dam in accordance with the additional criteria and operating plans specified in Section 1804 of the Act and to the exercise of authorities under existing laws in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and the Glen Canyon National Recreation Area were established, including but not limited to the natural and cultural resources and visitor use.

The Secretary of the Interior is implementing the Grand Canyon Protection Act (Act) of October 30, 1992, embodied in Public Law 102-575. The Act calls for implementation of long-term monitoring, research, and experimental programs and activities. As part of long-term monitoring, the Secretary's Record of Decision (ROD) mandated development of an Adaptive Management Program (AMP). The AMP provides for monitoring the results of the operating criteria and plans adopted by the Secretary and research and experimentation to suggest appropriate changes to those operating criteria and plans.

The AMP includes an Adaptive Management Work Group (AMWG). The AMWG will facilitate the AMP, recommend suitable monitoring and research programs, and make recommendations to the Secretary as required to meet the requirements of the Act. The AMWG may recommend research and monitoring proposals outside the Act which complement the AMP process, but such proposals will be funded separately, and do not deter from the focus of the Act.

Duration: It is the intent that the AMWG shall continue indefinitely, unless otherwise terminated by the Secretary.

Agency or Official to Whom the Committee Reports: The AMWG reports to the Secretary through the Secretary's designee who shall serve as the chairperson and Designated Federal Official of the AMWG. In the absence of the Chairperson, a senior level Interior representative will act as Chairperson for the AMWG.

The Secretary's designee shall be responsible for preparation of meeting agendas and scheduling meetings of the AMWG. The Secretary's designee shall attend and chair all meetings of the AMWG. The Secretary=s designee will also be responsible for sending a formal summary report after each Advisory Committee meeting directly to the Secretary of the Interior with copies of subject summary report to be provided to all AMWG members.

Bureau Responsible for Providing Necessary Support: The logistical and support services for the meetings of the AMWG shall be provided by the Bureau of Reclamation (Reclamation).

Estimated Annual Operating Costs: The operating costs are estimated at $200,000 annually for the establishment and support of the AMWG. This includes costs for required staff support, Reclamation staff and AMWG members, and expenses incurred in the recording and reproduction of meeting minutes, reports, notices, etc.

Description of Duties: The duties or roles and functions of the AMWG are in an advisory capacity only. They are to:

a. Establish AMWG operating procedures.

b. Advise the Secretary in meeting environmental and cultural commitments of the Record of Decision.

c. Recommend the framework for the AMP policy, goals, and direction.

d. Define and recommend resource management objectives for development and implementation of a long-term monitoring plan, and any necessary research and studies required to determine the effect of the operation of Glen Canyon Dam on the values for which the Grand Canyon National Park and Glen Canyon National Recreation Area were established, including but not limited to natural and cultural resources, and visitor use.

e. Review and provide input on the report required in Section 1804 (c)(2) of the Act to the Secretary, the Congress, and the Governors of the Colorado River Basin States. The report will include discussion of dam operations, the operation of the AMP, status of resources, and measures taken to protect, mitigate, and improve the resources defined in the Act.

f. Annually review long-term monitoring data to determine the status of resources and whether the AMP Strategic Plan goals and objectives are being met. If necessary, develop recommendations for modifying the GCDEIS ROD, associated operating criteria, and other resource management actions pursuant to the Grand Canyon Protection Act.

g. Facilitate input and coordination of information from stakeholders to the Secretary to assist in meeting consultation requirements under Sections 1804 (c)(3) and 1805 (c) of the Act.

h. Monitor and report on compliance of all program activities with applicable laws, permitting requirements, and the Act.

Allowances for Committee Members (compensation, travel, per diem, etc.) While engaged in the performance of official business at AMWG and AMWG sub-group meetings (regular, ad hoc, and Protocol Evaluation Panel meetings) away from home or their regular places of business, all

AMWG members or AMWG sub-group members shall, upon request, be reimbursed for travel expenses in accordance with current Federal travel regulations.

Estimated Number and Frequency of Meetings: The AMWG is expected to meet biannually. The Secretary's designee, who will serve as the Designated Federal Official, may call additional meetings as deemed appropriate. Fifteen members must be present at any meeting of the AMWG to constitute a quorum.

In accordance with FACA, a notice of each meeting of the AMWG shall be published in the Federal Register at least 15 days prior to the meeting advising the date, time, place, and purpose of the meeting. If it becomes necessary to postpone or cancel an announced meeting, a subsequent notice shall be published in the Federal Register as early as possible and shall explain the reasons for the postponement or cancellation. A news release for each meeting, postponement, or cancellation shall also be provided to selected major newspapers in Arizona, California, Colorado, Nevada, New Mexico, Wyoming, and Utah. News releases shall also be provided to agencies and organizations expressing interest in publishing meeting announcements in newsletters.

In accordance with FACA, all meetings of the AMWG shall be open to the general public. Any organization, association, or individual may file a written statement or, at the discretion of the AMWG, provide verbal input regarding topics on a meeting agenda in accordance with FACA.

The minutes of each AMWG meeting; reports; related documents; and copies of all documents received, issued, or approved by the AMWG shall be available for public inspection and duplication during regular business hours within 30 working days after the meeting at the:

Upper Colorado Regional Office
Bureau of Reclamation
125 South State Street, Room 6107
Salt Lake City, Utah 84138-1102
(801) 524-3880

Termination Date: It is the intent that the AMWG shall continue indefinitely, unless otherwise terminated by the Secretary. The committee is subject to the provisions of the Federal Advisory Committee Act (FACA), 5.U.S.C. Appendix 2, and will take no action unless the charter filing requirements of section 9 of FACA have been complied with. The Committee is subject to biennial review and will terminate 2 years from the date the charter is filed, unless, prior to that time, the charter is renewed in accordance with Section 14 of the FACA.

Committee Membership: Members of the AMWG to be appointed by the Secretary shall be comprised of:

a. Secretary's Designee, who shall serve as chairperson for the AMWG.

b. One representative each from the 12 cooperating agencies associated with the EIS:

(1) Bureau of Reclamation
(2) Bureau of Indian Affairs
(3) U.S. Fish and Wildlife Service
(4) National Park Service
(5) Western Area Power Administration
(6) Arizona Game and Fish Department
(7) Hopi Tribe
(8) Hualapai Tribe
(9) Navajo Nation
(10) San Juan Southern Paiute Tribe
(11) Southern Paiute Consortium
(12) Pueblo of Zuni

c. One representative each from the seven basin states:

(1) Arizona
(2) California
(3) Colorado
(4) Nevada
(5) New Mexico
(6) Wyoming
(7) Utah

d. Two representatives each from:

(1) Environmental groups
(2) Recreation interests
(3) Contractors who purchase Federal power from Glen Canyon Powerplant

Members will be appointed to the AMWG by the Secretary, with input and recommendations from the cooperating agencies, States, tribes, contractors for Federal power from Glen Canyon Dam, environmental representatives, and other stakeholders. To be eligible for appointment to the AMWG, a person must (a) be qualified through education, knowledge, or experience to give informed advice on water supply, diversion and delivery facilities, and their operation and management, or the environmental aspects of such operation; and (b) have the capability to

constructively work in a group setting toward a common objective of structuring a mechanism for program implementation.

Members of the AMWG will be appointed for a 4-year term. At the discretion of the Secretary, members may be reappointed to additional terms. Vacancies occurring by reason of resignation, death, or failure to regularly attend meetings will be filled by the Secretary for the balance of the vacating member's term using the same method by which the original appointment was made. Failure of an organization to be represented at two consecutive meetings will substantiate grounds for dismissal. The Chairperson will make the final determination in dismissing a

member.

To avoid conflict of interest issues arising from entities, including Federal agencies, having representatives on the AMWG and also submitting responses to request for proposals to perform work, the Federal procurement process shall be strictly adhered to. While members of the AMWG may give advice to the Secretarial Designee, all decisions in the procurement process shall be made by Federal procurement officials free of influence from AMWG members.

Subgroups: The committee may establish such workgroups or subcommittees as it deems necessary for the purposes of compiling information, discussing issues, and reporting back to the AMWG.

Authority: The Grand Canyon Protection Act (Act) of October 30, 1992, embodied in Public Law 102-575, directs the Secretary of the Interior (Secretary), among others, to operate Glen Canyon Dam in accordance with the additional criteria and operating plans specified in section 1804 of the Act and to exercise other authorities under existing law in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and the Glen Canyon National Recreation Area were established, including but not limited to the natural and cultural resources and visitor use. The Secretary shall implement this section in a manner fully consistent with and subject to Section 1802 of the Act. Section 1805 of the Act calls for implementation of long-term monitoring programs and activities that will ensure that Glen Canyon Dam is operated in a manner consistent with that of Section 1802.

Bruce Babbitt
Secretary of the Interior

January 10, 2001
Date signed

January 10, 2001
Date Filed

Appendix D

GLEN CANYON DAM
ADAPTIVE MANAGEMENT WORK GROUP
OPERATING PROCEDURES

FOREWORD

The Grand Canyon Protection Act (Act) of October 30, 1992, (Public Law 102-575) directs the Secretary of the Interior (Secretary) to "establish and implement long-term monitoring programs and activities that will ensure that Glen Canyon Dam is operated in a manner consistent with that of section 1802" of the Act. "The monitoring programs and activities shall be established and implemented in consultation with the Secretary of Energy; the Governors of the States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming; Indian tribes; and the general public, including representatives of academic and scientific communities, environmental organizations, the recreation industry, and contractors for the purchase of Federal power produced at Glen Canyon Dam." In order to comply with the consultation requirement of the Act, the Glen Canyon Dam EIS recommended formation of a Federal Advisory Committee. To fulfill this requirement the Glen Canyon Adaptive Management Work Group (AMWG) has been established. The AMWG Charter imposes the following criteria: (1) the AMWG shall operate under the Federal Advisory Committee Act (Public Law 92-463); (2) the Chairperson shall be designated by the Secretary; (3) the Secretary's Designee, shall also serve as the Designated Federal Official under the Federal Advisory Committee Act; (4) the Bureau of Reclamation will provide the necessary support in taking accurate minutes of each meeting; and (5) the AMWG shall continue in operation until terminated or renewed by the Secretary of the Interior under the Federal Advisory Committee Act.

OPERATION

1. Meetings. The AMWG is expected to meet semiannually. The Secretary's Designee may call additional meetings as deemed appropriate. A minimum of one meeting will be held annually. All meetings shall be announced by notice in the Federal Register and by news release to local newspapers.

Fifteen members must be present at any meeting of the AMWG to constitute a quorum.

Robert's Rules of Order will be generally followed, except that some flexibility will be allowed as needs dictate.

The Bureau of Reclamation is responsible for arranging meetings and for other duties associated with operation of the AMWG. They will arrange for meeting location, provide staff for the Designee, minutes, Federal Register Notices and other operational requirements of the AMWG.

Meetings of the AMWG shall be held in the following locations: Flagstaff, Las Vegas, Phoenix, and Salt Lake City. Meetings shall be rotated between the four sites as decided upon by the work group.

2. Chairperson. The Chairperson will be the Secretary's Designee, who will preside over the

meetings of the AMWG. In the absence of the Chairperson, the Chairperson will appoint an alternate. The Chairperson will designate an alternate who is a member of the Department of the Interior. The Chairperson or designated alternate must be present before a meeting of the AMWG may convene. The Chairperson or his alternate is authorized to adjourn an AMWG meeting at any time.

3. Members. Membership shall follow the guidelines in the AMWG Charter. Members of the AMWG will be designated by the Secretary of the Interior. They shall serve for a term of four years. Members may be re-designated to serve for more than one term.

4. Alternate Committee Members. Each AMWG member may designate an alternate to serve for the same term as the member. Alternates must be identified to the Chairperson in writing. If the alternate is to represent the member at any AMWG meeting, the member will so notify the chairperson 1.5 days prior to such meeting. Alternates must meet the same qualifications as the member. Alternates will have authority to participate in AMWG business, including quorum and voting privileges. Representation by an alternate does not satisfy the minimum personal attendance requirement of the member as described in the Charter. A list of members and alternates shall be maintained and made available to AMWG members.

5. Agenda. At least thirty days prior to any meeting of the AMWG, a draft of the proposed agenda and related information will be sent to the group members. Members shall review the agenda and return comments and proposed agenda items to the Designee within two weeks of the agenda mailing date. The final agenda will be sent to the members 15 to 30 days prior to the meeting. The Secretary=s Designee shall approve the agendas.

6. Voting. The maker of a motion must clearly and concisely state and explain his or her motion. Motions may be made verbally or submitted in writhing in advance of the meeting. Notice of motions to be made by any member of the AMWG should be announced in the Federal Register and presented on the agenda. Motions may be proposed by any member in meetings where they are related to an agenda topic. After a motion there should be presentations by staff followed by a discussion and a call for questions. The public will be given opportunity to comment during the question period as allowed by the Chairperson. Any member of the public asked to address the AMWG, shall have a minimum of 2 minutes to comment. The Chairperson can limit the total time allowed to the public for comments. Comments shall address the motion and not be repetitive to presentations, group discussions or other comments previously presented. The motion must be fully documented for the minutes and restated clearly by the Chairperson before a vote is taken.

The group should attempt to seek consensus but, in the event that consensus is not possible, a vote should be taken. Voting shall be by verbal indication or by raised hand. Approval of a motion will require a two-thirds majority of members present and voting. The views of any dissenting member or minority group shall be transmitted to the Secretary along with the majority recommendation. Voting shall occur only with the formal meetings of the group.

7. Minutes. Detailed minutes of each meeting will be kept. The minutes will contain a record of persons present and a description of pertinent matters discussed, conclusions reached, and actions

taken on motions. Minutes shall be limited to approximately 5 to 15 pages. The corrections and adoption of the minutes will be by vote of the AMWG at the next subsequent meeting. The Secretary=s Designee shall approve all minutes. The Bureau of Reclamation is responsible for recording and disseminating minutes to AMWG members within 60 days of the subject meeting.

8. Public Involvement. No later than fifteen days prior to each meeting of the AMWG or any subcommittee thereof, a notice will be published in the Federal Register. Meetings will be open to the public and advertised in local newspapers. Interested persons may appear in person, or file written statements to the AMWG. Public comments can be on any issue related to operation of the Glen Canyon Dam. A specific time for public comment will be identified in the agenda. Advance approval for oral participation may be prescribed, and speaking time may be limited. Minutes of the AMWG meetings and copies of reports submitted to the AMWG will be maintained for public review at the Bureau of Reclamation's Upper Colorado Regional Office in Salt Lake City, Utah and at the Library of Congress in Washington, D.C.

9. Payment of Travel. Members of the AMWG may receive compensation for travel expenses, including travel and per diem. Compensation for those expenses will be made under relevant federal guidelines. Alternates representing the official committee member may also receive compensation for travel expenses.

10. Open/Closed Meetings. If any member proposes discussion of a sensitive issue felt to require a closed session, he or she should so state in a proposal submitted to AMWG members in sufficient time to include it in the agenda published in the Federal Register Notice announcing the next meeting. A closed executive session may be held during a regular meeting, but should be used rarely. Any sensitive cultural issues will require consultation with Native Americans prior to meeting.

Telephone conference meetings must have a notice in the Federal Register 15 days prior to the call. There must be adequate opportunity for the general public to listen to the conference call.

The AMWG may conduct business outside of formal meetings through telephone polls conducted by the Chairperson or his/her designee. In emergency situations, telephone polls can be requested by the AMWG member to act on clearly defined written motions for AMWG approval. Following approval by the Chairperson, a telephone poll will be conducted within 7 working days. During a telephone poll, all members will be contacted and requested to vote. Approval of a motion will be by at least a two-thirds majority of all members voting. The Chairperson is responsible for documenting in writing how each member voted and distributing the record to all AMWG members.

11. Reports and Record Keeping. The Annual Report (AR) required by the Grand Canyon Protection Act shall be written by the AMWG. The State of the Natural and Cultural Resources in the Colorado River Ecosystem report developed by the Grand Canyon Monitoring and Research Center will be attached to the AR and shall contain information on the condition of the resources

impacted by the operation of Glen Canyon Dam. The AR shall be concise, containing critical resource issues and recommendations to the Secretary on future dam operations.

AMWG staff will supply GSA the required information to complete the summary report for Federal Advisory Committees.

12. Committee Expenses and Cost Accounting. An accounting of the expenses for operation of the AMWG shall be maintained by Reclamation. Expenses and other information will be submitted to GSA as required by FACA. Committee expenses are limited to approximately $154,000 annually.

SUB-GROUPS

1. Formation. -The AMWG may form sub-groups in order to facilitate the mission of the AMWG as identified in the Act and the AMWG Charter. Sub-groups will be formed for completion of specific tasks or for specified periods of time. Sub-group members will be named by the members of the AMWG. Upon formation of a sub-group, the Chairperson of the AMWG, with the advice of AMWG members, will approve nominated members to serve on the sub-group. Effort shall be made to keep sub-groups small. Sub-groups will be formed or dissolved by a vote of the AMWG.

2. Requirements. -Sub-groups may choose their chairperson from among the AMWG named sub-group members. The chairperson of any sub-group may convene group meetings at his or her discretion. Sub-groups may develop their own operating procedures. Sub-group meetings must follow requirements of FACA, except they need not be chartered and members need not be appointed by the Secretary. One standing sub-group or subcommittee of the AMWG will be the Glen Canyon Technical Work Group (TWG). The TWG membership shall consist of one representative names from each organization represented in the AMWG, with the exception that two members from the National Park Service representing the Grand Canyon National Park and the Glen Canyon Recreational Area, and one representative from the US Geological Survey. All sub-groups will elect their own officers. Names of all sub-group members will be announced to the AMWG at regular meetings and will be attached to the minutes. Sub-group members may designate alternates subject to approval of the Designee and the AMWG.

3. Charge. -Sub-groups will receive their charges from the AMWG. Sub-groups will work only on issues assigned them by the AMWG. They will not be empowered to follow other issues on their own. They are encouraged to submit issues to the AMWG they feel worthy of consideration and discussion, but the AMWG must approve work on all new issues. The AMWG may require the sub-groups to develop plans and direct them to come to a consensus or majority opinion at their discretion. Sub-groups shall determine their own operating procedures, which must be reduced to writing and included with the AMWG and sub-group records.

4. Reporting. - Sub-groups will report at least annually to the AMWG at the request of the Chairperson. Sub-groups shall report only to the AMWG. They shall provide information as necessary for preparing annual resource reports and other reports as required for the AMWG.

5. Ad Hoc Groups. Ad hoc groups shall consist of members of the sub-group only. These groups may meet to discuss assignments from the sub-group. Ad hoc meetings will not require federal register notices. Minutes are recommended but, not required. Ad hoc groups shall report only to the main body of the sub-group. On a case by case basis the AMWG will provide direction to the

subgroups on the flexibility they have in forming Ad hoc groups.

Adopted by vote of the TWG on January 16, 1998 in Phoenix, Arizona.

Approved: Stephen V. Magnussen June 18, 1998
Chairperson Date

Appendix E

GLEN CANYON DAM
TECHNICAL WORK GROUP
OPERATING PROCEDURES

FOREWORD

The Grand Canyon Protection Act (Act) of October 30, 1992, (Public Law 102-575) directs the Secretary of the Interior (Secretary) to "establish and implement long-term monitoring programs and activities that will ensure that Glen Canyon Dam is operated in a manner consistent with that of section 1802" of the Act. "The monitoring programs and activities shall be established and implemented in consultation with the Secretary of Energy; the Governors of the States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming; Indian tribes; and the general public, including representatives of academic and scientific communities, environmental organizations, the recreation industry, and contractors for the purchase of Federal power produced at Glen Canyon Dam." In order to comply with the consultation requirement of the Act, the Glen Canyon Dam EIS recommended formation of a Federal Advisory Committee and a Technical Work Group. To fulfill this requirement the Glen Canyon Adaptive Management Work Group (AMWG) was established. The AMWG held their first meeting on September 10-11, 1997 and officially formed the Glen Canyon Technical Work Group (TWG) as a subgroup. This group is comprised of technical representatives who represent the various stakeholders on the AMWG. The TWG shall perform those tasks charged to them by the AMWG. Additional responsibilities of the TWG are to develop criteria and standards for monitoring and research programs; provide periodic reviews and updates; develop resource management questions for the design of monitoring and research by the Grand Canyon Monitoring and Research Center; and provide information, as necessary, for preparing annual resource reports and other reports, as required, for the AMWG. The TWG shall comply with all regulations of the Sunshine Act and the Federal Advisory Committee Act pertaining to sub-committees. (See 41 CFR 101-6.10 Federal Advisory Committee Management). Staff resources for the TWG shall be provided by the Grand Canyon Monitoring and Research Center and Reclamation.

OPERATION

1. Meetings. - TWG meetings will be held quarterly or more frequently as required. Where possible meetings will be scheduled 2-3 months in advance. Information will be provided to all interested parties. The Bureau of Reclamation (Reclamation) will be responsible for submitting meeting notices to be published in the Federal Register 15 days prior to meetings. Federal register notices may provide information on up to 3 meetings at a time. The Chairperson will draft a reminder meeting notice to the TWG members and the staff will distribute it at least 10 days prior to the meeting. Meeting format will be in accordance with these Operating Procedures. Sixteen members must be present at any meeting of the AMWG to constitute a quorum.

2. Officers. - The TWG will elect its own officers. The Chairperson will be elected for a 1-year term and selected by a vote of the TWG. The elected chairperson shall have the option of appointing an alternate member to represent the stakeholder for the term of the chairperson, however, the

stakeholder shall have only one vote. With the recommendation of the TWG, compensation for the chairperson may be provided from Adaptive Management Program (AMP) funds. A Vice-chair will be selected to assist the Chairperson and will be an employee of Reclamation to ensure requirements of federal regulations are met and to provide assistance. Reclamation and GCMRC will provide staff and meeting resources. Reclamation shall be responsible for, and shall assure compliance with, the applicable federal regulations including those referenced above. The Chairperson shall be elected in the December meeting of the TWG or the meeting prior to the first calendar year meeting of the AMWG. The new Chairperson will take office at the first meeting of the TWG following the first meeting of the AMWG of the year.

Chair responsibilities:

Attend all TWG and AMWG meetings when possible.

Facilitate TWG meetings by leading discussions, arranging for an outside facilitator when required, and inviting input from TWG members, technical experts, and the public.

Organize or disband Ad Hoc task groups per TWG direction.

Ensure recognition of consensus or voting on decision items as appropriate, including development of minority opinion papers when consensus cannot be reached.

Present overview of TWG activities and recommendations at AMWG meetings.

Vice-Chair responsibilities include:

Attend all TWG and AMWG meetings when possible.

Assist the chairperson in facilitating the TWG meetings, ensuring that action items, responsible parties, and future agenda items are summarized and reviewed with the group by close of meeting.

Contact speakers, ad hoc committee chairpersons, and other contributors at least three weeks before the next TWG meeting to review assignments and determine how much time should be allotted for their presentations.

Prepare draft agenda for next meeting and provide review copies by E-mail to co-chairperson, GCMRC program managers, and speakers about three weeks before the next meeting. Finalize agenda and send to co-chairperson two weeks before meeting.

Track and coordinate contributions of products for TWG/AMWG review with stakeholders, GCMRC, ad hoc groups, and others.

Ensure complete meeting preparations (meeting room, motel, audio visual equipment, recording of minutes, etc.)
Review and distribute TWG products to AMWG.

3. Grand Canyon Monitoring and Research Center (GCMRC)

Develop GCMRC planning documents for TWG review.

Provide scientific opinions, documents, presentations, and reviews of TWG documents.

Develop research designs and proposals for implementing monitoring and research identified by the AMWG, including draft budget estimates.

Provide scientific information and updates to the TWG for all resources of concern identified in the EIS. Coordinate, prepare, and distribute technical reports and documentation for review and as final products.

Prepare and forward technical management recommendations and annual reports as specified in Section 1804 of the GCPA to the TWG.

4. Members. - The TWG membership shall consist of one representative named from each organization represented in the AMWG, with the exception of two members from the National Park Service representing the Grand Canyon National Park and the Glen Canyon Recreational Area, and one representative from the U.S. Geological Survey. The TWG organizational membership was nominated by the AMWG, with the USGS representative having been nominated by the Secretary's Designee. Members were selected by the respective organization's representatives. A list of TWG members will be distributed to the AMWG at regular meetings. TWG members may designate alternates.

5. Alternate Committee Members. Alternates shall be designated by TWG members. Members can designate an alternate for any TWG or Ad Hoc group meeting they will be unable to attend, or for which the alternate is better prepared to represent the organization's interests. Alternates shall sign-in on the attendance sheet noting that they are the alternate to the official member. The officially designated alternate, in the absence of the member, is allowed to fully participate and vote in TWG meetings without prior notification and be counted in the quorum.

6. Agenda. - Members, and others, requesting an item be added to the agenda should notify the Chairperson in writing (by mail, fax, or E-mail) at least 15 days prior to the meeting. The following information should be provided with each request: a discussion topic or title, the nature of the topic (e.g., sharing of information, discussion of an issue, or a proposed action), name(s) of the presenter(s), total amount of time required for presentation, and any other relevant points for meeting planning. The agenda will be finalized when the schedule is filled or when the pre-meeting briefing documents are distributed. Requests received after the agenda is finalized may be considered under new business (time permitting), or may have to be postponed until a future meeting. An agenda
will be prepared and approved by the Chairperson and forwarded to the TWG meeting recorder. The meeting recorder will distribute the final agenda (by e-mail and/or by other means) to the TWG members and others on the distribution list. Reclamation is responsible for compliance with federal

regulations. Reclamation will include in the Federal Register Notice: meeting dates, times, location, and a list of meeting agenda items.

7. Guidelines for Discussions. - The following ground rules will guide all discussions while the meeting is in session: Members will endeavor to arrive, return from breaks, and depart the meeting on schedule. Any person needing to continue private discussions after the meeting has been called to order will take their business outside the conference room. Members, alternates, and visitors wishing to address the TWG will wait to be recognized by the Chairperson or designated discussion leader before speaking. Speakers will make their points succinctly and yield the floor to the next speaker, waiting to again be recognized for rebuttals. Comments are to be applicable to the motion and not repetitive to presentations, group discussion or other comments previously presented. Discussions of new or unrelated business will be postponed until the appointed time on the agenda.

8. Voting. - The maker of a motion must clearly and concisely state and explain their motion. Motions may be made verbally or submitted in writing in advance of the meeting. Motions may be proposed by a member in meetings where they are related to an agenda topic. After a motion and a second to the motion there shall be presentations by staff, where they are necessary or desired. Presentations shall be followed by discussion and a call for questions. The public will be given opportunity to comment during the question period as provided for in these operating procedures. Any member of the public who has asked to address the TWG, shall be provided a reasonable time to comment. The Chairperson may limit the total time allowed to the public for comments. Comments shall be applicable to the motion and not be repetitive of prior presentations, group discussions, or other comments. The motion shall be fully documented for the minutes and restated clearly by the Chairperson before seeking a determination of consensus or a vote is taken.

Consensus is the desired result. All reasonable efforts will be made to bring the group to a consensus decision or recommendation, including, for example, formation of ad hoc groups. If consensus cannot be achieved, a vote will be taken on motions and recommendations to be forwarded to the AMWG. Only members of the TWG or their alternate may vote. A majority recommendation will go forward along with a minority opinion report (containing the alternate recommendation and identification of who constitutes the minority). Ad hoc groups consisting of the dissenting members may be formed as needed to prepare minority opinions. Each appointed TWG representative is expected to explain and/or clarify issues to their respective AMWG member.

Recommendations to the TWG or AMWG will be summarized in report form, will contain relevant background material on the issues, and will include a brief summary of previous discussions related to the issue (e.g., ad hoc group or TWG discussions). Requests for actions associated with a briefing document will be posed as a specific written recommendation that can be approved as written, approved with modification, or not approved. Reports and recommendations forwarded to the AMWG will be identified as having been approved through consensus of the entire TWG, except when a minority opinion is submitted to the Chairperson in writing prior to the agreed date for forwarding TWG recommendations to the AMWG (generally 60 days before the next AMWG meeting). Members subscribing to the minority opinion will be listed in the minority report, which shall follow the same format outlined above for the consensus or majority report. The TWG Chairperson may invite a representative of the minority group to present the minority opinion to the AMWG.

9. Ad Hoc Groups and Meetings. - Ad hoc groups can be formed by the TWG as needed with membership consisting of TWG members and alternates only. Groups may invite technical advisors outside the TWG membership to assist on some issues. These groups may meet to discuss assignments from the TWG. Ad hoc meetings will not require federal register notices. Minutes are recommended, but not required. Ad hoc groups shall report of their deliberations and findings to the TWG. Presentations of findings from Ad Hoc groups may be given by individual members of the group. Ad hoc groups shall report only to the main body of the TWG. The AMWG may provide direction to the TWG on the flexibility they have in forming ad hoc groups. Ad hoc groups shall be formed by the consensus or vote of the TWG and shall terminate as soon as the assigned task is completed.

10. Minutes, Reports, and Record Keeping. - Minutes will be recorded by TWG staff support from Reclamation. Minutes will address the key topics of the TWG meetings including proposals, motions, voting/approval of motions, majority/minority opinions, public comments, presentations, findings from ad hoc groups, and other pertinent information. Minutes will not be a complete transcript of the discussions. An audio tape recording of the meeting will be kept for each meeting. The corrections and adoption of the minutes will be reached by consensus of the TWG at the following meeting.

Minutes, attachments, agendas, and materials for upcoming TWG meetings will be distributed according to the schedule below:

A. Submittal of materials for upcoming TWG Meetings.

15 Business Days Prior to TWG Mtg:	Responsible Person	Submit To
_Agenda items	Committee Members	Chairman
_Materials for duplication & dist.	Committee Members	Staff

TWG members responsible for materials for an upcoming meeting shall forward them to the designated staff member in time to be included with the distribution which will occur 10 days prior to the meeting. Materials may be provided via e-mail or hard copy. Where copies of material are not provided to the designated staff member in time for normal distribution, the person or organization will be responsible for making their own copies and bringing them to the meeting. They may either: (1) e-mail, fax or other means; (2) duplicate prior to and distribute at the meeting. Staff, members, and public providing materials for distribution at the meeting should bring at least 40 copies. Meeting documents distributed at the meeting are to be provided first to the meeting recorder, TWG members, and the GCMRC Chief. Copies of all handouts will be placed in a designated location for official visitors and the public. If action is anticipated to be taken on or as a result of that material, all reasonable effort will be made to provide those materials to the members in advance of the meeting. In the event materials are not provided in advance of the meeting, action on this topic may be delayed at the Chairperson's discretion. Individuals making presentations at TWG meetings shall notify TWG staff of any special audio visual equipment or supply needs at least two weeks before the meeting.

A mailing list containing members' mailing addresses, phone numbers, fax numbers, and E-mail addresses, as appropriate, will be maintained and distributed as needed. Updates will be prepared and the list re-distributed as appropriate. A copy of the roster of TWG members or alternates attending any meeting of the TWG shall be attached to the minutes, and shall include a list of all others in attendance.

B. Meeting material distribution to TWG members

10 Calendar Days Prior to TWG Meeting:	Responsible:
_Minutes and attachments from the previous meeting	Staff
_Agenda for the upcoming meeting	Staff
_Materials needed for the upcoming meeting	Staff

E-mail, regular mail, or other means shall be used for the distribution.

Reclamation will be responsible for reports and distribution of materials to AMWG, and providing copies of information to the Library of Congress. The TWG shall assist GCMRC in preparation of the draft Annual Report to Congress pursuant to the Grand Canyon Protection Act.

Minutes, documentation from meetings, and reports shall be made available to the public at the Library of Congress in Washington, D.C. and the Upper Colorado Regional Office of the Bureau of Reclamation in Salt Lake City, Utah.

11. Arranging meetings and other duties associated with operation of the TWG. - Where possible, meetings will be scheduled 2-3 months in advance. All meetings shall also have a Federal Register Notice published 15 days or more in advance of any meeting. Meeting locations will be determined by the group in a preceding meeting. The staff will arrange meeting rooms and audio visual equipment, and block a number of hotel guest rooms. Meeting rooms will be arranged so that each of the 26 TWG members can be seated around the table. Alternates representing an absent TWG member should take their place at the table. Additional seating will be provided around the margin or rear of the room for alternates who are attending with the member, for official visitors and for the general public.

12. Public, Visitors, and Open and Closed Meetings. - All meetings are open to the public. It is not anticipated the group will require closed sessions unless a provision is made to do so. Only members of the TWG or their alternate may participate in discussions of the group. Appropriate staff of Reclamation and the GCMRC shall provide pertinent information from their organization to respond to questions or make presentations when approved by the group. The public will be allowed to comment after discussion of each agenda item requiring a decision of that group and at the end of the TWG meeting or as provided in the agenda. Each person will be given up to 10 minutes to address the TWG members at the time specified on the agenda for public comment. Greater consideration will be given to individuals submitting discussion issues and/or requesting time in advance of the meeting to the Chairperson. The Chairperson will control adherence to the time limit so the meeting is not unduly prolonged. Each speaker will be expected to provide their name and

affiliation for the meeting minutes. The Chairperson will accept written comments from the public, and will allow their distribution if copies are available for all members (40 copies required). Written comments will be attached to the meeting minutes if they are identified with the name, address, and affiliation of the provider.

Adopted by vote of the TWG on _____, Phoenix, Arizona.

Approved: Rick Johnson _____ 2 Mar 00 _____
Chairperson Date

Appendix F

Endangered Species Act Compliance

In brief, to comply with the Endangered Species Act, an evaluation of the affects of any discretionary federal action must be conducted by the action agency in conjunction with informal consultation with the Fish and Wildlife Service. For minor activities, this can be limited to verbal communication. For a larger or more complex action, or for any major construction activity as defined, the action agency is required to prepare a biological assessment. The biological assessment describes the action and evaluates the affect to each species that may be present in the action area by comparing the current condition of the population and habitat to what it is expected to occur during and following the action. A determination is limited to either "no affect," which equates to no effect at all, positive, negative, or neutral, or to "may affect," which equates to any effect, positive, negative, or neutral. "May affect" can be further qualified with a determination of 'likely to adversely affect' or 'not likely to adversely affect.' A "may affect and is likely to adversely affect" determination triggers formal consultation with the Fish and Wildlife Service. A determination of "may affect and not likely to adversely affect" can be addressed with informal consultation with the Fish and Wildlife Service.

Any "may affect" determination triggers formal consultation which may result in either a "not likely to adversely affect" determination or issuance of a biological opinion. Once consultation is requested, the Fish and Wildlife Service has 90 days to render a biological opinion and an additional 45 days to write the biological opinion. The Fish and Wildlife Service usually prepares a draft biological opinion. The period of time that the draft is under review does not count toward the 135 days. Consultation is between the action agency, an applicant if there is one, and the Fish and Wildlife Service. If there is an affect on tribal lands or waters, the tribes must be consulted.

If the Fish and Wildlife Service determines that the proposed action will jeopardize the continued existence of the species by appreciably reducing the likelihood of both survival and recovery of the species in the wild by further reducing its number, reproduction, or distribution (the jeopardy threshold), they prepare a biological opinion which must contain a reasonable and prudent alternative. A reasonable and prudent alternative must be within the jurisdiction of the action agency, technologically and economically feasible, consistent with the original intended purpose of the project, and one that the Fish and Wildlife Service believes will remove jeopardy. The biological opinion must also contain an "incidental take" statement if any take is expected to occur, reasonable and prudent measures, and terms and conditions designed to reduce take and address adverse modification of designated critical habitat. The biological opinion can contain conservation measures, conservation recommendations, and other topics as well. Once the action agency receives the draft biological opinion, they may choose to share the document with other stakeholders (see March 1988 Consultation Handbook, Fish and Wildlife Service).

Appendix G

Record of Decision

Operation of Glen Canyon Dam

Final Environmental Impact Statement

October 1996

Approved

Eluid L. Martinez _____ Date OCT 08 1996
Commissioner, U.S. Bureau of Reclamation

Bruce Babbitt _____ Date OCT 09 1996
Secretary of the Interior

RECORD OF DECISION

OPERATION OF GLEN CANYON DAM
FINAL ENVIRONMENTAL IMPACT STATEMENT

I. INTRODUCTION

This record of decision (ROD) of the Department of the Interior, Bureau of Reclamation (Reclamation), documents the selection of operating criteria for Glen Canyon Dam, as analyzed in the final Environmental Impact Statement (EIS), dated March 21,1995 (FES 95-8). The EIS on the operation of Glen Canyon Dam was prepared with an unprecedented amount of scientific research, public involvement, and stakeholder cooperation.

Scientific evidence gathered during Phase I of the Glen Canyon Environmental Studies (GCES) indicated that significant impacts on downstream resources were occurring due to the operation of Glen Canyon Dam. These findings led to a July 1989 decision by the Secretary of the Interior for Reclamation to prepare an EIS to reevaluate dam operations. The purpose of the reevaluation was to determine specific options that could be implemented to minimize, consistent with law, adverse impacts on the downstream environment and cultural resources, as well as Native American interests in Glen and Grand Canyons. Analysis of an array of reasonable alternatives was needed to allow the Secretary to balance competing interests and to meet statutory responsibilities for protecting downstream resources and producing hydropower, and to protect affected Native American interests.

In addition, the Grand Canyon Protection Act of 1992 was enacted on October 30, 1992. Section 1802 (a) of the Act requires the Secretary to 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."

Alternatives considered include the No Action Alternative as well as eight operational alternatives that provide various degrees of protection for downstream resources and hydropower production.

II. DECISION

The Secretary's decision is to implement the Modified Low Fluctuating Flow Alternative (the preferred alternative) as described in the final EIS on the Operation of Glen Canyon Dam with a minor change in the timing of beach/habitat building flows (described below). This alternative was selected because it will reduce daily flow fluctuations well below the no action levels (historic pattern of releases) and will provide high steady releases of short duration which will protect or enhance downstream resources while allowing limited flexibility for power operations.

The Modified Low Fluctuating Flow Alternative incorporates beach/habitat-building flows which are scheduled high releases of short duration designed to rebuild high elevation sandbars, deposit nutrients, restore backwater channels, and provide some of the dynamics of a natural system. In the final EIS, it was assumed that these flows would occur in the spring when the reservoir is low, with a frequency of 1 in 5 years.

The Basin States expressed concern over the beach/habitat-building flows described in the final EIS because of the timing of power plant by-passes. We have accommodated their concerns, while maintaining the objectives of the beach/habitat-building flows. Instead of conducting these flows in years in which Lake Powell storage is low on January 1, they will be accomplished by utilizing reservoir releases in excess of power plant capacity required for dam safety purposes. Such releases are consistent with the 1956 Colorado River Storage Project Act, the 1968 Colorado River Basin Project Act, and the 1992 Grand Canyon Protection Act.

Both the Colorado River Management Work Group and the Transition Work Group, which participated in the development of the Annual Operating Plan and the EIS, respectively, support this change as it conforms unambiguously with each member's understanding of the Law of the River. These groups include representatives of virtually all stakeholders in this process.

The upramp rate and maximum flow criteria were also modified between the draft and final EIS. The upramp rate was increased from 2,500 cubic feet per second per hour to 4,000 cubic feet per second per hour, and the maximum allowable release was increased from 20,000 to 25,000 cubic feet per second. We made these modifications to enhance power production flexibility, as suggested by comments received. These modifications were controversial among certain interest groups because of concerns regarding potential impacts on resources in the Colorado River and the Grand Canyom However, our analysis indicates that there would be no significant differences in impacts associated with these changes (“Assessment of Changes to the Glen Canyon Dam EIS Preferred Alternative from Draft to Final EIS", October 1995).

The 4,000 cubic feet per second per hour upramp rate limit will be implemented with the understanding that results from the monitoring program will be carefiXy considered. If impacts differing from those described in the final EIS are identified, a new ramp rate criterion will be considered by the Adaptive Management Work Group and a recommendation for action forwarded to the Secretary.

The maximum flow criterion of 25,000 cubic feet per second will be implemented with the understanding that actual maximum daily releases would only occasionally exceed 20,000 cubic feet per second during a minimum release year of 8.23 million acre-feet. This is because the maximum allowable daily change constraint overrides the maximum allowable release and because monthly release volumes are lower during minimum release years. If impacts differing from those described in the final EIS are identified through the Adaptive Management Program, the maximum flow restriction will be reviewed by the Adaptive Management Work Group and a recommendation for action will be forwarded to the Secretary.

III. DESCRIPTION OF ALTERNATIVES

Nine alternative methods of operating Glen Canyon Dam (including the No Action Alternative) were presented in the final EIS. The eight action alternatives were designed to provide a reasonable range of alternatives with respect to operation of the dam. One alternative would allow unrestricted fluctuations in flow (within the physical constraints of the power plant) to maximize power production, four would impose varying restrictions on fluctuations, and three others would provide steady flows on a monthly, seasonal, or annual basis. The names of the alternatives reflect the various operational regimes. In addition, the restricted fluctuating flow and steady flow alternatives each include seven elements which are common to all of them. These common elements are: 1) Adaptive Management, 2) Monitoring and Protecting Cultural Resources, 3) Flood Frequency Reduction Measures, 4) Beach/Habitat-Building Flows, 5) New Population of Humpback Chub, 6) Further Study of Selective Withdrawal, and 7) Emergency Exception Criteria. A detailed description of the alternatives and common elements can be found in Chapter 2 of the final EIS. A brief description of the alternatives is given below.

UNRESTRICTED FLUCTUATING FLOWS

No Action: Maintain the historic pattern of fluctuating releases up to 31,500 cubic feet per second and provide a baseline for impact comparison.

Maximum Power plant Capacity: Permit use of full power plant capacity up to 33,200 cubic feet per second.

RESTRICTED FLUCTUATING FLOWS

High: Slightly reduce daily fluctuations from historic levels.

Moderate: Moderately reduce day fluctuations from historic levels; includes habitat maintenance flows.

Modified Low (Preferred Alternative): Substantially reduce daily fluctuations from historic levels; includes habitat maintenance flows.

Interim Low: Substantially reduce daily fluctuations from historic levels; same as interim operations except for addition of common elements.

STEADY FLOWS

Existing Monthly Volume: Provide steady flows that use historic monthly release strategies.

Seasonally Adjusted: Provide steady flows on a seasonal or monthly basis; includes habitat maintenance flows.

Year-Round: Provide steady flows throughout the year.

Table I shows the, specific operational criteria for each of the alternatives.

IV. SIGNIFICANT ISSUES AND ALTERNATIVES

The Glen Canyon Dam EIS scoping process was initiated in early 1990 and the public was invited to comment on the appropriate scope of the EIS. More than 17,000 comments were received during the scoping period, reflecting the national attention and intense interest in the EIS.

As a result of the analysis of the oral and written scoping comments, the following were determined to be resources or issues of public concern: beaches, endangered species, ecosystem integrity, fish, power costs, power production, sediment, water conservation, rafting/boating, air quality, the Grand Canyon wilderness, and a category designated as "other" for remaining concerns. Comments regarding interests and values were categorized as: expressions about the Grand Canyon, economics, nonquantifiable values, nature versus human use, and the complexity of Glen Canyon Dam issues.

The EIS team consolidated and refined the public issues of concern, identifying the significant resources and associated issues to be analyzed in detail. These resources include: water, sediment, fish, vegetation, wildlife and habitat, endangered and other special status species, cultural resources, air quality, recreation, hydropower, and non-use value.

Further meetings were held with representatives from the cooperating agencies and public interest groups who provided comments on the criteria for development of reasonable alternatives for the EIS. The public also had an opportunity to comment on the preliminary selection of alternatives at public meetings and through mailings. The final selection of alternatives took into consideration the public's views.

V. COMMENTS RECEIVED ON THE FINAL EIS

Many comments and recommendations on the final EIS were received in the form of pre-printed postcards and letters that addressed essentially the same issues. The comments are summarized below along with Reclamation’s responses.

COMMENT: **Maintain Draft EIS flows.** Modifying the upramp, rate and maximum flows

Table 1.—Operating limits of alternatives identified for detailed analysis

	Unrestricted Fluctuating Flows		Restricted Fluctuating Flows					Steady Flows	
	No Action	Maximum Powerplant Capacity	High	Moderate	Modified Low	Interim Low	Existing Monthly Volume	Seasonally Adjusted	Year-Round
Minimum releases (cfs)[1]	1,000 Labor Day-Easter [2]3,000 Easter-Labor Day	1,000 Labor Day-Easter [2]3,000 Easter-Labor Day	3,000 5,000 8,000 depending on monthly volume, firm load, and market conditions	5,000	8,000 between 7a.m. and 7 p.m. 5,000 at night	8,000 between 7a.m. and 7 p.m. 5,000 at night	8,000	[3]8,000 Oct-Nov 8,500 Dec 11,000 Jan-Mar 12,500 Apr 18,000 May-Jun 12,500 Jul 9,000 Aug-Sep	Yearly volume prorated[4]
Maximum releases (cfs)[5]	31,500	33,200	31,500	31,500 (may be exceeded during habitat maintenance flows)	25,000 (exceeded during habitat maintenance flows)	20,000	Monthly volumes prorated	18,000 (exceeded during habitat maintenance flows)	Yearly volume prorated[4]
Allowable daily flow fluctuations (cfs/24 hours)	30,500 Labor Day-Easter 28,500 Easter-Labor Day	32,200 Labor Day-Easter 30,200 Easter-Labor Day	15,000 to 22,000	±45% of mean flow for the month not to exceed ±6,000	[6]5,000 6,000 or 8,000	[6]5,000 6,000 or 8,000	[7]±1,000	[7]±1,000	[7]±1,000
Ramp rates (cfs/hour)	Unrestricted	Unrestricted	Unrestricted up, 5,000 or 4,000 down	4,000 up 2,500 down	4,000 up 1,500 down	2,500 up 1,500 down	2,000 cfs/day between months	2,000 cfs/day between months	2,000 cfs/day between months
Common elements	None	None	Adaptive management (including long-term monitoring and research) Monitoring and protecting cultural resources Flood frequency reduction measures Beach/habitat-building flows New population of humpback chub Further study of selective withdrawal Emergency exception criteria						

1 In high volume release months, the allowable daily change would require higher minimum flows (cfs).
2 Releases each weekday during recreation season (Easter to Labor Day) would average not less than 8,000 cfs for the period from 8 a.m. to midnight.
3 Based on an 8.23-million-acre-foot (maf) year; in higher release years, additional water would be added equally to each month, subject to an 18,000-cfs maximum.
4 for an 8.23-maf year, steady flow would be about 11,400 cfs.
5 Maximums represent normal or routine limits and may necessarily be exceeded during high water years.
6 Daily fluctuation limit of 5,000 cfs for monthly release volumes less than 600,000 acre-feet; 6,000 cfs for monthly release volumes of 600,000 to 800,000 acre-feet; and 8,000 cfs for monthly volumes over 800,000 acre-feet.
7 Adjustments would allow for small power system load changes.

between the draft and final EIS has neither been open for public review nor subjected to serious scientific scrutiny. These changes should have been addressed in the draft EIS and made available for public comment at that time. Credible proof, based on the testing of a specific scientific hypothesis, that alterations in operating procedures at Glen Canyon Dam follow the spirit and intent of the Grand Canyon Protection Act needs to be provided. The burden of proof that there will be no impact on downstream resources rests with those proposing changes.

RESPONSE: The modification of the preferred alternative, which incorporated changes in the upramp rate and maximum flows, was made after extensive public discussion. The new preferred alternative was discussed as an agenda item during the May, June, August, and November 1994 public meetings of the Cooperating Agencies who assisted in the development of the EIS. A wide range of public interest groups received advance mailings and agendas and were represented at the public meetings. The environmental groups attending these meetings included: America Outdoors, American Rivers, Desert Flycasters, Environmental Defense Fund, Friends of the River, Grand Canyon River Guides, Grand Canyon Trust, Sierra Club, and Trout Unlimited. Meeting logs indicate that representatives from at least some of these groups attended all but the May meeting. In addition, approximately 16,000 citizens received periodic newsletters throughout the EIS process. This included a newsletter outlining the proposed changes issued several months prior to the final EIS. The environmental groups mentioned above were included on the newsletter mailing list.

Reclamation's research and analysis has been thorough with regards to changes in flows and ramping rates and potential impacts upon downstream resources. A complete range of research flows was conducted from June 1990 to July 1991. These included high and low fluctuating flows with fast and slow up and down ramp rates. Glen Canyon Environmental Studies Phase II identified cause and effect relationships between downramp rates and adverse impacts to canyon resources. However, no cause and effect relationships between upramp rates and adverse impacts to canyon resources were identified. The draft EIS, (a public document peer reviewed by GCES and the EIS Cooperating Agencies) states that upramp rates have not been linked to sandbar erosion (page 95) and that "Rapid increases in river stage would have little or no effect on sandbars." (page 190).

With respect to potential impacts occurring with the change in flows, it should be noted that sand in the Grand Canyon is transported almost exclusively by river flows. The amount of sand transported increases exponentially with increases in river flow. Maintaining sandbars over the long term depends on the amount of sand supplied by tributaries, monthly release volumes, range of flow fluctuations, and the frequency and distribution of flood flows. Conversely, occasional flows between 20,000 and 25,000 cubic feet per second may cause minor beach building, and may provide water to riparian vegetation.

As part of the EIS, the effects of each alternative on long-term sand storage in Marble Canyon (river miles 0 to 61) were analyzed. The Marble Canyon reach was chosen for analysis because it is more sensitive to impacts from darn operations than downstream reaches. For each fluctuating flow alternative, the analysis used 20 years of hourly flow modeled by Spreck Rosekrans of the Environmental Defense Fund and 85 different hydrologic scenarios (each representing 50 years of

monthly flow data). This analysis was documented in the draft EIS on page 182, and Appendix D, pages 4-5. The analyses relating to the probability of net gain in riverbed sand for each alternative is documented in the draft EIS on pages 54-55, 184, 187, and 194.

Specific peer reviewed studies relating to the above analyses are listed in Attachment 1.

COMMENT: Do not change the upramp rate and maximum flow criteria at the same time. While acknowledging Reclamation's good efforts to identify and establish optimum operating criteria for all users of Glen Canyon Dam, changing two flow criteria (upramp rate and maximum flow criterion of preferred alternative) does not make prudent scientific sense. It will not result in reliable data. Not enough information is at hand to predict the outcome of these proposals.

RESPONSE: Viewed from the purely scientific viewpoint, it would be preferable to change variables one at a time in a controlled experiment. However, many uncontrolled variables already exist, and from a resource management standpoint the interest lies in measuring the possible resource impact, if any, which might result from jointly changing both criteria. The best available information suggests that the long-term impact of changing both criteria at once will be difficult, if not impossible to detect.

Even though both parameters would change, for 8 months of an 8.23 million acre foot year (minimum release year), only the upramp rate will be used. The ability to operationally exceed 20,000 cubic feet per second only exists in months in which releases are in excess of 900,000 acre feet. In a minimum release year, flows above 20,000 cubic feet per second will most likely occur in December, January, July, and August. Evaluation of the upramp rates can be initiated immediately with the evaluation of the increase in maximum flow relegated to the months with the highest volumes. New upramp and maximum flow criteria would be recommended through the Adaptive Management Program should monitoring results indicate that either of these criteria are resulting in adverse impacts to the natural, cultural, or recreational (human safety) resources of the Grand Canyon differing from those shown in the final EIS.

COMMENT: **"Habitat/Beach Building Floods" designed to redeposit sediment and reshape the river's topography much like the Canyon's historic floods should be conducted**.
An experimental release based on this premise is critical to restore some of the river's historic dynamics; without it, any flow regime will result in continued loss of beach and backwater habitat. This "spike" should be assessed and implemented for the spring of 1996, subject to a critical evaluation of its flow size, timing, impact on fisheries, and completion of a comprehensive monitoring plan. Recent side-canyon floods underscore the need for restoring natural processes.

RESPONSE: Reclamation and the Cooperating Agencies continue to support this concept. The preferred alternative supports such a flow regime. A test flow was conducted this spring. The results of this flow are currently being analyzed. We expect to conduct more of these flows in the future.

COMMENT: Endorse the Fish & Wildlife Service's Biological Opinion and implement

experimental steady flows to benefit native fishes, subject to the results of a risk/benefit analysis now in progress.

RESPONSE: The preferred alternative provides for experimental steady flows through the Adaptive Management Program for the reasons put forth in the Biological Opinion.

COMMENT: Fund and implement immediately an Adaptive Management Program. This is the appropriate forum to address important issues. It is imperative that resource management rely on good science to monitor, and respond to possible adverse effects resulting from changes in dam operations.

RESPONSE: The preferred alternative provides for implementation of an Adaptive Management Program.

COMMENT: Interior Secretary Babbitt should issue a Record of Decision by December 31, 1995, and conduct an efficient and timely audit by the General Accounting Office as mandated by the Grand Canyon Protection Act.

RESPONSE: In compliance with the Grand Canyon Protection Act, Interior Secretary Babbitt could not issue the Record of Decision until considering the findings of the General Accounting Office. Those findings were issued on October 2, 1996.

OTHER COMMENTS: Another set of comments were received from municipalities and other power user groups. These letters made up about 3 percent of the total received and were essentially identical in content. Although the authors were not totally in agreement with the preferred alternative because of the reduction in peaking power, they believe it is a workable compromise. These letters characterized the final EIS as ". . a model for resolving complex environmental issues among divergent interests." They also urged the government to protect the integrity of the process, resist efforts to overturn the FEIS, and allow the scientists' assessment to stand, in as much as the Adaptive Management Process will give Reclamation an opportunity to evaluate the effects of operational changes over time and make modifications according to scientific findings.

RESPONSE: While the preferred alternative may not satisfy all interests, Reclamation believes it is a workable compromise and meets the two criteria set out in the EIS for the reoperation of the dam, namely restoring downstream resources and maintaining hydropower capability and flexibility.

A letter of comment from the Environmental Protection Agency (EPA) indicates that EPA!s comments on the draft EIS were adequately addressed in the final EIS. It also expresses their support for the preferred alternative.

Samples of the comment letters and cards, and a copy of EPA’s comment letter are included as Attachment 2.

VI. ENVIRONMENTAL COMMITMENTS AND MONITORING

The following environmental and monitoring commitments will be carried out under the preferred alternative or any of the other restricted fluctuating or steady flow alternatives described in the final EIS. A detailed description of these commitments can be found on pages 33 - 43 of that document. All practicable means to avoid or minimize environmental harm from the preferred alternative have been adopted.

1. **Adaptive Management**: This commitment includes the establishment of an Adaptive Management Workgroup, chartered in accordance with the Federal Advisory Committee Act; and development of a long-term monitoring, research, and experimental program which could result in some additional operational changes. However, any operational changes will be carried out in compliance with NEPA.

2. **Monitoring and Protection of Cultural Resources**: Cultural sites in Glen and Grand Canyons include prehistoric and historic sites and Native American traditional use and sacred sites. Some of these sites may erode in the future under any EIS alternative, including the no action alternative. Reclamation and the National Park Service, in consultation with Native American Tribes, will develop and implement a long-term monitoring program for these sites. Any necessary mitigation will be carried out according to a programmatic agreement written in compliance with the National Historic Preservation Act. This agreement is included as Attachment 5 in the final EIS.

3. **Flood Frequency Reduction Measures**: Under this commitment, the frequency of unanticipated floods in excess of 45,000 cubic feet per second will be reduced to an average of once in 100 years. This will be accomplished initially through the Annual Operating Plan process and eventually by raising the height of the spillway gates at Glen Canyon Dam 4.5 feet.

4. **Beach/Habitat-Building Flows:** Under certain conditions, steady flows in excess of a given alternative's maximum will be scheduled in the spring for periods ranging from I to 2 weeks. Scheduling, duration, and flow magnitude will be recommended by the Adaptive Management Work Group and scheduled through the Annual Operating Plan process. The objectives of these flows are to deposit sediment at high elevations, re-form backwater channels, deposit nutrients, restore some of the natural system dynamics along the river corridor, and help the National Park Service manage riparian habitats.

5. **New Population of Humpback Chub:** In consultation with the U.S. Fish and Wildlife Service (FWS), National Park Service, and Arizona Game and Fish Department (AGFD), Reclamation will make every effort (through funding, facilitating, and technical support) to ensure that a new population of humpback chub is established in the mainstem or one or more of the tributaries within Grand Canyon.

6. **Further Study of Selective Withdrawal:** Reclamation will aggressively pursue and support research on the effects of multilevel intake structures at Glen Canyon Dam and use the results of this research to decide whether or not to pursue construction. FWS, in consultation with AGFD,

will be responsible for recommending to Reclamation whether or not selective withdrawal should be implemented at Glen Canyon Dam. Reclamation will be responsible for design, NEPA compliance, permits, construction, operation, and maintenance.

7. **Emergency Exception Criteria**: Operating criteria have been established to allow the Western Area Power Administration to respond to various emergency situations in accordance with their obligations to the North American Electric Reliability Council. This commitment also provides for exceptions to a given altemative's. operating criteria during search and rescue situations, special studies and monitoring, dam and power plant maintenance, and spinning reserves.

VII. BASIS FOR DECISION

The goal of selecting a preferred alternative was not to maximize benefits for the most resources, but rather to find an alternative dam operating plan that would permit recovery and long-term sustainability of downstream resources while limiting hydropower capability and flexibility only to the extent necessary to achieve recovery and long-term sustainability.

Based on the impact analysis described in the final EIS, three of the alternatives are considered to be environmentally preferable. They are: the Moderate Fluctuating Flow Alternative, the Modified Low Fluctuating Flow Alternative, and the Seasonally Adjusted Steady Flow Alternative. Modified Low Fluctuating Flow is selected for implementation because it satisfies the critical needs for sediment resources and some of the habitat needs of native fish, benefits the remaining resources, and allows for future . hydropower flexibility, although there would be moderate to potentially major adverse impacts on power operations and possible decreases in long-term firm power marketing. Nearly all downstream resources are dependent to some extent on the sediment resource. This alternative meets the critical requirements of the sediment resource by restoring some of the pre-dam variability through floods and by providing a long-term balance between the supply of sand from Grand Canyon tributaries and the sand-transport capacity of the river. This, in turn, benefits the maintenance of habitat. The critical requirements for native fish are met by pursuing a strategy of warming releases from Glen Canyon Dam, enhancing the sediment resource, and substantially limiting the daily flow fluctuations.

The decision process for selecting the preferred alternative for the EIS followed a repetitive sequence of comparisons of effects on downstream resources resulting from each alternative. Alternatives resulting in unacceptable adverse effects on resources (such as long-term loss of sandbars leading to the destruction of cultural resource sites and wildlife habitat) were eliminated from further comparisons. Comparisons continued until existing data were no longer available to support assumed benefits.

All resources were evaluated in terms of both positive and adverse effects from proposed alternatives. Once it was determined that all alternatives would deliver at least 8.23 million acre feet of water annually, water supply played a minor role in subsequent resource evaluations. (One of the objectives of the "Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs" is a minimum annual release of 8.23 million acre feet of water fforn Glen Canyon

Dam.) The alternatives covered a range of possible dam operations from maximum utilization of peaking power capabilities with large daily changes in downstream river levels (Maximum Powerplant Capacity Alternative) to the Year-Round Steady Flow Alternative that would have eliminated all river fluctuations and peaking power capabilities. Within this range, the Maximum Powerplant Capacity, No Action, and High Fluctuating Flow alternatives were eliminated from consideration as the preferred alternative because they would not meet the first criterion of resource recovery and long-term sustainability. Data indicated that while beneficial to hydropower production, these alternatives would either increase or maintain conditions that resulted in adverse impacts to downstream resources under no action. For example, under these alternatives, the sediment resource would not likely be maintained over the long-term.

At the other end of the range, the Year-Round Steady Flow Alternative was also eliminated from consideration as the preferred alternative. This alternative would result in the greatest storage of sand within the river channel, the lowest elevation sandbars, the largest potential expansion of riparian vegetation, and the highest white-water boating safety benefits. However, it would not provide the variability on which the natural processes of the Grand Canyon are dependent (e.g. beach building, unvegetated sandbars, and backwater habitats). A completely stable flow regime would encourage the growth of vegetation thereby reducing bare-sand openings and patches of emergent marsh vegetation. This would limit beach camping and reduce the habitat value of these sites. With respect to other resources, this alternative did not provide any benefits beyond those already provided by other alternatives. Steady flows could also increase the interactions between native and non-native fish by intensifying competition and predation by non-natives on native fish. Such interactions would reach a level of concern under steady flows. Finally, this alternative would have major adverse impacts on hydropower (power operations and marketing).

The Existing Monthly Volume Steady Flow Alternative was eliminated from selection as the preferred alternative for reasons similar to those discussed above for the Year-Round Steady Flow Alternative.

Although the Interim Low Fluctuating Flow Alternative performed well over the interim period (August 1991 to the present), long-term implementation of this alternative would not restore some of the pre-dam variability in the natural system. The selected Modified Low Fluctuating Flow Alternative is an improved version of the Interim Low Fluctuating Flow Alternative because it would provide for some pre-dam variability through habitat maintenance flows.

The three remaining alternatives-the Moderate Fluctuating, Modified Low Fluctuating, and Seasonally Adjusted Steady Flow Alternatives-- provide similar benefits to most downstream resources (e.g.. vegetation, terrestrial wildlife, and cultural resources) with respect to increased protection or improvement of those resources (see Table 11-7 in the EIS). The Moderate Fluctuating Flow Alternative provided only minor benefits to native fish over no action conditions because of the relative similarity in flow fluctuations; and the benefits from the Seasonally Adjusted Steady Flow Alternative were uncertain given the improvement in habitat conditions for non-native fish this alternative would provide. Seasonally adjusted steady flows also would create conditions significantly different from those under which the current aquatic ecosystem has developed in the last 30 years and would adversely affect hydropower to a greater extent than the

other two alternatives. The Modified Low Fluctuating Flow could substantially improve the aquatic food base and benefit native and non-native fish. The potential exists for a minor increase in the native fish population.

Although the Moderate Fluctuating, Modified Low Fluctuating, and Seasonally Adjusted Steady Flow Alternatives provide similar benefits to most downstream resources, the Modified Low Fluctuating Flow Alternative was selected as the preferred alternative because it would provide the most benefits with respect to the original selection criteria, given existing information. This alternative would create conditions that promote the protection and improvement of downstream resources while maintaining some flexibility in hydropower production. Although there would be a significant loss of hydropower benefits due to the selection of the preferred alternative (between V 5. 1 and $44.2 million annually) a recently completed non-use value study conducted under the Glen Canyon Environmental Studies indicates that the American people are willing to pay much more than this loss to maintain a healthy ecosystem in the Grand Canyon. The results of this nonuse value study are summarized in Attachment 3 of the ROD.

The results of a General Accounting Office (GAO) audit mandated by the Grand Canyon Protection Act are in Attachment 4 of the ROD. This audit generally concludes that Reclamation used appropriate methodologies and the best available information in determining the potential impact of various dam flow alternatives on important resources. However, GAO identified some shortcomings in the application of certain methodologies and data, particutarly with respect to the hydropower analysis. Reclamation's assumptions do not explicitly include the mitigating effect of higher electricity prices on electricity demand (price elasticity). GAO also determined that Reclamation's assumptions about natural gas prices were relatively high and that two computational errors were made during the third phase of the power analysis. According to GAO, these limitations suggest that the estimated economic impacts for power are subject to uncertainty. GAO also found limitations with some of the data used for impact analysis. Certain data was incomplete or outdated, particularly data used in assessing the economic impact of alternative flows on recreational activities. Nevertheless, the National Research Council peer reviewed both the Glen Canyon Environmental Studies and the EIS, and generally found the analysis to be adequate. The GAO audit concluded that these shortcomings and limitations are not significant and would not likely alter the findings with respect to the preferred alternative and usefulness of the document in the decision-making process. The audit also determined that most of the key parties (83 percent of respondents) support Reclamation's preferred alternative for dam operations, although some concerns remain.

ATTACHMENT 1.

Specific peer reviewed sediment studies:

Beus, S. and C. Avery 1993. The influence of variable discharge regimes on Colorado River sand bars below Glen Canyon Dam. Glen Canyon Environmental Studies, Report PHY0101, Chapters I through 7. Northern Arizona University, Flagstaff, AZ

Beus, S., M.A. Kaplinski, J. E. Hazel, L. A. Tedrow, and L. H. Kearsley. 1995. Monitoring the effects of interim flows from Glen Canyon Dam on sand bar dynamics and campsite size in the Colorado River corridor, Grand Canyon National Park, AZ. Glen Canyon Environmental Studies, Report PHY 0112. Northern Arizona University, Flagstaff, AZ

Budhu, M and R. Gobin. 1994. Monitoring of sand bar instability during the interim flows: a seepage erosion approach. Glen Canyon Environmentaf Studies, Report PHY 0400. University of Arizona, Tucson, AZ

Carpenter, M., R. Carruth, Fink, D. Boling, and B. Cluer. 1995. Hydrogeology of sand bars 43.1 and 172.3L and the implications on flow alternatives along the Colorado River in the Grand Canyon. Glen Canyon Environmental Studies, Report PHY 0805. U.S. Geological Survey, Tucson, AZ

Cluer, B. 1993. Annual Report. Sediment mobility within eddies and the relationship to rapid erosion events. Glen Canyon Environmental Studies, Report PHY 0 11. National Park Service, Ft. Collins, CO

Cluer, B. and L. Dexter. 1994. An evaluation of the effects of the interim flows from Glen Canyon Dam on the daily change of beach area in Grand Canyon, AZ. Glen Canyon Environmental Studies, Report PHY 0 109. Northern Arizona University, Flagstaff, AZ

Nelson, J., N. Andrews, and J. MacDonald. 1993. Movement and deposition of sediments from the main channel to the eddies of the Colorado River in the Grand Canyon. Glen Canyon Environmental Studies, Report PHY 0800. U.S. Geological Survey, Boulder, CO

Randle, T.J., R.I. Strand, and A. Streifel. 1993. Engineering and environmental considerations of Grand Canyon sediment management. In: Engineering Solutions to Environmental Challenges: Thirteenth Annual USCOLD Lecture, Chattanooga, TN. U.S. Committee on Large Dams, Denver, CO.

Schmidt, J. 1994. Development of a monitoring program of sediment storage changes in alluvial banks and bars, Colorado River, Grand Canyon, AZ. Glen Canyon Envirorunental Studies, Report PHY 0401. Utah State University.

Smith, J. and S. Wiele. 1994. Draft report. A one-dimensional unsteady. model of discharge waves

in the Colorado River through the Grand Canyon. Glen Canyon Environmental Studies, Report PHY 0805. U.S. Geological Survey, Boulder, CO

Werrell, W., R. Ingliss, and L. Martin. 1993. Beach face erosion in Grand Canyon National Park: A response to ground water seepage during fluctuating flow releases from Glen Canyon Dam. Glen Canyon Environmental Studies, Report PHY 0101, Chapter 4 in The influence of variable discharge regimes on Colorado River sandbars below Glen Canyon Dam, Report PHY 0101. National Park Service, Ft. Collins, CO .

Appendix H

TWG AD HOC GROUP ON BUDGET DEVELOPMENT PROCESS
REPORT TO TWG
Approved by AMWG on April 13, 2001

At its September 20, 1999, meeting, after some discussion of AMP budget issues and processes, the TWG voted to form a TWG ad hoc group to "review the budget process and bring recommendations back to the TWG". Members appointed to the group were: Cliff Barrett, chairman, Clayton Palmer, Randy Peterson, Wayne Cook, Robert Begay, Bill Persons, and Norm Henderson. During the TWG discussion of the budget issues the following comments or suggestions were made and captured on a flip chart:

1. Develop a more effective consensus building process for budget review and approval
2. Develop a better forum for discussion of minority views
3. Start budget discussions earlier in the budget process
4. Develop a prioritization method
5. Organize a "lobbying" effort in Washington, D.C., to support the budget once it is approved.
6. Develop a process for frequent updates of the TWG and AMWG on the budget as it moves through the Administration and the Congress.

The ad hoc group used these six items as the starting point for discussion and the framework for this report. This report contains the ad hoc group's recommendations to the TWG for actions that will help in the AMP budget process.

BASIC ASSUMPTION

All of the following discussion and recommendations are based on the assumption that the AMWG wants the TWG to be deeply involved in the AMP budget process and wants to receive TWG's recommendations on the budget and budgeting issues. This assumption should be confirmed.

<u>RECOMMENDATION</u>

- The ad hoc group recommends that the TWG ask AMWG for guidance on the degree of involvement AMWG wants in the AMP budget process and how much help it wants from the TWG in meeting that goal.

ITEMS 1-3

The first three items relate to having more timely and effective discussions. Effective discussions, during which all views on a topic are heard, discussed, and understood by interested and involved TWG participants has been a goal of the TWG for some time. TWG has a game plan and meeting rules that will provide for this. What is needed more than anything else is for the TWG agenda to be prepared in a way that allows enough

time for thorough budget discussions at a place in the meeting where the participants have the time and are of the mindset to apply themselves to the problem, i.e., not at the end of the meeting nor the end of the day. Let's give the budget some "quality time."

TWG consideration of the budget would be facilitated if a small group were to work with the USBR and GCMRC throughout the entire budget process, from initial formulation to formal budget presentations and on into the execution phase. TWG needs a small permanent group of members that have the time and inclination to work together on detailed budget problems. This group could then work with USBR and GCMRC in the budget process, do required liaison with TWG members, and help USBR and GCMRC bring to the TWG budgets that have had some review, had major items discussed, and are prepared for full TWG discussion and recommendation. To provide continuity from year to year this should be a permanent work group of the TWG.

A major concern with this and other proposals in this report is the potential violation of the GCMRC RFP protocols which are intended to prevent the conflict of interest that occurs when potential bidders on RFPs are involved in detailed discussions of work plans, budgets, and RFP issues. As there are several potential bidders on the AMWG and TWG, the budget review process must be done in a way that ensures there is not the perception or reality of potential bidders obtaining insider information. An extreme way to accomplish this is for all potential bidders to exclude themselves from any work plan, budget, or RFP discussions. This may result in a dysfunctional AMWG and TWG when it comes to these issues. The other extreme is for AMWG and TWG to be only superficially involved in the budgeting process at a level that may even preclude the ability to make informed recommendations to the Secretary on budget issues. The TWG Budget Group and the Director of the GCMRC, and perhaps the USGS Contracting Officer need to have a full discussion of this problem before the proposed AMP budget process is implemented.

The timing of TWG and AMWG budget considerations within the budget process has been a problem and has been discussed at the most recent meetings of both TWG and AMWG. The ad hoc group has reviewed the GCDAMP Budget Protocols and Federal Budget Process document adopted in 1998 and prepared a draft revision that attempts to provide for the current budget situation that includes both USBR and USGS funds as well as those from other agencies. A draft is attached to this report. This document should be finalized by the TWG Budget Work Group, reviewed by TWG, and presented to AMWG for adoption in July 2001.

Success will also depend on obtaining from GCMRC, USGS, and USBR budget documents that give the information needed for a comprehensive review, and are internally consistent in format. The AMWG has developed a trial format and GCMRC has been presenting its budget in this format as of FY2001. It is "a work in progress" and some patience will be required by all parties as AMWG and GCMRC work toward the "ideal." Completion of this effort could be assigned to the AMP Budget Working Group.

RECOMMENDATIONS

Regarding Items 1-3, the ad hoc group recommends the following:

- The TWG form a permanent AMP Budget Work Group

- The TWG assign the Budget Work Group the task of reviewing and finalizing the attached draft GCDAMP Budget Protocol and Process and bringing it to the TWG for recommendation to the AMWG in July 2001. The Work Group will assure that the process allows ample time for internal Tribal discussions to take place before key meetings of TWG and AMWG on budget matters.

- The TWG recommend to the AMWG that it assigns the AMP Budget Work Group the task of completing the work on standard budget formats.

- The chairman of the TWG assure that TWG agenda gives appropriate time for full discussion of the budget, and that budget documents are furnished to TWG members sufficiently in advance to allow for their review prior to the meeting.

- The TWG should discuss the way budget discussions are conducted and determine if there is a need for training the TWG in meeting process, conflict resolution, and other items that will increase the ability of the TWG to work together as a team. The TWG should then make appropriate recommendations to the AMWG and the involved Federal agencies to obtain the help needed. Adoption of this recommendation will help the TWG in all of its work, not just the budget.

ITEM 4: Develop a Prioritization Method

All parties (AMWG, TWG, GCMRC, USBR, USGS) must recognize the fact that not all funds needed and requested will always be made available. Prioritization of work is essential to the budgeting process. This is especially true as we move toward a budget that has some fixed resources (power revenues) and some that depend on further Congressional action (appropriated funds) and some that are outside the federal system (non-federal funding). A system must be devised that gives the TWG /AMWG a clear idea as to how available funds will be allocated if all the anticipated funding is not obtained. TWG/AMWG must have this information throughout the budget process so that guidance can be given to GCMRC/USBR/USGS as they go through their internal processes even before the budget goes to the Congress. There are many opportunities for budget adjustments in this process, and TWG/AMWG need to be involved if they are then to be expected to support the final budget as it goes to the Congress.

The Strategic Plan, the Goals and Management Objectives, and especially the prioritized Information Needs should serve as the base for determining budget priorities. At its basic level the budget should put the baseline monitoring and high priority information needs ahead of other activities. This will necessarily be modified year to year by hydrology and

other scientific considerations. An appropriate priority will also have to be given to PA activities included in the AMP.

RECOMMENDATION

- The ad hoc group recommends that GCMRC and USBR be requested to identify a prioritization process that they will use in the event of budget reductions anytime in the budget process. This process may include a list of items that could be reduced if required, in some order of priority. This list would then be considered by TWG/AMWG in their budget recommendation process.

ITEM 5. Organize a Lobbying Effort to Support the Budget

This breaks into two levels. The first is in the budget formulation phase while the agencies, the department and OMB are developing the budget that will be sent to the Congress. During this phase the members of TWG and AMWG need to work with the Secretary's representative to the AMWG and the Federal members of TWG/AMWG to assure that sufficient funding is proposed. This is best done during the process described above where the budget is reviewed, discussed and prioritized. The federal members and the Secretary's representative should get a good idea as to the TWG/AMWG support for the budget from these discussions, and can carry that message to the involved offices in the Department.

The second level is at the Congress. The ad hoc group views this as a task for the non-Federal members of the AMWG. The AMWG could form a group to develop a concrete game plan for this effort. The plan would include: a) identification of key Congressmen and staff members who either deal directly with the budget, or who are interested and can exert influence; b) organize a letter writing effort; c) organize visits in Washington with members and staff.

RECOMMENDATION

- The ad hoc group recommends that the TWG recommend to the AMWG the formation of a group of non-Federal AMWG members to devise and carry out a plan to gain support for the AMP program and required budget from the involved members of Congress and the Congressional Committees.

ITEM 6. Frequent Budget Updates for the TWG and AMWG

There is a need for all members of the TWG and AMWG to be fully informed on budget issues as the budget is prepared and moves through the Federal approval and appropriation process. This will be a natural result of the recommendations made above. The AMP Budget Work Group, the GCMRC and USBR will report to the TWG frequently as the budget is formulated, executed, and adjusted. More complete and timely communication and reporting of TWG members with their AMWG member will be required to aid the AMWG in understanding, accepting, and recommending the budget

to the Secretary. Further updates to the AMWG will be necessary as it organizes the support needed to carry the budget through the Administration and the Congress, and in applying the priorities.

RECOMMENDATIONS

- The ad hoc group recommends that a brief budget update by GCMRC and USBR be included on the agenda for every TWG meeting. In addition TWG members should be responsible for keeping their AMWG members fully informed on budget issues.

- AMP budget status and issues should be on the agenda for every January and July AMWG meeting, with time allocated for a full discussion. Brief status reports should be given at other AMWG meetings as needed.

GENERAL

In addition to the above recommendations the ad hoc group, having completed its work, and assuming its recommendation to form a permanent AMP Budget Committee is adopted, further recommends that this ad group on budget process be discontinued.

Appendix I

ISSUE PAPERS

Issue A: Potential Development of Management Objectives for Lake Powell

Issue: The issue is whether MOs should be developed for Lake Powell or whether the MOs should be limited to downstream resources. Management Objectives are defined as the desired future condition of a particular resource. Monitoring and research in Lake Powell is needed, as outlined in the IWQP and the Black/Gray/White monitoring decision document in order to understand and predict the downstream impact of changing Lake Powell water quality parameters.

Response: Management Objectives should be developed for resources downstream of Glen Canyon Dam. Defining downstream water quality MOs implicitly mandates water quality monitoring and research work in Lake Powell, but appropriately focuses the impacts and benefits of such targets on the downstream resources

Rationale: The GCPA directs the operation of GCD to protect the resources of the Grand Canyon National Park and the Glen Canyon National Recreation Area. In several places, the committee language accompanying the statute further defines the area of concern as the GCNP and GCNRA downstream of the dam, noting that while "the primary purpose of this title is to authorize changes in the operation of Glen Canyon Dam to prevent damage to downstream resources," other authorities were identified "to address downstream effects of Glen Canyon Dam if such other remedial measures meet this title's goal of protecting, mitigating damage to, and improving the resources downstream of the dam." With this strong focus on the downstream resources, we believe it important to have the management objectives tied directly to these downstream resources, both for directness of application and appropriateness of measurement.

Specific downstream targets associated with these MOs that are directly tied to Lake Powell characteristics will need to be monitored in order to both predict and ensure that the downstream management objectives are met. The IWQP was developed with this conclusion as a basic premise. The Loveless Guidance Document also confirms that work above Lake Powell is justified based on the impacts to downstream resources. The term Colorado River Ecosystem used in the principles and goals was defined in such a way to include the forebay of Lake Powell and appropriate tributaries of the downstream Colorado River to allow monitoring and research activities in these areas if necessary to understand and improve and protect the conditions in the downstream riverine environment.

Issue B: Native Fish Versus Lee's Ferry Rainbow Trout

Issue: Is there a conflict between Adaptive Management Program (AMP) goals and management objectives for native fish versus the goals for Lees Ferry rainbow trout?

Response: Upstream of the Paria River, naturally reproducing Rainbow trout and native fish populations will attempted to be conserved and enhanced concurrently. Downstream of the Paria River, native fish are accorded preferential status over all non-native fish.

Rationale: This issue is focused on the need to concurrently manage for two desired resources that may be in conflict with each other, specifically: endangered native fishes and non-native Rainbow trout. Healthy populations of native fish in the ecosystem are a primary management objective as reflected in National Park Service policy directives. A healthy Rainbow trout fishery is also desired. Both fisheries are considered resources of concern by the AMP stakeholders and in the GCDEIS.

The principles, goals, and management objectives developed by the AMP imply that the rainbow trout above the Paria River in the Lees Ferry reach have a different status as compared to other non-native fish in the Colorado River ecosystem. These same principles, goals and management objectives provided guidance for resolving conflicts between native fish and rainbow trout above the Paria River in the Lees Ferry reach. Under the above guidance, flows, temperature regimes and other management actions one might consider to benefit native fish throughout the Colorado River ecosystem are initially constrained by the range of flows, temperatures, and other effects that provide for the continued existence of rainbow trout above the Paria River in the Lees Ferry reach.

Issue C: Responsibility Scope of the Management Objectives

Issue: Should we include only those MOs that are the responsibility of the AMP, or should we include all MOs needed to accomplish the Goal? Is it appropriate to include MOs that cannot be accomplished solely through modifications to dam operations, or that may require activities that may not be funded by hydropower revenues?

Response: In summary, the MOs should be focused on resources and impacts within Glen Canyon National Recreation Area and Grand Canyon National Park below Glen Canyon Dam. The question of whether nonreimbursable CRSP hydropower revenues may be used to accomplish an MO does not have to be resolved when an MO is listed. The GCPA authorizes both changes to dam operations and activities other than changes to dam operations to accomplish the purposes of the act.

Rationale: This question is addressed by Principle 1, which states that "Some of the Objectives and actions that fall under these Goals may not be the responsibility of the GCDAMP, and may be funded by other sources, but are included here for completeness." There are two underlying assumptions. First is that the MOs will be focused on resources within the scope of the program and second, that some of the actions needed to accomplish the MOs may be accomplished through "other authorities" and other funding. The GCPA clearly states that the Secretary has the authority to implement changes to dam operations as well as non-operational measures to accomplish the purposes of the act.

The basis for this Principle stems from the Grand Canyon Protection Act (GCPA), the Senate Report Language for the Act (Report Language), the Charter of the Adaptive Management Work Group (Charter), and the Glen Canyon Dam Adaptive Management Program AMWG FACA Committee Guidance document (Guidance) prepared by Scott Loveless.

Sections 1807, 1805, 1804 (c, B) and 1802 of the GCPA authorize the Secretary to use CRSP hydropower revenue for research, monitoring, consultation, and other activities that will ensure Glen Canyon Dam is operated 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." The nonreimbursable expenditures allowed under the GCPA included preparation of the EIS and its supporting studies as well as the other actions mentioned in this paragraph.

According to the Report Language "All measures undertaken pursuant to the authority of this Act have as their focus the improvement of conditions for downstream resources within the two Park Service units." The geographic focus of the AMP is also described in the definition of the Colorado River Ecosystem contained in this Strategic Plan. We recognize that there may be operational impacts on resources beyond the narrow geographic area defined above. Examples of activities that may be funded through

nonreimbursable CRSP hydropower revenues and other sources are included in the Guidance (p. 7).

According to the Guidance "The relevant Senate Report language says, after discussion of the primary purpose of the Act, that: "other reasonable remedial measures may be available to the Secretary. The phrase 'exercise other authorities under existing law' means that the Secretary should consider and may implement non-operational measures to address downstream effects of Glen Canyon Dam if such other remedial measures meet this title's goal of protecting, mitigating damage to, and improving the resources downstream of the dam."

The Charter further allows that "AMWG may recommend research and monitoring proposals outside the Act which complement the AMP process, but such proposals will be funded separately, and do not deter from the focus of the Act." However, the aspect of nonreimbursable funding applies only to specific expenditures within the authority of the GCPA.

Issue D: Riparian Biotic Community

Issue: This paper is focused on clarifying whether the AMP objectives for riparian biotic communities should be focused on native biotic communities (e.g., old high-water zone and sand beach), or on the naturalized biotic community (e.g., new high-water zone, marshes, tamarisk-dominated).

Response: In natural river systems in the southwest, disturbance events from snowmelt or rainfall and periods of no precipitation define the climate that shape the riparian community and morphology of the rivers. The Grand Canyon was historically characterized by spring floods that scoured near shore vegetation and deposited sand beaches. Mesquite/acacia and other riparian communities that became established above the 10-year flood level (about 120,000 cfs) survived this regime, but the canyon in general had less vegetation than after the dam was constructed.

Except for years in which large snowmelt runoff could not be totally controlled, the post-dam flow regime significantly reduced the annual peak flood stage from the pre-dam flood level. The resultant powerplant bypasses reset the riparian system to a degree dependant on the magnitude of the releases. However, since the peak releases of the majority of post-dam years was less than powerplant capacity, the NHWZ and marsh communities became more dominant.

Stakeholders place different values on each of the types of riparian communities, and have differing views on the operational and management actions that could be taken to enhance particular communities. However, AMWG members indicated that all of these communities are important, and as a result value aspects of both natural and controlled river processes. Thus, the MOs for riparian resources attempt to preserve OHWZ and sand beach communities through occasional large-magnitude, triggered BHBFs. During the intervening period between BHBF's, NHWZ and marsh communities will become re-established or recover. The ebb and flow thus established will mimic some of the processes of natural rivers, but perhaps on a time scale of years instead of months. The magnitude of BHBFs may determine the level at which the OHWZ community is retained and could vary from the pre-dam level, and other factors such as sediment budget and aquatic and cultural resources may play a role in these decisions.

Issue E: Consistency Between Recovery Plans and Management Objectives

Issue: Should AMP management objectives for T&E species parallel objectives in USFWS recovery plans?

Response: AMP management objectives for T&E species need to be consistent with our Vision-Mission and Goals and the current FWS recovery plans.

Rational: AMP objectives need to be consistent with our Vision-Mission and Goals to meet Principle 1. AMP objectives may not identical to recovery plan objectives simply because those objectives descend from different goals.

Issue F: Socio-Economics

Issue: Should there be a goal for Socio – Economics instead of Goal 11 related only to hydropower?

Response: Goal 11 will be retained and the related MOs will be measured in metrics having other than dollar values. Determination and consideration of socio-economic values will be included in a MO for Goal 13.

Rationale: Although it is not a natural resource, hydropower generation was recognized as a resource of concern in developing the GCPA, the EIS, the ROD and the Guidance Document. Goals need to be developed for all resources of concern including both hydropower and recreation as well as others that are not considered to be primarily natural resources.

Socio – economic values are not a goal. They are a way to measure the value of the resources of concern and, as suggested by the NRC Downstream report, may provide a useful tool in presenting data to be used in making decisions. Development of socio – economic data (including non-use values) for use in decision making has been made a management objective in Goal 13.

Issue G: Principle Six

Issue: Does Principle No. 6 appropriately recognize the continuing existence of Glen Canyon Dam (GCD) as well the possibility for management actions other than changes in dam operations?

Response: The ad hoc group suggests a more appropriate statement of the principle is "Management actions, including changes in dam operations, will be tried that attempt to return ecosystem patterns and processes to their range of natural variability. When this is not appropriate, or beyond the range of operational flexibility of the dam, experiments will be conducted to test other approaches."

Rationale: Principle No. 6 must be read and interpreted within the context of the Vision statement, the Guidance Document, and in combination with Principles 5 and 7. The second paragraph of the Vision Statement clearly states the AMP program will be accomplished through the operation of GCD and other means. The Guidance Document has several references to continued dam operations; page 2 paragraph 2 refers to the legislative intent in GCPA, and on page 4 quotes from the ROD on finding "an alternative dam operating plan." Given the statements in the underlying documents it is clear that Principle 6 assumes continued operation of the dam and places that restriction on the range of natural variability target. The principle should be modified to reflect that situation and to be more clear that non-operational actions are available to achieve some goals.

GLOSSARY

Adaptive Management
Adaptive management is an iterative process, designed to experimentally compare selected management actions by evaluating alternative hypotheses about the ecosystem being managed. It consists of three parts: management actions, monitoring, and adaptation. Management actions are treated as experiments subject to modification. Monitoring is conducted to detect the effects of the management actions. Finally, management actions are refined based on the enhanced understanding about how the ecosystem responds.

Area of Potential Effects
As defined in 36 CFR 800.16, area of potential effects means the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties.

Biodiversity
Biodiversity is "the variety of organisms considered at all levels, from genetic variants belonging to the same species through arrays of species to arrays of genera, families, and still higher taxonomic levels [including]…ecosystems." (Wilson 1992).

Biological Goals
Biological goals include Goal 1 (food base), Goal 2 (native fish), Goal 3 (extirpated species), Goal 5 (Kanab ambersnail), and Goal 6 (riparian and spring communities).

Capacity (Generating)
Generating capacity is a measure of the ability to generate electric power, usually expressed in MW (megawatts). The capacity of a hydropower plant is a function of head (reservoir elevation) and maximum water flow through the turbines.

Colorado River Ecosystem
The Colorado River ecosystem is the Colorado River mainstem corridor and interacting resources in associated riparian and terrace zones, located primarily from the fore bay of Glen Canyon Dam to the western boundary of Grand Canyon National Park. It includes the area where dam operations impact physical, biological, recreational, cultural, and other resources. The scope of GCDAMP activities may include limited investigations into some tributaries (e.g., the Little Colorado and Paria Rivers).

Critical Reaches
Critical reaches are where there are only very few, very small, or very high use campsites. These reaches are river mile (RM) 6 to 41, RM 75 to 114, RM 130 to 165, and perhaps RM 216 to 246.

Cultural Goal
Cultural goal refers to Goal 11.

Cultural Resources
Cultural resources are those resources of traditional, cultural, religious, or historic importance to Indian tribes, other sociocultural groups, or to the American people in general. They include, but are not limited to, archeological, historical, and traditional cultural resources, prehistoric or historic districts, sites, buildings, structures, landscapes, or objects. Properties of traditional religious and cultural importance to an Indian tribe are included in this definition under Section 101(d)(6)(A) of NHPA.

Ecosystem
An ecosystem is "a community of organisms and their physical environment interacting as an ecological unit." (Lincoln 1998:). An ecosystem consists of patterns and processes that are dynamic and occur within a particular range of temporal and spatial variability.

Ecosystem Management
An ecosystem management approach differs from an issue-, species-, or resource-specific approach. Ecosystem management is a method for sustaining or restoring ecosystems and their functions and values. "It is goal driven, and it is based on a collaboratively developed vision of desired future conditions that integrates ecological, economic, and social factors. It is applied within a geographic framework defined primarily by ecological boundaries." (Interagency Ecosystem Management Task Force 1995). Ecosystem management is a process that attempts to mimic appropriate ecosystem patterns (abundance and distribution of species and habitats) and ecosystem processes (drivers of ecosystem patterns). It includes managing for viable populations of all native species.

Ecosystem Patterns
Ecosystem pattern is the abundance of species, biotic communities, and physical habitats, as well as their spatial and temporal distribution. This is a broader concept than composition and structure. Composition usually refers only to species presence or absence and structure usually refers to the distribution of biotic communities.

Ecosystem Processes
Ecosystem processes are the abiotic (i.e., non-living) and biotic (living) functions, disturbances, or events that shape ecosystem patterns. There are physical processes (e.g., fire, hydrologic, geomorphic, and climatic regimes; air chemistry, nutrient cycling), biological processes (competition, predation, herbivory, parasitism, disease, migration, dispersal, gene flow, succession, recruitment, maturation), and anthropogenic processes (e.g., habitat conversion, novel toxins, vandalism).

Emergency Exception Criteria
Emergency exception criteria are operating criteria that allow the Western Area Power Administration to depart from Record of Decision operating criteria in response to various emergency situations in accordance with their obligations to the North American Electric Reliability Council. These criteria also provide for exceptions to the Record of Decision criteria during search and rescue situations, special studies and monitoring, and dam and power plant maintenance.

Extirpated Species
An extirpated species is one that no longer occurs (i.e., has become extinct) in a particular area. Examples from the CRE include roundtail chub, bonytail chub, and Colorado pikeminnow.

Financial Exception Criteria
Financial exception criteria would allow a temporary departure from ROD operating constraints on dam releases, as a response to a regional electricity market that is extraordinarily expensive. These criteria do not exist at this time. Similar criteria were in place during the period of Interim Flows (August 1991 to October 1996).

Fluvial Wetland (Marsh) Community
This community is composed mainly of herbaceous plants such as cattail, bulrush, and common reed. This community became established at low elevations within the sand beach community following closure of Glen Canyon Dam. Currently, it usually occurs between about 8000 and 25,000 cfs in periodically inundated environments such as return current channels.

Historic Property
As defined in 36 CFR 800.16, historic property means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to Indian tribes and that meet the National Register criteria for evaluation.

Interested Party (per NHPA)
As defined under the National Historic Preservation Act, interested parties are certain individuals and organizations with a demonstrated interest in an undertaking that may participate as consulting parties due to the nature of their legal or economic relation to the undertaking or affected properties, or their concern with an undertaking's effects on historic properties.

Invasive Species
An invasive species is one that has invaded an area following changes in one or more ecosystem processes and has become dominant. Examples from the CRE include non-native species (e.g., tamarisk) and native species (e.g., willow).

Jeopardize the Continued Existence
As defined in 50 CFR 402, to jeopardize the continued existence means “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.”

Listed Species
As defined in 50 CFR 402, listed species means any species of fish, wildlife, or plant that has been determined to be endangered or threatened under section 4 of the Endangered Species Act.

Monitoring
Monitoring is the "collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective." (Elzinga *et al.* 1998). Monitoring needs to produce data of sufficient statistical power to detect a trend if in fact it is occurring (Gibbs *et al*. 1998). Monitoring differs from inventory, which is defined as measurement of environmental attributes at a given point in time to determine what is present. It also differs from research, which is the measurement of environmental attributes to test a specific hypothesis.

Native Species
A native species is one that occurred in an area before anthropogenic alterations to ecosystem patterns and/or processes. Examples from the CRE include humpback chub, razorback sucker, flannelmouth sucker, bluehead sucker, speckled dace, Colorado pikeminnow, bonytail, roundtail chub, river otter, Kanab ambersnail, Southwest willow flycatcher, brown-headed cowbird, netleaf hackberry, honey mesquite, and catclaw acacia.

New High Water Zone Community
The vegetation in this community type is dominated by tamarisk. Other woody plants include coyote willow, arrowweed, and seepwillow. In addition to tamarisk, non-native species include camelthorn, and red brome. This community became established mainly at low to mid elevations within the sand beach community following closure of Glen Canyon Dam. Currently, it usually occurs between about 18,000 and 45,000 cfs.

Non-native Species
A non-native species is one that did not occur in an area before anthropogenic alterations to ecosystem patterns and/or processes. Non-natives are also known as introduced, exotic, or alien species. Many, but not all, non-native species can be categorized as an invasive species. Examples of non-native species in the CRE include rainbow trout, brown trout, common carp, red shiner, channel catfish, tamarisk, and camelthorn.

Old High Water Zone Community
The vegetation in this community type is dominated by Apache plume upstream of river mile (RM) 40, and catclaw acacia downstream of RM 40. Mesquite is co-dominant with catclaw acacia between RM 40-77 and RM 167-225. Other woody plants include redbud and netleaf hackberry. This community currently occurs on pre-dam flood terraces, sand dunes, and stabilized talus slopes above the pre-dam scour zone (about 100,000 cfs stage elevation) and below desert vegetation.

Programmatic Agreement
As defined in 36 CFR 800.16, a programmatic agreement under the National Historic Preservation Act means a document that records the terms and conditions agreed upon to resolve the potential adverse effects of a federal agency program, complex undertaking, or other situations in accordance with 36 CFR 800.14(b).

Range of Natural Variability
Range of Natural Variability is the spatial and temporal variation in ecosystem patterns and ecosystem processes under which the ecosystem has evolved. The range of natural variability for ecological processes is usually defined by their frequency (e.g., number/year), intensity (cubic feet per second), duration (number of days), magnitude (acres), seasonally, and rate of change (Landres 1999).

Reasonable and Prudent Alternatives
As defined in 50 CFR 402, reasonable and prudent alternatives "refer to alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, that is economically and technologically feasible, and that the Director believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat."

Reasonable and Prudent Measure
As defined in 50 CFR 402, reasonable and prudent measures "refer to those actions the Director believes necessary or appropriate to minimize the impacts, *i.e.*, amount or extent, of incidental take."

Recovery
As defined in 50 CFR 402, "recovery means improvement in the status of a listed species to the point at which listing is no longer appropriate, under the criteria set out in section 4(a)(1) of the [Endangered Species] Act.

Recreational Goals
Recreational goals include Goal 4 (trout) and Goal 9 (recreation).

Regulation
Western operates two load control areas that are tied to GCD. A load control area is a specific geographic areas assigned to an operator to regulate the moment-by-moment changes in electrical demand on the transmission lines in the area. Regulation is the adjustment in electrical generation within a load control area to meet minor changes in electrical use as reflected by electrical readings on transmission lines. Currently, GCD is committed to providing regulation up to plus or minus 1,000 cfs on an instantaneous basis to Western's load control area.

Regulation for Others
Regulation for others is that which can be made available for other electrical utilities, provided they have an electrical transmission link to GCD and that they are a control area operator or have contracted an agreement with their control area operator to receive this service.

Removal of Jeopardy
Removing (or avoiding) jeopardy is intended to be accomplished through the implementation of reasonable and prudent alternatives. (See also, jeopardize the continued existence.)

Riparian Zone
The riparian zone is the streamside area that is influenced by riverine processes, e.g., flood regime and distance to subsurface water.

Sand Beach Community
The sparse vegetation in this community type is dominated by Indian ricegrass, beavertail, four-wing saltbush, and ephemeral species that are adapted to frequent floods and scour events. This community has been invaded with non-native species such as camelthorn, Russian thistle, and red brome. Although this community occurs in the pre-dam scour zone (below about 100,000 cfs), willows and other woody species became established in some reaches of lower Grand Canyon.

Seep and Spring Communities
The vegetation in this community type is composed of a large array of herbaceous and woody species including maidenhair fern, crimson monkey flower, golden columbine, common reed, Fremont cottonwood, poison ivy, and birchleaf buckthorn. The water source for these communities can include both groundwater and surface water.

Tribal Consultation
Tribal consultation in the AMP is defined as the formal dialogue with designated governmental representatives and other AMWG members, through AMWG and TWG meetings, about trust assets, resources, and other tribal interests, that results in all the members of the AMWG understanding and appreciating tribal perspectives and the inclusion of tribal values within the AMP. Additionally, this consultation assists federal agencies in realizing their trust responsibility to tribal nations and fulfills the federal government's consultation requirements. Such consultation and the subsequent inclusion of tribal values can add to the knowledge base of the AMP, and tribal perspectives and values can temper the traditional western scientific approach used by the AMP, thus making it stronger.

Tribal Participation
Tribal participation ensures that tribal values inform the interpretation of the quantity and quality of resources that results from a Western scientific approach to monitoring and research. Tribal participation is defined as a set of activities that may include one or more of the following: conducting or collaborating in resource projects awarded through the competitive process, participating in discussions with principal investigators regarding where and how they will conduct monitoring and research activities, and tribally relevant data analysis and information sharing.

Viable Population
A population is considered viable when there is a high chance of persistence over a long timeframe without demographic or genetic augmentation. Population viability is not the same as "recovery" or "removal of jeopardy" for a species. However, the concept of population viability is an important consideration in determining recovery and removal of jeopardy.

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ABBREVIATIONS
Adaptive Management Program Strategic Plan

AFDW	ash-free dry weight
AGFD	Arizona Game and Fish Department
AIRFA	American Indian Religious Freedom Act
AMP	adaptive management program
AMWG	Glen Canyon Dam Adaptive Management Work Group
APE	Area of Potential Effect
BHBF	beach/habitat building flow
BO	biological opinion
BOR	Bureau of Reclamation
cfs	cubic feet per second
CPOM	coarse particulate organic matter
CPUE	catch per unit effort
CRE	Colorado River ecosystem
D50	median grain size
DO	dissolved oxygen
EO	Executive Order
FPOM	fine particulate organic matter
GCD	Glen Canyon Dam
GCMRC	Grand Canyon Monitoring and Research Center
GCPA	Grand Canyon Protection Act
GLCA	Glen Canyon National Recreation Area
GRCA	Grand Canyon National Park
HBC	Humpback chub
HMF	Habitat maintenance flow
KAS	Kanab ambersnail
LCR	Little Colorado River
LSSF	Low steady summer flow
MA	management action
MO	management objective
MSCP	Multi-Species Conservation Plan
Ne	effective population size
NHPA	National Historic Preservation Act
NHWZ	new high water zone
NPS	National Park Service
OHWZ	old high water zone
PI	principal investigator
popn	population
PVA	population viability analysis
RBT	Rainbow trout
Register	National Register of Historic Places
RM	river mile
RNV	range of natural variability
ROD	record of decision
RPA	reasonable and prudent alternative
SAB	Scientific Advisory Board (of GCMRC)
SWWF	Southwestern willow flycatcher
TBD	to be determined
USBR	United States Bureau of Reclamation
WACM	Western Area - Colorado and Missouri
WALC	Western Area - Lower Colorado
WAPA	Western Area Power Administration, Department of Energy
Wr	mean annual relative weight
WSCC	Western Systems Coordinating Council

Action Taken on the Strategic Plan by the AMWG

January 17, 2002

1. Add to the Strategic Plan in Chapter 1, in the section "Adaptive Management Program Organizational Framework," subsection "Glen Canyon Dam Adaptive Management Program Defined," top of page 2, second bullet:

   - "The AMP evaluates how well the preferred alternative of the EIS/ROD and other management actions meet the goals of the GCPA and the mix of resource benefits in the EIS/ROD."

2. On the bottom of page 4, in the section "Adaptive Management Program Organizational Framework," subsection "Organizations and Positions With the Glen Canyon Dam Adaptive Management Program," under the heading "Adaptive Management Work Group," second set of bulleted items; change "Wyoming Interstate Streams Engineer" to "Wyoming State Engineer's Office."

3. Referred to the Ad Hoc Committee on Strategic Planning (AHCSP) the development of a process and timeline for the following, in order to complete the Strategic Plan: prioritization, MAs and INs, and identification of which MOs are in and which are out of the AMP. The AHCSP is to take its recommendation to the TWG before reporting to the AMWG at its next meeting.

4. Referred to the Ad Hoc Committee on Strategic Planning (AHCSP) consideration of the addition of a new Management Objective 7.3. Maintain suitable water quality in GCD releases to meet downstream Management Objectives. The AHCSP is to take its recommendation to the TWG before reporting to the AMWG at its next meeting.

5. Recommended to the Secretary of the Interior to accept the Strategic Plan (vision, mission, principles, goals, management objectives, qualitative targets, and narrative sections) with amendments approved at this meeting. (one abstention, no nay votes)

At its meeting in January 2003, the AMWG adopted these recommendations with no changes.

MEMORANDUM

TO: Members of the Glen Canyon Dam Adaptive Management Work Group (AMWG)

FROM: Members of the AMWG Ad Hoc Committee on What is In and Out of the AMP (AHCIO)
Randy Seaholm, Chair

Robert Begay	Wayne Cook	Kurt Dongoske	Lloyd Greiner
Norm Henderson	Pam Hyde	Phil Lehr	Don Metz
Clayton Palmer	Bill Persons	Randy Peterson	John Shields

CC: AMWG Alternates and interested parties

RE: Recommendation for action at your January meeting

At your April 25, 2002 meeting, you directed the formation of an ad hoc committee, the Ad Hoc Committee on What is In and Out of the AMP (AHCIO), to make a recommendation to you regarding criteria for MOs and INs determined inappropriate for the AMP.

1. The AHCIO recommends to you the adoption of the following criteria to use to determine whether an Information Need is inappropriate for inclusion in the AMP Strategic Plan. An Information Need is inappropriate for inclusion in the AMP Strategic Plan if:
   A. It contributes nothing to the accomplishment of the Vision and Mission of the AMP.
   B. It describes how an agency should develop information needed for the AMP, instead of describing information needed for the AMP. (Note: Some Information Needs may need to be re-written if this criterion is accepted by the AMWG.)

2. The AHCIO also recommends to you that each Information Need in the AMP Strategic Plan should eventually be placed into one of three categories:
   A. Information Needs that are appropriate for funding by power revenues and for accomplishment by the Grand Canyon Monitoring and Research Center (GCMRC).
   B. Information Needs that may be addressed by the GCMRC but are not appropriate for funding by power revenues.
   C. Information Needs that are funded and accomplished under the authority of an entity other than the GCMRC.

3. The AHCIO further recommends to you that if there are Information Needs that you decide are not appropriate for funding from power revenues, the proper role of the AMWG is:

A. To recommend to the Secretary of the Interior that particular Information Needs should be addressed by an agency or agencies under her purview, when that is the case, and

B. To assist any agency or agencies that should address the Information Needs to obtain appropriated dollars to fund that work.

4. The AHCIO further recommends that you:

   a. Ask the AHCIO to sort the Information Needs into the three categories listed above under #2, and test the Information Needs to see if any of them meet the criteria listed under #1, above; and

   b. Ask the TWG to review the results of that work and make a recommendation for action to the AMWG.

5. The AHCIO further recommends that you delete the RINs under MO 12.2 and RIN 6.5.4 from the Strategic Plan, and substitute a narrative. The Information Needs that would be deleted are as follows:

~~RIN 12.2.1 What is the most appropriate field sampling method(s) (e.g., sampling size, spatial and temporal distribution, analysis, explicit assumptions, limitations, and uncertainties) and statistical analysis to monitor the status and trends of resources targeted by management objectives?~~

~~RIN 12.2.2 What remote sensing technologies are available to less intrusively and more cost effectively monitor, characterize and map: (a) the aquatic food base, (b) fish, (c) fish habitat features, (d) Kanab ambersnail habitat, (e) water quality parameters, (f) bathymetry and associated substrates and (g) cultural sites?~~

~~RIN 12.2.3 What digital, or other, technologies exist and should be used to record field observations and spatially reference these data to facilitate their integration into GCMRC databases and use by PIs and stakeholders?~~

~~RIN 12.2.4 What historic data sets currently exist for all resources targeted by management objectives in the GCDAMP?~~

~~RIN 12.2.5 What remote sensing data are available or can be obtained that will support the production of a system-wide resource map?~~

~~RIN 12.2.6 What are the acceptable detection levels for change in Colorado River ecosystem resources? How should those levels most appropriately be determined and who should make the determinations?~~

~~RIN 12.2.7 How can GIS be used to designate and stratify habitats to improve system-wide extrapolation of population estimates and habitat in the Colorado River ecosystem?~~

~~RIN 12.2.8 Determine accurate, reliable, and standardized methods for measuring erosion at historic sites.~~

~~RIN 6.5.4 How can remote sensing assist in the development of a map of non-native species distributions in the Colorado River ecosystem including characterization of the types of habitat that supports non-native species?~~

The following substitute language would be insert under Management Objective 12.2 ("Attain or improve monitoring and research programs to achieve the appropriate scale and sampling design needed to support science-based adaptive management recommendations."):

<u>"This MO is intended to encourage continuous improvement in research and monitoring techniques to provide the AMP with the best available science. However, exploration of new techniques and methods should not come at the expense of long-term monitoring and resource protection.</u>

“Unlike the other Management Objectives, this MO reflects an ongoing need to consider new information regarding the most cost-effective and least intrusive techniques and methods available for monitoring and conducting research on the resources of the CRE. GCMRC seeks this information as part of its normal operations, using Protocol Evaluation Panels and other means."

Action Taken by AMWG on the AMP Strategic Plan

August 13-14, 2003 Meeting

On a vote of 18 yes, 1 no, and 1 abstention, the AMWG approved the following motion on August 13, 2003 regarding the attached report from the Ad Hoc Committee on What's In and Out of the Strategic Plan (AHCIO):

"Accept the recommendation and report of the AHCIO as a working document, change wording from "exploration of new techniques may not result in an RFP" to "exploration of new techniques and methods might not result in an RFP," under Goal 12, and assign Category C to RIN 2.6.1."

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Memo

To: Members of the Glen Canyon Dam Adaptive Management Program

From: Mary Orton

CC: AMWG alternates, TWG members and alternates, interested persons

Date: July 11, 2003

Re: Report from the Ad Hoc Committee on What's In and Out of the Strategic Plan (AHCIO)

Charge from the AMWG to the AHCIO
At your January 2003 meeting, you charged the Ad Hoc Committee on What's In and Out of the Strategic Plan (AHCIO) to do the following:

1. Apply the following criteria to determine whether an Information Need is inappropriate for inclusion in the AMP Strategic Plan. An Information Need is inappropriate for inclusion in the AMP Strategic Plan if:
   A. It contributes nothing to the accomplishment of the Vision and Mission of the AMP.
   B. It describes how an agency should develop information needed for the AMP, instead of describing information needed for the AMP. (Note: Some Information Needs may need to be re-written if this criterion is accepted by the AMWG.)
2. Place each Information Need in the AMP Strategic Plan into one of the three following categories:
   A. Information Needs that are appropriate for funding by power revenues and for accomplishment by the Grand Canyon Monitoring and Research Center (GCMRC).
   B. Information Needs that may be addressed by the GCMRC but are not appropriate for funding by power revenues.
   C. Information Needs that are funded and accomplished under the authority of an entity other than the GCMRC.

AHCIO Report
Attached is the latest version of the Final Draft Information Needs, updated June 25, 2003. The following changes have been made since the last time you saw it:

All the changes to the document that were approved by AMWG on January 28, 2003 have been incorporated. These were the deletion of the INs under MO 12.2, the deletion of RIN 6.5.4, and adding the narrative found under MO 12.2. These changes are not redlined. Note that you did not approve the INs or their sequence order at that meeting because you wanted to defer approval until the work of the AHCIO was complete.

- The redlining shows you the results of the work of the AHCIO. The proposed changes include a recommended new principle (on the page immediately following this memo), several recommended changes in wording of INs, and recommended categories for all but one Information Need.

The committee agreed on categories for all Information Needs but one, RIN 2.6.1. Following are the various reasons to support each choice of a category.

> *M.O. 2.6 Maintain (flannelmouth sucker, bluehead sucker and speckled dace) abundance and distribution in the Colorado River ecosystem below Glen Canyon Dam for viable populations.*
>
> *RIN 2.6.1 What is a viable population?*
> Reasons to support Category B or C for RIN 2.6.2 (by Randy Seaholm):
> In RIN 2.6.1, concerning what is a viable population, we are okay with the AMP, through the monitoring program, collecting certain data for use in helping to make an estimate of what a viable population is. However, once the information is collected, we are of the opinion that it is then the responsibility of the Arizona Fish and Game or the National Park Service if appropriate, to determine what the viable population value is. There are a number of ways to establish what a viable population is, again, we believe it is the responsibility of either Arizona Fish and Game or the National Park Service to describe the methodology that they believe is sufficient for determining what a viable population of any native fish species which is not endangered is. We are opposed to doing a full "Population Viability Analysis" absent a fully justified and demonstratable need for such. We understand that the AMP needs a value to use when it comes to setting targets, but it is not the responsibility of AMP to establish this value. Therefore, this is at least a Category B and likely a Category C task.
>
> Reasons to support Category A for RIN 2.6.1 (by Pam Hyde):
> The AMP has an interest in keeping native fish species in Grand Canyon off the endangered species list. And in fact, we wish to do more than that – we wish to maintain viable populations of these native species.
>
> Since these species are not listed, it is not the exclusive responsibility and jurisdiction of the U.S. Fish and Wildlife Service to recover these species, and, in the process, set recovery goals based on a determination of what constitutes a viable population. Other

agencies can do their own work and set their own levels for what they think constitutes viable populations of these native species. Arizona Game and Fish Department and the National Park Service each have management responsibility for wildlife within Grand Canyon National Park, so they would be the most logical agencies to make a determination of viable populations. However, neither agency has yet done so, and both are members of the AMWG, so by default it would be appropriate for GCMRC to do the work to determine what a viable population of each of these native fish species would be, so that we can monitor and manage the fish to maintain those viable populations. If AGFD and/or NPS choose to determine viable populations on their own, presumably the AMP would consider those determinations carefully in developing or reviewing its own determinations, just as we have indicated in the Strategic Plan that we will consider NPS plans in determining recreation targets.

We can reasonably assume that all fish species that use the mainstem are affected by operations of the dam, even if we have difficulty precisely quantifying what those effects are. There does not appear to be any disagreement on this point. Clearly there are other factors that affect the species, but we can't separate dam operations and other factors out as we address this RIN. When the ad hoc committee has come across this situation with other INs, we have gone by the unspoken rule that if dam operations are a factor, then it is appropriate to answer the IN through funding from power revenues, and placed the IN in Category A. Since we have the same case here, this RIN is *appropriate* for funding by power revenues, and should be placed into Category A. (Whether power revenues are used for specific monitoring and/or research projects that address this RIN can be determined as part of the GCMRC workplan review.)

There may be some concern that determining population viability will be difficult and costly to do. However, this has no bearing on what category this RIN should be placed in, but should be addressed at the stage at which GCMRC is developing workplans. When we place RINs into categories, we are determining whether or not they are *appropriate to be addressed by GCMRC* and whether they are *appropriate for funding by power revenues*. We are not addressing the scope of answering the RIN, nor are we deciding to spend unlimited funds to answer it.

Review by TWG

At your January 2003 meeting, you directed the TWG to review the results of the committee's work and make a recommendation for action to you. The TWG reviewed the report from the AHCIO on June 30, 2003 but did not make a recommendation for action to the AMWG. While TWG members did not raise any concerns about the edits to the Information Needs as recommended by the AHCIO, they did raise the following concerns:

1. Some questioned whether the Information Needs should be categorized at all, suggesting that nowhere in law or regulation is found the mandate that "other management actions" should be paid for with funds other than power revenues. In response, the Loveless guidance document was referenced. It was also noted that

the authorization to use power revenues for the AMP is discretionary in the Grand Canyon Protection Act.

2. It was noted that the document might be inconsistent in its categories, since power revenues are now paying for mechanical removal of non-native fish. In response, it was noted that there might not be a bright-line distinction between what is connected with dam operations and what is not.
3. There was discussion on RIN 2.2.1, referring to viable HBC spawning aggregations outside of the LCR in the CRE. The RIN reads, "What is a viable population and what is the appropriate method to assess population viability of native fish in the Colorado River ecosystem? What is an acceptable probability of extinction over what management time period for humpback chub throughout the Colorado River ecosystem?" This RIN is noted as "accomplished" in the AHCIO report. Some said the better question to be asked in the RIN might be, "What population of HBC is desired in the CRE?" Some TWG members felt that setting these numbers is under the purview of the Fish and Wildlife Service (FWS). Others felt that the AMP could set its own goal for HBC population, in concert with the FWS numbers.
4. The role of the AMP vis-à-vis HBC recovery was discussed. Some felt that the AMP is not responsible for recovery, but can contribute. Some felt that the AMP should manage for the minimum HBC levels set by the FWS, and others felt that the AMP should manage for a number that is higher than the minimum. It was clarified that the states' intent is downlisting or delisting of the species.

In addition to these questions, GCMRC staff also raised a question about the proposed new principle, which reads, "Understanding cause and effect relationships is essential for managing the Colorado River ecosystem. The adaptive management approach will be geared toward gaining an improved understanding of the cause and effect relationships that occur within the Colorado River ecosystem, and their connection, if any, to dam operations, while also documenting resource status and trends." This principle is proposed to replace RIN 12.3.3, which reads, "What are the best scientific methods to determine cause and effect relationships in experiments and other management actions conducted under the GCDAMP?" The concern about the change was that cause and effect relationships are difficult, if not impossible, to demonstrate in large-scale complex ecosystems. In addition, the focus on cause and effects relationships changes the emphasis of the RIN from utilization of best scientific methodology to emphasizing cause and effect relationships.

Questions

Please feel free to contact any member of the AHCIO or me if you have any questions. The members of the Committee are as follows:

Randy Seaholm, Chair

Robert Begay	Wayne Cook	Kurt Dongoske	Lloyd Greiner
Norm Henderson	Pam Hyde	Dennis Kubly	Phil Lehr
Don Metz	Clayton Palmer	Bill Persons	John Shields

Proposed new principle to replace "RIN 12.3.3 What are the best scientific methods to determine cause and effect relationships in experiments and other management actions conducted under the GCDAMP?"

PRINCIPLES

The ~~nine~~ ten principles of the Glen Canyon Dam Adaptive Management Program are:

1. The goals represent a set of desired outcomes that together will accomplish our vision and achieve the purpose of the Grand Canyon Protection Act. Some of the objectives and actions that fall under these goals may not be the responsibility of the Adaptive Management Program, and may be funded by other sources, but are included here for completeness.
2. The construction of Glen Canyon Dam and the introduction of non-native species have irreversibly changed the Colorado River ecosystem.
3. Much remains unknown about the Colorado River ecosystem below Glen Canyon Dam and how to achieve the Adaptive Management Program goals.
4. The Colorado River ecosystem is a managed ecosystem. An ecosystem management approach, in lieu of an issues, species, or resources approach, will guide our efforts. Management efforts will prevent any further human-induced extirpation or extinction of native species.
5. An adaptive management approach will be used to achieve Adaptive Management Program goals, through experimentation and monitoring, to meet the intent of the Grand Canyon Protection Act, Glen Canyon Dam Environmental Impact Statement, and the Record of Decision.
6. Understanding cause and effect relationships is essential for managing the Colorado River ecosystem. The adaptive management approach will be geared toward gaining an improved understanding of the cause and effect relationships that occur within the Colorado River ecosystem, and their connection, if any, to dam operations, while also documenting resource status and trends.

~~6.~~7. Dam operations and management actions will be tried that attempt to return ecosystem patterns and processes to their range of natural variability. When this is not appropriate, experiments will be conducted to test other approaches.

~~7.~~8. Because management actions to achieve a goal may benefit one resource or value and adversely affect another, those action alternatives that benefit all resources and values will be pursued first. When this is not possible, actions that have a neutral impact, or as a last resort, actions that minimize negative impacts on other resources, will be pursued consistent with the Glen Canyon Dam Environmental Impact Statement and the Record of Decision.

~~8.~~9. If the target of a management objective proves to be inappropriate, unrealistic, or unattainable, the Adaptive Management Program will reevaluate that target and the methods used to attain it.

~~9.~~10. Recognizing the diverse perspectives and spiritual values of the stakeholders, the unique aesthetic value of the Grand Canyon will be respected and enhanced.

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Glen Canyon Dam Adaptive Management Program
FINAL DRAFT INFORMATION NEEDS

November 7, 2002
Updated June 25, 2003 With Recommendations from the
Ad Hoc Committee on What's In and Out of the Strategic Plan (AHCIO)

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***NOTE from November 7, 2002**: This version of the draft Information Needs reflects recommended sequence order and changes developed by the TWG at their November 7, 2002 meeting. When approved by AMWG for recommendation to the Secretary of the Interior, the Information Needs and other information included in this document will be incorporated into the next version of the Strategic Plan.*

Core Monitoring INs are not sequenced because the core monitoring function is ongoing. EINs are not sequenced, with the exception of the two EINs that do not have a corresponding RIN: 11.3.1 and 11.3.2.

***NOTE from January 28, 2003**: This version of the Information Needs includes changes approved by AMWG at its January 2003 meeting. These were the deletion of all INs under MO 12.2, the deletion of RIN 6.5.4, and adding the narrative now found under MO 12.2. These changes are not redlined.*

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***NOTE from June 25, 2003:** This version of the Information Needs includes recommended changes from the Ad Hoc Committee on What's In and Out of the Strategic Plan (AHCIO). These include the addition of categories for each Information Need, per direction from AMWG at its January 2003 meeting, as well as some recommended changes to Information Needs. The recommended changes come in part from the application of the criteria for what should be included in the Strategic Plan, per direction from the AMWG from its January 2003 meeting. They also include amendments to the language under MO 12.2, and the moving of that language to immediately after Goal 12. These changes are redlined.*

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Introduction
The Information Needs (INs) provided in this document represent data needed to meet management objectives and programmatic goals. The Information Needs are nested within Management Objectives and are categorized as: core monitoring information needs (CMIN), effects monitoring information needs (EIN), or research information needs (RIN), defined below. In an effort to reflect integration across resource programs, some Information Needs are supporting information needs for other resources (SIN). Information Needs that do not fit under any particular management objective, but are necessary to achieve the goal are placed above the Management Objectives for that goal.

The process for developing these INs is described in Appendix 1.

Glossary

NOTE: Glossary entries that are already included in the Strategic Plan have been deleted. The glossary entries below should be added to the next version of the Strategic Plan.

Management Objectives (MOs): Management Objectives define desired future resource conditions. They should be: 1) Specific; 2) Measurable; 3) Achievable; 4) Results-oriented; 5) Time-specific, and 6) within the legal and policy framework of the Adaptive Management Program.

Information Needs (INs): Information Needs define the specific knowledge or understanding (i.e., information) one needs for accomplishing a management objective. They define what one needs to know. The information may be needed to:

a) quantify or define a management objective (i.e., help determine a target level);

b) assess whether or not a management objective is being achieved (i.e., help determine why the system is not responding as predicted);

c) develop basic understanding about cause and effect relationships;

d) meet the legal/policy requirements of consultation; and

e) test more effective ways to achieve desired resource conditions.

Information Needs are categorized as follows:

- Core Monitoring Information Need (CMIN): Core monitoring consists of consistent, long-term, repeated measurements using set protocols, and is designed to establish status and trends in meeting specific management objectives. Core monitoring is implemented on a fixed schedule regardless of variable factors or circumstances (e.g., water year, experimental flows, temperature control, stocking strategy, non-native control, etc.) affecting target resources.

- Effects Monitoring Information Need (EIN): Effects monitoring is the collection of data associated with an experiment performed under the Record of Decision, unanticipated event, or other management action. Changes in resource conditions measured by effects monitoring generally will be short-term responses. The purpose of effects monitoring is to supplement the fixed schedule and variables collected under core monitoring. This will both increase the understanding of the resource status and trends and provide a research opportunity to discover the effect of the experiment or management action.

- Research Information Need (RIN): Research can be descriptive or experimental. When descriptive it describes relationships in the Colorado River ecosystem (e.g., describe trophic interactions in the aquatic ecosystem). When experimental it tests specific hypotheses for determining and understanding

cause and effects relationships between dam operations, or other driving variables, and resource responses (e.g., how is the abundance and composition of benthic invertebrates affected by grazers, predators and dam operations?). Research requires a purposeful design with established statistical criteria, including allowable errors for accepting and rejecting null hypotheses. Research may also result in the collection of data that can be used to help determine or refine Core Monitoring Information Needs.

- Supporting Information Need (SIN): A SIN contributes to understanding the basis for a resource response and its link to other resource management goals.

- Status and Trends: Status refers to the condition of a resource at a given time or place. Trends refer to a statistically based temporal or spatial series for a given resource, during the periods and at the locations where data were collected.

- Cause and Effect: Cause and effect assigns a resource response to a particular event(s) or driving variable(s).

- Glen Canyon Dam Operations: Glen Canyon Dam operations refers to the operation of the power plant and other release structures, such as bypass structures, spillways, and potentially a temperature control device among others. Their uses conform to applicable law. The AMWG develops recommendations for all of the dam's structures to further the purposes of the GCPA and meet the environmental commitments in the EIS/Record of Decision on the operations of Glen Canyon Dam. This is done within the limits of the Record of Decision and/or through experimentation.

- Record of Decision Operations: Record of Decision operations are defined as the modified low fluctuating flow alternative described in the Record of Decision including restrictions on upramp and downramp rates, the allowable range of daily fluctuations and the allowable minimum and maximum daily flows. In addition operations include beach/habitat-building flows (up to 45,000 cfs) habitat maintenance flows (up to power plant capacity) and any flows defined as experiments within the environmental commitments of the Record of Decision.

NOTE: *The MOs presented in this document represent language that has been extracted and paraphrased from the original MOs table. It is included here to provide a context for reviewing the INs without having to embed them in the original Goals and MOs table. In the next version of the Strategic Plan, approved Information Needs and their sequence order will be incorporated into the MOs table.*

Key to Categories, as approved by AMWG January 2003:

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Category A: Information Needs that are appropriate for funding by power revenues and for accomplishment by the Grand Canyon Monitoring and Research Center (GCMRC).

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Category B: Information Needs that may be addressed by the GCMRC but are not appropriate for funding by power revenues.

Category C: Information Needs that are funded and accomplished under the authority of an entity other than the GCMRC.

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Goal 1. Protect or improve the aquatic foodbase so that it will support viable populations of desired species at higher trophic levels.

Sequence Order	Category	Research INs
4	A	**RIN 1.1** What are the fundamental trophic interactions in the aquatic ecosystem?
5	A	**RIN 1.2** How are the production, composition, density, and biomass of the benthic invertebrate community affected by primary productivity vs. allochthonous inputs?
5	A	**RIN 1.3** What foodbase criteria do other agencies use to assess aquatic ecosystem health?
4	A	**RIN 1.4** What is the current carbon budget for the Colorado River ecosystem?

M.O. 1.1 Maintain or attain primary producers (algae, macrophytes) biomass and community composition in the Glen Canyon Reach.

Category	Core Monitoring INs
A	**CMIN 1.1.1** Determine and track the composition and biomass of primary producers between Glen Canyon Dam and the Paria River in conjunction with measurements of flow, nutrients, water temperature, and light regime.

Sequence Order	Category	Research INs
5	A	**RIN 1.1.1** How are the composition and biomass of primary producers between Glen Canyon Dam and the Paria River affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors.
9	A	**RIN 1.1.2** What is the estimated productivity for the reach between Glen Canyon Dam and the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]
6	A	**RIN 1.1.3** How do top-down effects (grazing and predation) on primary producers affect food base productivity?
5	A	**RIN 1.1.4** What are the habitat characteristics between Glen Canyon Dam and the Paria River that most affect primary productivity? How are these characteristics affected by Glen

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Canyon Dam operations?

Category	Effects INs
A	**EIN 1.1.1** How does primary productivity for the reach between Glen Canyon Dam and the Paria River change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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M.O. 1.2 Maintain or attain benthic invertebrates biomass and community composition in the Glen Canyon Reach.

Category	Core Monitoring INs
A	**CMIN 1.2.1** Determine and track the composition and biomass of benthic invertebrates in the reach between Glen Canyon Dam and the Paria River in conjunction with measurements of flow, nutrients, water temperature, and light regime.

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Sequence Order	Category	Research INs
5	A	**RIN 1.2.1** How are the composition and biomass of benthic invertebrates between Glen Canyon Dam and the Paria River affected by flow, water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), new invasive species, and water borne diseases, or other factors?
5	A	**RIN 1.2.2** What is the estimated productivity of benthic invertebrates for the reach between Glen Canyon Dam and the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]
6	A	**RIN 1.2.3** How do top-down effects (grazing and predation) affect the abundance and composition of benthic invertebrates?
5.5	A	**RIN 1.2.4** What are the habitat characteristics between Glen Canyon Dam and the Paria River that most affect benthic invertebrates? How are these characteristics affected by Glen Canyon Dam operations?

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Category	Effects INs
A	**EIN 1.2.1** How do benthic invertebrates in the reach between Glen Canyon Dam and the Paria River change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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M.O. 1.3 Maintain or attain adequate levels of energy sources (algae, macrophytes) in the Colorado River ecosystem (to the extent primary producers in the tributaries are influenced by dam operations) below the Paria River.

Category	Core Monitoring INs
A	**CMIN 1.3.1** Determine and track the composition and biomass of primary producers in the Colorado River ecosystem below the Paria River.

Sequence Order	Category	Research INs
5.5	A	**RIN 1.3.1** How are the composition and biomass of primary producers in the Colorado River ecosystem below the Paria River affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors.
8	A	**RIN 1.3.2** What is the estimated primary productivity in the Colorado River ecosystem below the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]
6	A	**RIN 1.3.3** How do top-down effects on primary producers (grazing and predation) affect food base productivity?
6	A	**RIN 1.3.4** What are the habitat characteristics in the Colorado River ecosystem below the Paria River that most affect primary productivity? How are these characteristics affected by Glen Canyon Dam operations?

Category	Effects INs
A	**EIN 1.3.1** How does primary productivity in the Colorado River ecosystem below the Paria River change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 1.4 Maintain or attain benthic invertebrates biomass and community composition in the Colorado River ecosystem (to the extent benthic invertebrates in the tributaries are influenced by dam operations) below the Paria River.

Category	Core Monitoring INs
A	**CMIN 1.4.1** Determine and track the composition and biomass of benthic invertebrates in the Colorado River ecosystem below the Paria River in conjunction with measurements of flow, nutrients, water temperature, and light regime.

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Sequence Order	Category	Research INs
5	A	**RIN 1.4.1** How are the composition and biomass of benthic invertebrates in the Colorado River ecosystem below the Paria River affected by flow, water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), new invasive species, and water borne diseases, or other factors? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]
8	A	**RIN 1.4.2** What is the estimated productivity of benthic invertebrates in the Colorado River ecosystem below the Paria River? [Note: If the cost of obtaining this data, relative to the benefit of the information suggests the information is not worth the expense, this RIN will not be pursued.]
5.5	A	**RIN 1.4.3** How do top-down effects (grazing and predation) affect the abundance and composition of benthic invertebrates?
6	A	**RIN 1.4.4** What are the habitat characteristics in the Colorado River ecosystem below the Paria River that most affect benthic invertebrates? How are these characteristics affected by Glen Canyon Dam operations?
	Category	Effects INs
	A	**EIN 1.4.1** How do benthic invertebrates in the Colorado River ecosystem below the Paria River change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 1.5 Maintain or attain drift (Diptera, CPOM, FPOM, DOC) in the mainstem and tributaries (to the extent drift in the tributaries is influenced by dam operations).

	Category	Core Monitoring INs
	A	**CMIN 1.5.1** Determine and track the composition and biomass of drift in the Colorado River ecosystem.

Sequence Order	Category	Research INs
5.5	A	**RIN 1.5.1** How are the composition and biomass of drift in the Colorado River ecosystem affected by flow and water quality (including nutrients, temperature, light regime, toxins, dissolved oxygen), and water borne diseases, or other factors?
5	A	**RIN 1.5.2** How do top-down effects (grazing and predation)

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affect the abundance and composition of drift?

3 A **RIN 1.5.3** How has the value and availability of drift as a food source for Humpback chub changed with the implementation of Record of Decision operations?

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Category Effects INs

A **EIN 1.5.1** How does drift in the Colorado River ecosystem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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Goal 2. Maintain or attain viable populations of existing native fish, remove jeopardy for humpback chub and razorback sucker, and prevent adverse modification to their critical habitats.

M.O. 2.1 Maintain or attain humpback chub abundance and year-class strength in the LCR and other aggregations at appropriate target levels for viable populations and to remove jeopardy.

	Category	Core Monitoring INs
	A	**CMIN 2.1.1** Determine and track year class strength of HBC between 51 – 150 mm in the LCR and the mainstem.
	A	**CMIN 2.1.2** Determine and track abundance and distribution of all size classes of HBC in the LCR and the mainstem.

Sequence Order	Category	Research INs
2.5	Accomp-lished	**RIN 2.1.1** What is the minimum population size of HBC that should be sustained in the LCR, to ensure a viable spawning population of HBC in the LCR?
1	A	**RIN 2.1.2** Quantify sources of mortality for humpback chub < 51 mm in rearing habitats in the LCR and mainstem and how these sources of mortality are related to dam operations.
1.5	A	**RIN 2.1.3** What is the relationship between size of HBC and mortality in the LCR and the mainstem? What are the sources of mortality (i.e., predation, cannibalism, other) in the LCR and the mainstem?
2	A	**RIN 2.1.4** What habitats enhance recruitment of native fish in the LCR and mainstem? What are the physical and biological characteristics of those habitats?
2	A	**RIN 2.1.5** Determine the timing and quantity of young-of-year humpback chub dispersal (passive and active) from the LCR.

Category	Effects INs
A	**EIN 2.1.1** How does the abundance and distribution of all size classes of HBC in the LCR and mainstem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?
A	**EIN 2.1.2** How does the year class strength of HBC (51 – 150 mm) in the LCR and mainstem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?
A	**EIN 2.1.3** How does the abundance and distribution of recruiting HBC in the LCR and mainstem change in response to an experiment performed under the Record of Decision,

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unanticipated event, or other management action?

M.O. 2.2 Sustain or establish viable HBC spawning aggregations outside of the LCR in the Colorado River ecosystem below Glen Canyon Dam to remove jeopardy.

Sequence Order	Category	Research INs
3.5	Accomp-lished	**RIN 2.2.1** What is a viable population and what is the appropriate method to assess population viability of native fish in the Colorado River ecosystem? What is an acceptable probability of extinction over what management time period for humpback chub throughout the Colorado River ecosystem?
4	A	**RIN 2.2.2** Determine if a population dynamics model can effectively predict ~~viability~~ response of native fish under different flow regimes and environmental conditions.
2	C	**RIN 2.2.3** What are the measurable criteria that need to be met in order to remove jeopardy for humpback chub in the Colorado River ecosystem?
2.5	A	**RIN 2.2.4** What is the relationship between the "aggregations" in the mainstem and LCR? Are mainstem aggregations "sinks" of the LCR? Are aggregations real or due to sampling bias?
2	A	**RIN 2.2.5** What are the appropriate habitat conditions for HBC spawning? Where are these found? Can they be created in the mainstem?
4	A[1]	**RIN 2.2.6** What are the criteria for establishment of spawning aggregations (i.e., how does one determine ~~its~~ if it is "established")?
3	A	**RIN 2.2.7** Determine if implementation and operation of the TCD and/or steady flows represent a technically feasible, ecologically sustainable, and practical option for establishing mainstem spawning.
2	A	**RIN 2.2.8** What combination of dam release patterns and non-native fish control facilitates successful spawning and recruitment of humpback chub in the Colorado River ecosystem?
2	A	**RIN 2.2.9** What is the appropriate role of humpback chub augmentation as a management strategy to establish mainstem spawning aggregations?

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[1] Normally, this RIN would be placed in Category C. However, pursuant to the 2001 Department of the Interior Appropriations Bill that established the power revenue cap, this RIN is placed in Category A.

3	A	**RIN 2.2.10** What techniques are available to determine natal stream of fishes in the Colorado River ecosystem?
6	A	**RIN 2.2.11** What are the impacts of current recreational activities on mortality, recruitment and the population size of humpback chub?
3	A	**RIN 2.2.12** What are the impacts of research activities on mortality, recruitment and the population size of humpback chub?

M.O. 2.3 Monitor HBC and other native fish condition and disease/parasite numbers in LCR and other aggregations at an appropriate target level for viable populations and to remove jeopardy.

	Category	Core Monitoring INs
	A	**CMIN 2.3.1** Determine and track the parasite loads on HBC and other native fish found in the LCR and in the Colorado River ecosystem.
	A	**CMIN 2.3.2** Determine and track status and trends in the condition (Kn or Wr) of HBC and other native fish found in the LCR and in the Colorado River ecosystem?

Sequence Order	Category	Research INs
3	A	**RIN 2.3.1** How do parasite/disease loads affect population viability?
2	A	**RIN 2.3.2** How will warming mainstem temperatures affect the abundance and distribution of parasites/disease?
3.5	A	**RIN 2.3.3** How does non-native fish control affect disease/parasite loads? [Note: The concept is if there are fewer hosts, there will be a lower incidence of parasites.]
	Category	Effects Monitoring INs
	A	**EIN 2.3.1** How do disease/parasite loads on HBC and other native fish found in the LCR and in the Colorado River ecosystem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 2.4 Reduce native fish mortality due to non-native fish predation/competition as a percentage of overall mortality in the LCR and mainstem to increase native fish recruitment.

	Category	Core Monitoring INs
	A	**CMIN 2.4.1** Determine and track the abundance and

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distribution of non-native predatory fish species in the Colorado River ecosystem and their impacts on native fish.

Sequence Order	Category	Research INs
2	A	**RIN 2.4.1** What are the most effective strategies and control methods to limit non-native fish predation and competition on native fish?
2.5	A	**RIN 2.4.2** Determine if suppression of non-native predators and competitors increases native fish populations?
2	A	**RIN 2.4.3** To what degree, which species, and where in the system are exotic fish a detriment to the existence of native fish through predation or competition?
3	A	**RIN 2.4.4** What are the target population levels, body size and age structure for non-native fish in the Colorado River ecosystem that limit their levels to those commensurate with the viability of native fish populations?
3	A	**RIN 2.4.5** What are the sources (natal stream) of nonnative predators and competitors?
2.5	A	**RIN 2.4.6** What are the population dynamics of those non-native fish that are the major predators and competitors of native fish?
	Category	Effects Monitoring INs
	A	**EIN 2.4.1** How does the abundance and distribution of non-native predatory fish species and their impacts on native fish species in the Colorado River ecosystem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 2.5 Attain Razorback sucker abundance and critical habitat condition sufficient to remove jeopardy as feasible and advisable in the Colorado River ecosystem below Glen Canyon Dam.

Sequence Order	Category	Research INs
11	A	**RIN 2.5.1** If razorback suckers were stocked into the Colorado River ecosystem, what is the risk that hybridization with flannelmouth suckers would compromise the genetic integrity of either species?
11	A	**RIN 2.5.2** How does existing hybridization between razorback suckers and flannelmouth suckers affect the genetic integrity of either species? What are the factors contributing to this ongoing hybridization?

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4.5	A	**RIN 2.5.3** What characteristics define suitable habitat for razorback sucker? Does suitable habitat for razorback sucker occur in the Colorado River ecosystem?
8	A	**RIN 2.5.4** What is the feasibility and advisability of augmenting razorback sucker in the Colorado River ecosystem to attain a viable population including technical/legal/policy constraints?
9	A	**RIN 2.5.5** What are the genetic and ecological criteria for reintroducing razorback sucker into the Colorado River ecosystem?
11	C	**RIN 2.5.6** What are the measurable criteria that would need to be met to remove jeopardy for razorback sucker in the Colorado River ecosystem?

M.O. 2.6 Maintain (flannelmouth sucker, bluehead sucker and speckled dace) abundance and distribution in the Colorado River ecosystem below Glen Canyon Dam for viable populations.

Category	Core Monitoring INs
A	**CMIN 2.6.1** Determine and track the abundance and distribution of flannelmouth sucker, bluehead sucker, and speckled dace populations in the Colorado River ecosystem.

Sequence Order	Category	Research INs
2		**RIN 2.6.1** What is a viable population?
2	A	**RIN 2.6.2** What are the significant threats to these species? ~~What is the probability of extinction over what management time period for species of concern? What is the appropriate method to assess viability?~~
6	A	**RIN 2.6.3~~2~~** What are the physical and biological characteristics of habitats that enhance recruitment of flannelmouth sucker, bluehead sucker, and speckled dace populations in the Colorado River ecosystem?
4.5	A	**RIN 2.6.4~~3~~** What is the age structure, including relationship between age and size of flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem?
4	A	**RIN 2.6.5~~4~~** How are movement patterns for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem affected by age, natal stream, and dam operations?
4	A	**RIN 2.6.6~~5~~** How is the rate of mortality for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado

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River ecosystem related to individual body size? What are the sources of mortality for flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem?

5 A **RIN 2.6.76** How does temperature modification in the mainstem affect recruitment and mortality for flannelmouth sucker, bluehead sucker, and speckled dace originating from tributary spawning efforts?

Category Effects Monitoring INs

A **EIN 2.6.1** How does the abundance, distribution, recruitment and mortality of flannelmouth sucker, bluehead sucker and speckled dace populations in the Colorado River ecosystem change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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Goal 3. Restore populations of extirpated species, as feasible and advisable.

M.O. 3.1 Restore Colorado pikeminnow, bonytail, and roundtail chub and river otter abundances in the Colorado River ecosystem as feasible and advisable.

Sequence Order	Category	Research INs
9.5	C	**RIN 3.1.1** What information (including technical, legal, economic, and policy issues) should be considered in determining the feasibility and advisability of restoring pikeminnow, bonytail, roundtail chub, river otter, or other extirpated species?

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Goal 4. Maintain a wild reproducing population of rainbow trout above the Paria River, to the extent practicable and consistent with the maintenance of viable populations of native fish.

M.O. 4.1 Maintain or attain RBT abundance, proportional stock density, length at age, condition, spawning habitat, natural recruitment and prevent or control whirling disease and other parasitic infections.

Category	Core Monitoring INs
A	**CMIN 4.1.1** Determine annual population estimates for age II+ rainbow trout in the Lees Ferry reach.
A	**CMIN 4.1.2** Determine annual proportional stock density of rainbow trout in the Lees Ferry reach.
A	**CMIN 4.1.3** Determine annual rainbow trout growth rate in the Lees Ferry reach**.**
A	**CMIN 4.1.4** Determine annual standard condition (Kn) and Relative weight of rainbow trout in the Lees Ferry reach**.**
A	**CMIN 4.1.5** Determine if whirling disease is present in the Lees Ferry reach. Determine annual incidence and relative infestation of trout nematodes in rainbow trout in the Lees Ferry reach.
A	**CMIN 4.1.6** Determine quantity and quality of spawning habitat for rainbow trout in the Lees Ferry reach as measured at 5-year intervals.
A	**CMIN 4.1.7** Determine annual percentage of naturally recruited rainbow trout in the Lees Ferry reach**.**

Sequence Order	Category	Research INs
10	A	**RIN 4.1.1** What is the target proportional stock density (i.e., trade-off between numbers and size) for rainbow trout in the Lees Ferry reach?
9	A	**RIN 4.1.2** What is the minimum quantity and quality of spawning substrate necessary for maintaining a wild reproducing rainbow trout population in the Lees Ferry reach?
4.5	A	**RIN 4.1.3** To what extent is there overlap in the Lees Ferry reach of RBT habitat and native fish habitat?
10	A	**RIN 4.1.4** How does the genetics or "strain" of rainbow trout in the Lees Ferry reach influence the average size of fish creeled by anglers?

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Category	Effects Monitoring INs
A	**EIN 4.1.1** How does RBT abundance, proportional stock density, length at age, condition, spawning habitat, natural recruitment, whirling disease and other parasitic infections change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 4.2 Limit Lees Ferry RBT distribution below the Paria River of the Colorado River ecosystem to reduce competition or predation on downstream native fish.

Sequence Order	Category	Research INs
2.5	A	**RIN 4.2.1** What is the rate of emigration of rainbow trout from the Lees Ferry reach?
2.5	A	**RIN 4.2.2** What is the most effective method to detect emigration of rainbow trout from the Lees Ferry reach?
4.5	A	**RIN 4.2.3** How is the rate of emigration of RBT from the Lees Ferry reach to below the Paria River affected by abundance, hydrology, temperature, and other ecosystem processes?
5.5	A	**RIN 4.2.4** What is the target population size of RBT appropriate for the Lees Ferry reach that limits downstream emigration?
4.5	A	**RIN 4.2.5** To what extent is there overlap in the Colorado River ecosystem below the Paria River of RBT habitat and native fish habitat?
2	A	**RIN 4.2.6** To what extent are RBT below the Paria River predators of native fish, primarily HBC? At what size do they become predators of native fish, especially HBC, i.e. how do the trophic interactions between RBT and native fish change with size of fish?
3.5	A	**RIN 4.2.7** What dam release patterns most effectively maintain the LEES Ferry RBT trophy fishery wile limiting RBT survival below the Paria River?

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Goal 5. Maintain or attain viable populations of Kanab ambersnail.

MO 5.1 Attain and maintain Kanab ambersnail population at Vasey's Paradise from the current level to the target level.

Category	Core Monitoring INs
A	**CMIN 5.1.1** Determine and track the abundance and distribution of Kanab ambersnail at Vasey's Paradise in the lower zone (below 100,000 cfs) and the upper zone (above 100,000 cfs).

Sequence Order	Category	Research INs
6.5	A	**RIN 5.1.1** What constitutes population viability for Kanab ambersnail at Vasey's Paradise?
5	A	**RIN 5.1.2** What parameters have the greatest influence on population viability of Kanab ambersnail at Vasey's Paradise (e.g., parasites, predation, discharges, habitat size, quality, and human use/visitation)?
5	A	**RIN 5.1.3** Develop a population dynamic model to predict Kanab ambersnail viability under different flows and environmental conditions.
4	A	**RIN 5.1.4** Identify and evaluate alternative Management Actions to ensure viability of Kanab ambersnail at Vasey's Paradise where (1) the population dynamic model predicts loss of population viability, or (2) monitoring discovers substantial habitat or Kanab ambersnail population declines.
2.5	C	**RIN 5.1.5** What is the taxonomic identity of the *Oxyloma* snails at Vasey's Paradise? Is a change to the existing taxonomic status warranted?
2.5	C	**RIN 5.1.6** What is the range of occurrence of the ambersnail taxon found at Vasey's Paradise? [NOTE: Intended to address the issue of whether this is an endemic population or a relict population or part of a metapopulation.]
9	C	**RIN 5.1.7** What is the historic range of Oxyloma haydeni? Can this range be determined from subfossil or fossil evidence? [NOTE: This is intended to determine if this is a relict species and the initial work would be done at Vasey's Paradise, South Canyon and other probable sites within the Colorado River ecosystem.]
4	A	**RIN 5.1.8** What are the measurable criteria that need to be met to remove jeopardy for Kanab ambersnail at Vasey's Paradise?
3	A	**RIN 5.1.9** How can incidental take for Kanab ambersnail at

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Vasey's Paradise be minimized?

	Category	Effects Monitoring INs
	A	**EIN 5.1.1** How does Kanab ambersnail population abundance and recovery change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

MO 5.2 Maintain Kanab ambersnail habitat at Vasey's Paradise from the current level to the target level.

	Category	Core Monitoring INs
	A	**CMIN 5.2.1** Determine and track the size and composition of the habitat used by Kanab ambersnail at Vasey's Paradise.
Sequence Order	Category	Research INs
5	A	**RIN 5.2.1** How does the size, quality, and recovery time of Kanab ambersnail habitat change following natural scours, or other events?
2	A	**RIN 5.2.2** How does the size and quality of the habitat used by Kanab ambersnail change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?
6.5	A	**RIN 5.2.3** How can remote sensing technologies be used to less intrusively and more cost effectively characterize and monitor Kanab ambersnail habitat at Vasey's Paradise (vegetation type and distribution)?
	Category	Effects INs
	A	**EIN 5.2.1** How does Kanab ambersnail habitat at Vasey's Paradise change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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Goal 6. Protect or improve the biotic riparian and spring communities within the Colorado River ecosystem, including threatened and endangered species and their critical habitat.

Sequence Order	Category	Information Needs
6	A	**IN 6.1** Develop GIS coverages of natural communities in the Colorado River ecosystem to use in identification of status and trends.
6.5	A	**IN 6.2** Develop or adopt an existing ecological community classification system. The system should describe the composition and frequency of vascular plants, vertebrates, arthropods, and mollusks to an appropriate taxonomic level.
6	A	**IN 6.3** How is the abundance of vertebrate consumers affected by seasonal shifts in food base abundance in the Colorado River ecosystem?
5	A	**IN 6.4** How much allochthonous material (e.g., leaf litter) is exchanged between the terrestrial and aquatic systems?

M.O. 6.1 Maintain marsh community abundance, composition, and area in the Colorado River ecosystem in such a manner that native species are not lost.

	Category	Core Monitoring INs
	A	**CMIN 6.1.1** Determine and track the abundance, composition, distribution, and area of the marsh community as measured at 5-year or other appropriate intervals based on life cycles of the species and rates of change for the community.

Sequence Order	Category	Research INs
5	A	**RIN 6.1.1** How has the abundance, composition, distribution, and area of the marsh community changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)?

	Category	Effects INs
	A	**EIN 6.1.1** How do marsh community abundance, composition, distribution, and area change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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M.O. 6.2 Maintain NHWZ community patch number and distribution, composition and area to be no lower than values estimated for 1984.

	Category	Core Monitoring INs
	A	**CMIN 6.2.1** Determine and track the patch number, patch distribution, composition and area of the NHWZ community as measured at 5-year or other appropriate intervals based on life cycles of the species and rates of change for the community.

Sequence Order	Category	Research INs
4.5	A	**RIN 6.2.1** How has the patch number, patch distribution, composition and area of the NHWZ community changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)?

	Category	Effects INs
	A	**EIN 6.2.1** How does the patch number, patch distribution, composition and area of the NHWZ community change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 6.3 Maintain OHWZ community abundance, composition, and distribution in the Colorado River ecosystem.

	Category	Core Monitoring INs
	A	**CMIN 6.3.1** Determine and track the abundance, composition and distribution of the OHWZ community as measured at 5-year or other appropriate intervals based on life cycles of the species and rates of change for the community.

Sequence Order	Category	Research INs
5.5	A	**RIN 6.3.1** How has the abundance, composition, and distribution of the OHWZ community changed since dam closure (1963), high flows (1984), interim flows (1991), and the implementation of Record of Decision operations (1996)?
5	A or B	**RIN 6.3.2** What dam operations (Category A), or other management actions (Category B), have the potential to maintain the OHWZ community at the current stage elevation, or establish the community at a lower stage elevation?

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Category	Effects INs
A	**EIN 6.3.1** How do the abundance, composition, and distribution of the OHWZ community change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 6.4 Maintain sand beach community abundance, composition, and distribution in the Colorado River ecosystem at the target level.

Category	Core Monitoring INs
A	**CMIN 6.4.1** Determine and track composition, abundance, and distribution of the sand beach community as measured at 5-year or other appropriate intervals based on life cycles of the species and rates of change for the community.

Sequence Order	Category	Research INs
4	A	**RIN 6.4.1** How has the abundance, composition, and distribution of the sand beach community changed since dam closure (1963), high flows (1984), interim flows (1991), and the implementation of Record of Decision operations (1996)?

Category	Effects INs
A	**EIN 6.4.1** How does the abundance, composition, and distribution of the sand beach community change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 6.5 Reduce invasive non-native species abundance and distribution.

Category	Core Monitoring INs
A	**CMIN 6.5.1** Determine and track the distribution and abundance of non-native species in the Colorado River ecosystem as measured at 5-year or other appropriate intervals based on life cycles of the species and rates of change for the community.

Sequence Order	Category	Research INs
4.5	A	**RIN 6.5.1** Determine if non-native species are expanding or contracting at a local scale (patch or reach).
5	A or B	**RIN 6.5.2** What dam operations (Category A), or other management actions (Category B), have the potential to increase or decrease the distribution and abundance of non-native species?

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4	A	**RIN 6.5.3** How has the abundance and distribution of non-native species changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)?
	Category	Effects INs
	A	**EIN 6.5.1** How does the abundance and distribution of non-native species change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 6.6 Maintain seep and spring habitat in the Colorado River ecosystem.

	Category	Core Monitoring INs
	A	**CMIN 6.6.1** Determine and track the composition, abundance, and distribution of seep and spring communities as measured at 5-year or other appropriate intervals based on life cycles of the species and rates of change for the community.

Sequence Order	Category	Research INs
9	A	**RIN 6.6.1** How is seep and spring habitat affected by variation in dam operations, variation in seep or spring flow, and variation in water quality? How do flow rates and water quality parameters at seeps and springs compare with historic measurements?
5	A	**RIN 6.6.2** Which seeps and springs are culturally important or occupied by rare and endemic species?
8.5	A	**RIN 6.6.3** How has the composition, abundance and distribution of seep and spring communities changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)?
9	A	**RIN 6.6.4** What is the distribution, patch size, total area, and composition of seep and spring communities and the flow rate and water quality of all seeps and springs within the Colorado River ecosystem?
	Category	Effects INs
	A	**EIN 6.6.1** How do the composition, abundance, and distribution of seep and spring communities change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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M.O. 6.7 Maintain riparian habitat in the Colorado River ecosystem capable of supporting Southwest willow flycatcher.

	Category	Core Monitoring INs
	A	**CMIN 6.7.1** Determine and track the abundance, distribution, and reproductive success of southwestern willow flycatcher in the Colorado River ecosystem?

Sequence Order	Category	Research INs
8	A	**RIN 6.7.1** What is the function of the Colorado River ecosystem as a migratory corridor for southwestern willow flycatcher?
8	A	**RIN 6.7.2** What is the foodbase that supports southwestern willow flycatcher and other terrestrial vertebrates?
8	Accomp-lished	**RIN 6.7.3** What constitutes suitable southwestern willow flycatcher habitat?
9	A	**RIN 6.7.4** How has the abundance, distribution and reproductive success of southwestern willow flycatcher changed since dam closure (1963), high flows (1984), interim flows (1991) and the implementation of Record of Decision operations (1996)?
5.5	A	**RIN 6.7.5** What is the need, feasibility, and priority of maintaining habitat suitability for southwestern willow flycatcher in the Colorado River ecosystem?

	Category	Effects INs
	A	**EIN 6.7.1** How do the abundance, distribution and reproductive success of southwestern willow flycatcher change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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Goal 7. Establish water temperature, quality and flow dynamics to achieve GCDAMP ecosystem goals.

M.O. 7.1 Attain water temperature ranges and seasonal variability in the mainstem necessary to maintain or attain desired levels of desirable biological resources (e.g., native fish, foodbase and trout).

Category	Core Monitoring INs
A	**CMIN 7.1.1** Determine the water temperature dynamics in the mainstem, tributaries (as appropriate), backwaters, and near-shore areas throughout the Colorado River ecosystem.
A	**CMIN 7.1.2** Determine and track LCR discharge near mouth (below springs).

Sequence Order	Category	Research INs
5	A	**RIN 7.1.1** What are the desired ranges of spatial and temporal patterns of water temperatures for the Colorado River ecosystem?
4	A	**RIN 7.1.2** What are the most likely downstream temperature responses to a variety of scenarios involving a TCD on Glen Canyon Dam?
3	A	**RIN 7.1.3** What are the potential ecological effects of increasing mainstem water temperatures?

Category	Effects INs
A	**EIN 7.1.1** How does water temperature change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 7.2 Maintain water quality in the mainstem of the Colorado River ecosystem.

Category	Core Monitoring INs
A	**CMIN 7.2.1** Determine the seasonal and yearly trends in turbidity, water temperature, conductivity, DO, and pH, (decide below whether selenium is important) changes in the mainstem throughout the Colorado River ecosystem?

Sequence Order	Category	Research INs
5	A	**RIN 7.2.1** Which major ions should be measured? Where and how often?
5	A	**RIN 7.2.2** Which nutrients should be measured? Where and how often?

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4	A	**RIN 7.2.3** Which metals should be measured? Where and how often?
6.5	A	**RIN 7.2.4** What are the water-borne pathogens that are a threat to human health? How should they be monitored? Where and how often?

Sequence Order	Category	Supporting INs
5	A	**SIN 7.2.1** How do the hydrodynamics and stratification of Lake Powell influence the food base or fisheries downstream?
4.5	A	**SIN 7.2.2** Which water quality variables influence food base and fisheries in the Colorado River ecosystem?

Proposed New M.O. 7.3 Maintain suitable quality of water in Glen Canyon Dam releases to meet downstream management objectives.

	Category	Core Monitoring INs
	A	**CMIN** 7.3.1 What are the status and trends of water quality releases from Glen Canyon Dam?

Sequence Order	Category	Research INs
5	A	**RIN 7.3.1** Develop simulation models for Lake Powell and the Colorado River to predict water quality conditions under various operating scenarios, supplant monitoring efforts, and elucidate understanding of the effects of dam operations, climate, and basin hydrology on Colorado River water quality.
7.5	A	**7.3.1.a** Determine the status and trends of chemical and biological components of water quality in Lake Powell as a function of regional hydrologic conditions and their relation to downstream releases.
11.5	A	**7.3.1.b** Determine stratification, convective mixing patterns, and behavior of advective currents in Lake Powell and their relation to Glen Canyon Dam operations to predict seasonal patterns and trends in downstream releases.
11	A	**RIN 7.3.2** How accurately can modeling predict reservoir dynamics and operational scenarios?
9	A	**RIN 7.3.3** How do dam operations affect reservoir limnology?

Sequence Order	Category	Supporting INs
6	A	**SIN 7.3.1** Measure appropriate water quality parameters to determine the influence of these parameters on biological resources in the Colorado River ecosystem.

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	Category	Effects INs
	A	**EIN 7.3.1** How does the water quality of releases from Glen Canyon Dam change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 7.4 Maintain flow dynamics associated with power plant operations, BHBF and habitat maintenance flows.

	Category	Core Monitoring INs
	A	**CMIN 7.4.1** Determine and track releases from Glen Canyon Dam under all operating conditions.
	A	**CMIN 7.4.2** Determine and track flow releases from Glen Canyon Dam, particularly related to flow duration, upramp, and downramp conditions.

Sequence Order	Category	Research INs
11.5	A	**RIN 7.4.1** What is the desired range of seasonal and annual flow dynamics associated with powerplant operations, BHBFs, and habitat maintenance flows, or other flows that meet AMP goals and objectives?
5	A	**RIN 7.4.2** What is the desired pattern of seasonal and annual flow dynamics associated with powerplant operations, BHBFs, HMFs, or other flows to meet AMP Goals and Objectives?
4	A	**RIN 7.4.3** How do changes in flow volume and rate of change affect food base and energy productivity in the Colorado River ecosystem?
3	A	**RIN 7.4.4** How does flow rate and fluctuation affect habitat availability and utilization by fish and other organisms?

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Goal 8: Maintain or attain levels of sediment storage within the main channel and along shorelines to achieve GCDAMP ecosystem goals.

Sequence Order	Category	Information Needs
4.5	A	**IN 8.1** If sediment cannot be preserved in the system using available management actions, what is the feasibility (including technical, legal, economic, and policy issues) of sediment augmentation as a means of achieving this goal?

M.O. 8.1 Maintain or attain fine sediment abundance, grain-size, distribution in the main channel below 5,000 cfs

	Category	Core Monitoring INs
	A	**CMIN 8.1.1** Determine and track the biennial fine-sediment, volume, and grain-size changes below 5,000 cfs stage, by reach.
	A	**CMIN 8.1.2** What are the monthly sand and silt/clay -export volumes and grain-size characteristics, by reach, as measured at Lees Ferry, Lower Marble Canyon, Grand Canyon, and Diamond Creek Stations?
	A	**CMIN 8.1.3** Track, as appropriate, the monthly sand and silt/clay -input volumes and grain-size characteristics, by reach, as measured or estimated at the Paria and Little Colorado River stations, other major tributaries like Kanab and Havasu creeks, and "lesser" tributaries?

Sequence Order	Category	Research INs
5	A	**RIN 8.1.1** What is the longitudinal variability of fine-sediment inputs, by reach?
5	A	**RIN 8.1.2** What is the temporal variability of fine-sediment inputs, by reach?
5	A	**RIN 8.1.3** What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]

	Category	Effects INs
	A	**EIN 8.1.1** How do fine sediment abundance, grain-size, and distribution in the main channel below 5,000 cfs change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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M.O. 8.2 Maintain or attain fine sediment abundance, grain-size, and distribution within channel margins (not eddies) from 5,000 to 25,000 cfs

	Category	Core Monitoring IN
	A	**CMIN 8.2.1** Track, as appropriate, the biennial sandbar area, volume and grain-size changes outside of eddies between 5,000 and 25,000 cfs stage, by reach?
Sequence Order	Category	Research IN
5	A	**RIN 8.2.1** What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]
	Category	Effects INs
	A	**EIN 8.2.1** How does fine sediment abundance, grain-size, and distribution within channel margins (not eddies) from 5,000 to 25,000 cfs change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 8.3 Maintain or attain fine sediment abundance, grain-size, and distribution, within eddies below 5,000 cfs

	Category	Core Monitoring INs
	A	**CMIN 8.3.1** Track, as appropriate, the biennial sandbar area, volume and grain-size changes within eddies below 5,000 cfs stage, by reach?
Sequence Order	Category	Research IN
5	A	**RIN 8.3.1** What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]
	Category	Effects INs
	A	**EIN 8.3.1** How does fine sediment abundance, grain-size, and distribution, within eddies below 5,000 cfs change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 8.4 Maintain or attain fine sediment abundance, grain-size, and distribution within eddies between 5,000 to 25,000 cfs

	Category	Core Monitoring IN
	A	**CMIN 8.4.1** Track, as appropriate, the annual sandbar area, volume and grain-size changes within eddies between 5,000 and 25,000 cfs stage, by reach?

Sequence Order	Category	Research INs
5	A	**RIN 8.4.1** What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]

	Category	Effects INs
	A	**EIN 8.4.1** How does fine sediment abundance, grain-size, and distribution, within eddies between 5,000 to 25,000 cfs change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 8.5 Maintain or attain fine sediment abundance, grain-size, and distribution on shorelines between 25,000 cfs and the uppermost effects of maximum dam releases.

	Category	Core Monitoring INs
	A	**CMIN 8.5.1** Track, as appropriate, the biennial sandbar area, volume and grain-size changes above 25,000 cfs stage, by reach?

Sequence Order	Category	Research INs
4	A	**RIN 8.5.1** What elements of Record of Decision operations (upramp, downramp, maximum and minimum flow, MLFF, HMF, and BHBF) are most/least critical to conserving new fine-sediment inputs, and stabilizing sediment deposits above the 25,000 cfs stage?
5.5	A	**RIN 8.5.2** What is the reach-scale variability of fine-sediment storage throughout the main channel?
9.5	A	**RIN 8.5.3** What is the pre- and post-dam range of grain-size in fine-sediment deposits, by reach?
5	A	**RIN 8.5.4** What is the significance of aeolian processes in terrestrial sandbar reworking?
5.5	A	**RIN 8.5.5** What are the historic and ongoing longitudinal trends of fine-sediment storage, above 25,000 cfs?

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5	A	**RIN 8.5.6** What fine sediment abundance and distribution, by reach, is desirable to support GCDAMP ecosystem goals? [Note: Definition of "desirable" will be derived from targets for other resources and managers goals.]

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	Category	Effects Monitoring INs
	A	**EIN 8.5.1** How does fine sediment abundance, grain-size, and distribution on shorelines between 25,000 cfs and the uppermost effects of maximum dam releases change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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Sequence Order	Category	Supporting INs
9	A	**SIN 8.5.1** How do sandbar textures influence biological processes?
5	A	**SIN 8.5.2** What is the relationship between the fine-sediment budget and turbidity?
4	A	**SIN 8.5.3** What is the relationship between turbidity and biological processes?
4.5	A	**SIN 8.5.4** What is the role of turbidity and how can it be managed to achieve biological objectives?
5	A	**SIN 8.5.5** How can the ongoing fine sediment supply be managed to achieve sustainable habitats?
4	A	**SIN 8.5.6** What are the grain-size characteristics of sand bars associated with designated riparian vegetation zones?
5.5	A	**SIN 8.5.7** What are the limiting factors that regulate substrate availability and its distribution?
6	A	**SIN 8.5.8** What is the total area of different aquatic habitat types (cobble, gravel, sand, talus, etc,) in the Colorado River ecosystem?
6	A	**SIN 8.5.9** How are sandbar textures related to cultural site stability?
7.5	A	**SIN 8.5.10** How are sandbar textures related to recreational site stability?

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Proposed NEW M.O. 8.6 Maintain or attain coarse sediment (greater than 2 mm) abundance, grain-size and distribution throughout the Colorado River Ecosystem needed to achieve GCDAMP ecosystem goals.

	Category	Core Monitoring INs

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	A	**CMIN 8.6.1** Determine and track the change in coarse sediment abundance and distribution.

Sequence Order	Category	Research INs
6.5	A	**RIN 8.6.1** How do ongoing inputs of coarse-sediment from tributaries influence storage of fine sediment within pools, runs and eddies throughout the Colorado River ecosystem?
4.5	A	**RIN 8.6.2** How do ongoing inputs of coarse-sediment from tributaries alter the distribution of main channel habitats needed by benthic organisms within pools, runs, and eddies throughout the Colorado River ecosystem?
	Category	Effects INs
	A	**EIN 8.6.1** How does coarse sediment (greater than 2mm) abundance, grain-size and distribution change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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GOAL 9: Maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of GCDAMP ecosystem goals.

MO 9.1 Maintain or improve the quality and range of recreational opportunities in Glen and Grand Canyons within the capacity of the Colorado River ecosystem to absorb visitor impacts consistent with the NPS and tribal river corridor Management Plans.

Category	Core Monitoring INs
A	**CMIN 9.1.1** Determine and track the change in recreational quality, opportunities and use, impacts, and perceptions of users in the Colorado River Ecosystem.
A	**CMIN 9.1.2** Determine and track the frequency and scheduling of river-related use patterns.
A	**CMIN 9.1.3** Determine and track the level of satisfaction for river-related recreational opportunities in the Colorado River ecosystem.
A	**CMIN 9.1.4** Determine and track the economic benefits of river related recreational opportunities.

Sequence Order	Category	Research INs
11	A	**RIN 9.1.1** What are the attributes of a quality river experience? (How do you define a quality river experience?)
11	A	**RIN 9.1.2** Determine the appropriate carrying capacity for recreational activities within the Colorado River ecosystem.
11	A	**RIN 9.1.3** How do ongoing inputs of coarse-sediment from tributaries diminish or enhance navigability of rapids throughout the Colorado River ecosystem?

Category	Effects INs
A	**EIN 9.1.1** How do recreational use trends, impacts, and perceptions change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

MO 9.2 Maintain or improve the quality and range of opportunities in Glen and Grand Canyons in consideration of visitor safety, and the inherent risk of river-related recreational activities.

Category	Core Monitoring INs
A	**CMIN 9.2.1** Determine and track the change in quality and range of opportunities in consideration of visitor safety, and the inherent risk of river-related recreational activities.

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	A	**CMIN 9.2.2** Determine and track accident rates for visitors participating in river-related activities including causes and location (i.e. on-river or off-river), equipment type, operator experience, and other factors of these accidents in the Colorado River ecosystem.

M.O. 9.3 Increase the size, quality and distribution of camping beaches in critical and non-critical reaches in the mainstem within the capacity of the Colorado River Ecosystem to absorb visitor impacts consistent with NPS and tribal river corridor Management Plans.

	Category	Core Monitoring INs
	A	**CMIN 9.3.1** Determine and track the size, quality, and distribution of camping beaches by reach and stage level in Glen and Grand Canyons.
	A	**CMIN 9.3.2** Determine and track the effects Record of Decision operations on the size, quality, and distribution of camping beaches in the Colorado River ecosystem.

Sequence Order	Category	Research INs
5	A	**RIN 9.3.1** What is the desired target level of camping beaches by reach?
	Category	Effects INs
	A	**EIN 9.3.1** How do the size, quality, and distribution of camping beaches change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

M.O. 9.4 Maintain or enhance the wilderness experience in the Colorado River ecosystem in consideration of existing management plans.

	Category	Core Monitoring INs
	A	**CMIN 9.4.1** Determine and track the effects of Record of Decision operations on elements of wilderness experience specific to the Colorado River ecosystem.

Sequence Order	Category	Research INs
5.5	A	**RIN 9.4.1** Identify the elements of wilderness experience specific to the Colorado River ecosystem.

M.O. 9.5 Maintain or enhance visitor experiences as a result of GCDAMP research and monitoring activities.

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	Category	Core Monitoring INs
	A	**CMIN 9.5.1** Determine and track the frequency and scheduling of research and monitoring activity in Glen and Grand Canyons.

Sequence Order	Category	Research INs
7	A	**RIN 9.5.1** What effects do administrative trips, including research and monitoring activities have on recreational users?

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Goal 10: Maintain power production capacity and energy generation, and increase where feasible and advisable, within the framework of GCDAMP ecosystem goals.

Sequence Order	Category	Information Needs
7	A	**IN 10.1** Determine and track the impacts to power users from implementation of Record of Decision dam operations and segregate those effects from other causes such as changes in the power market.

M.O. 10.1 Maintain or increase power with respect to marketable capacity and energy at Glen Canyon Dam.

	Category	Core Monitoring INs
	A	**CMIN 10.1.1** Determine and track the effects on marketable capacity and energy of implementation of Record of Decision components (daily fluctuation limit, upramp and downramp limits, list components, maximum flow limit of 25,000 cfs, minimum flow limit of 5,000 cfs).

Sequence Order	Category	Research INs
6	A	**RIN 10.1.1.** What would be the effects on the Colorado River ecosystem and marketable capacity and energy of increasing the daily fluctuation limit?
5	A	**RIN 10.1.2.** What would be the effects on the Colorado River ecosystem and marketable capacity and energy of increasing the upramp and downramp limit?
5	A	**RIN 10.1.3** What would be the effects on the Colorado River ecosystem and marketable capacity and energy of raising the maximum power plant flow limit above 25,000 cfs?
5.5	A	**RIN 10.1.4** What would be the effects on the Colorado River ecosystem and marketable capacity and energy of lowering the minimum flow limit below 5,000 cfs?
11.5	A	**RIN 10.1.5** How do power-marketing contract provisions affect Glen Canyon Dam releases?

M.O. 10.2 Maintain or increase power within the existing emergency criteria for Western Area Power Administration systems.

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	Category	Core Monitoring INs
	A	**CMIN 10.2.1** Determine the effects of reserve group obligations on power.

M.O. 10.3 Maintain or increase power within the existing emergency criteria for the western interconnected electrical system.

	Category	Core Monitoring INs
	A	**CMIN 10.3.1** Determine the full range of effects of Glen Canyon Dam responses to western interconnected electrical system emergencies.
Sequence Order	Category	Research INs
5	A	**RIN 10.3.1** What are the effects of providing financial exception criteria?

M.O. 10.4 Maintain or increase power regulation at Glen Canyon Dam.

	Category	Core Monitoring INs
	A	**CMIN 10.4.1** Determine and track the effects on the Colorado River ecosystem and marketable power and energy of maintaining Automatic Generation Control at Glen Canyon Dam.
Sequence Order	Category	Research INs
6	A	**RIN 10.4.1** What are the effects on the Colorado River ecosystem and marketable power and energy of increasing Automatic Generation Control at Glen Canyon Dam?

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Goal 11: Preserve, protect, manage and treat cultural resources for the inspiration and benefit of past, present and future generations.

M.O. 11.1 Preserve historic properties in the area of potential effect via protection, management, and/or treatment (e.g., data recovery) for the purpose of federal agency compliance with NHPA, and AMP compliance with GCPA.

Category	Core Monitoring INs
A	**CMIN 11.1.1** Determine the status of historic properties under Record of Decision operations.
A	**11.1.1a** Determine periodically whether the essential physical features are visible enough to convey their significance or retain their information potential.
A	**CMIN 11.1.2** Determine the efficacy of treatments for mitigation of adverse effects to historic properties.
A	**CMIN 11.1.3** What are the thresholds for impacts that threaten the~~ir~~ integrity and eligibility of historic properties?
A	**11.1.3a** Are the current monitoring programs collecting the necessary information to assess resource integrity?
A	**CMIN 11.1.4** How effective is monitoring, what are the appropriate strategies to capture change at an archaeological site - qualitative, quantitative?

Sequence Order	Category	Research INs
4	A	**RIN 11.1.1** What are the sources of impacts to historic properties?
5	A	**11.1.1.a** What and where are the geomorphic processes that link loss of site integrity with dam operations as opposed to dam existence or natural processes?
5	A	**11.1.1.b** What are the terrace formation processes and how do dam operations affect current terrace formations processes?
5	A	**11.1.1.c** Determine if and where dam operations cause accelerated erosion to historic properties?
5	A	**11.1.1.d** What are the potential threats to historic properties relative to integrity and significance?
3.5	A	**RIN 11.1.2** What are the historic properties within the area of potential effects?
3.5	A	**11.1.2.a** For each tribe and living community, what are the register eligible traditional cultural properties?

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5	A	**11.1.2.b** How do specific sites meet National Register Criteria for Evaluation?
5	A	**11.1.2.c** Identify AMP activities that affect National Register eligible sites?
5.5	A	**11.1.2.d** Identify NPS permitted activities that affect National Register eligible sites.
3	A	**RIN 11.1.3** What are the thresholds triggering management actions?
5	A	**11.1.3.a** Determine the necessary information to assess resource integrity.
4	A	**11.1.3.b** How should adverse effects to historic properties be mitigated?
5.5	A	**RIN 11.1.5** What are appropriate strategies to preserve resource integrity?
	Category	Effects Monitoring INs
	A	**EIN 11.1.1** Determine the effects of experimental flows on historic properties.

M.O. 11.2 Preserve resource integrity and cultural values of traditionally important resources within the Colorado River Ecosystem.

	Category	Core Monitoring INs
	A	**CMIN 11.2.1** Are the traditionally important resources and locations for each tribe and other groups being affected?

Sequence Order	Category	Research INs
4.5	A	**RIN 11.2.1** What are traditionally important resources and locations for each tribe and other groups?
4.5	A	**RIN 11.2.2** What is the baseline measure for resource integrity?
4	A	**RIN 11.2.3** Determine acceptable methods to preserve or treat traditionally important resources within the Colorado River ecosystem.
5	A	**RIN 11.2.4** What changes are occurring in cultural resource sites, and what are the causes of those changes?

M.O. 11.3 Protect and maintain physical access to traditional cultural resources through meaningful consultation on AMP activities that might restrict or block physical access by Native American religious and traditional practitioners.

Sequence Order	Category	Effects INs
9	A	**EIN 11.3.1** Determine if and how experimental flows and other AMP actions restrict tribal access.
9	A	**EIN 11.3.2** Determine reasonable management actions that should be taken to facilitate tribal access.

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Goal 12: Maintain a high quality monitoring, research, and adaptive management program.

Research and monitoring techniques should be continuously improved to provide the AMP with the best-available science. However, exploration of new techniques and methods may not result in an RFP and should not come at the expense of long term monitoring and resource protection.

There is an ongoing need to consider new information regarding the most cost-effective and least intrusive techniques and methods available for monitoring and conducting research on the resources of the CRE. GCMRC seeks this information as part of its normal operations.

Any research into methodology will occur only as recommended by GCMRC, TWG, PEPs, or Science Advisors and approved by AMWG.

Sequence Order	Category	Information Needs
3	A	**IN 12.1** Develop information that can be used by the TWG, in collaboration with GCMRC, to establish current and target levels for all resources within the AMP as called for in the AMP strategic plan.
	A	**IN 12.2** Determine what information is necessary and sufficient to make recommendations at an acceptable level of risk.

M.O. 12.1 Maintain or attain socio-economic data for adequate decision-making.

Sequence Order	Category	Research INs:
~~4.5~~		~~**RIN 12.1.1** What is the necessary quantity and quality of cultural and socioeconomic information for adequate decision-making?~~
11.5	A	**RIN 12.1.1~~2~~** What is the economic value of the recreational use of the Colorado River ecosystem downstream from Glen Canyon Dam?
11	A	**RIN 12.1.2~~3~~** What are the use (e.g., hydropower, trout fishing, rafting) and non-use (e.g., option, vicarious, quasi-option, bequest and existence) values of the Colorado River ecosystem
11	A	**RIN 12.1.3~~4~~** How does use (e.g., hydropower, trout fishing, rafting) and non-use (e.g., option, vicarious, quasi-option, bequest and existence) values change in response to an experiment performed under the Record of Decision, unanticipated event, or other management action?

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M.O. 12.2: Attain or improve monitoring and research programs to achieve the appropriate scale and sampling design needed to support science-based adaptive management recommendations.

~~This MO is intended to encourage continuous improvement in research and monitoring techniques to provide the AMP with the best available science. However, exploration of new techniques and methods should not come at the expense of long-term monitoring and resource protection.~~

~~Unlike the other Management Objectives, this MO reflects an ongoing need to consider new information regarding the most cost-effective and least intrusive techniques and methods available for monitoring and conducting research on the resources of the CRE. GCMRC seeks this information as part of its normal operations, using Protocol Evaluation Panels and other means.~~

M.O. 12.3 Attain or maintain an integrated and synthesized "ecosystem-science"- based adaptive management program.

Sequence Order	Category	Research INs
4.5	A	**RIN 12.3.1** ~~What are the most effective method(s) to integrate and synthesize resource data to increase our understanding of the past and for ongoing interactions of humans with the Colorado River ecosystem.~~As necessary, investigate the most effective methods to integrate and synthesize resource data.
~~6~~		~~**RIN 12.3.2** What are the differences between western science and tribal processes for design of studies and for gathering, analyzing, and interpreting data used in the adaptive management program?~~
~~1~~		~~**RIN 12.3.3** What are the best scientific methods to determine cause and effect relationships in experiments and other management actions conducted under the GCDAMP?~~
5	A	**RIN 12.3.2~~4~~** What are the differences between western science and tribal processes for design of studies and for gathering, analyzing, and interpreting data used in the adaptive management program?How well do research designs and workplans incorporate~~do in incorporating~~ Tribal perspectives and values into the standard western science paradigm? Is it more beneficial to keep the perspective separated?
5	A	**RIN 12.3.3~~5~~** How effective is the AMP in addressing the EIS statement "Long-term monitoring and research are … implemented to measure how well the selected alternative meets resource management objectives."?

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M.O. 12.4 Attain or maintain an integrated and synthesized "ecosystem-science"-based adaptive management program.

Sequence Order	Research INs
~~4.5~~	~~**RIN 12.4.1** What are the most effective methods to maintain or attain the participation of externally-funded investigators?~~

M.O. 12.5 Foster effective two-way communication between scientists, external reviewers, managers, decision-makers, and the public.

Category	Core Monitoring INs
A	**CMIN 12.5.1** Determine whether effective two-way communication between AMP participants and individuals outside the program is occurring on a regular basis.

Sequence Order	Category	Research INs
5	A	**RIN 12.5.1** What are the most effective means to build AMP public support through effective public outreach?
5	A	**RIN 12.5.2** What are the most effective means to attain and maintain effective communication and coordination with other resource management programs in the Colorado River basin to ensure consideration of their values and perspectives into the AMP and vice versa?
6	A	**RIN 12.5.3** To what extent does the public understand and support the GCDAMP?
5	A	**RIN 12.5.4** What is the most effective way to distribute information to our stakeholders and the public in a secure and accessible fashion?
4.5	A	**RIN 12.5.5** Identify the desired level of information, education, and outreach provided for Glen and Grand Canyon river users and the general public?

M.O. 12.6 Attain and maintain an effective adaptive management program, composed of informed stakeholders.

M.O. 12.6a Maintain or attain funding from multiple sources.

M.O. 12.7 Attain and maintain effective tribal consultation to ensure inclusion of tribal values and perspectives into the AMP.

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Sequence Order	Category	Research INs:
5	A	**RIN 12.7.1** How effective are the current strategies to achieve tribal consultation?
5	A	**RIN 12.7.2** How well do the current strategies to achieve tribal consultation meet legal and AMP protocols?

M.O. 12.8 Attain and maintain tribal participation in the AMP research and long-term monitoring activities.

Sequence Order	Category	Research INs
5	B	**RIN 12.8.1** How well does current tribal participation in the AMP research and long-term monitoring programs meet tribal needs and desires?

M.O. 12.9 Recommend experiments of dam operations and other management actions to gain critical understanding of ecosystem function under different dam operations scenarios and other management actions.

Sequence Order	Category	Research INs
3	A	**RIN 12.9.1** What is the impact on downstream resources of short-term increases to maximum flow, daily fluctuations, and downramp limits?
2	A	**RIN 12.9.2** What is the best combination of dam operations and other management actions to achieve the vision, mission, goals, and objectives of the GCDAMP?
2	A	**RIN 12.9.3** What are the relationships between dam operations and other management actions in their effects on resources addressed by GCDAMP management objectives?

M.O. 12.10 Maintain or attain adequate funding from power revenues, foundations and corporations, appropriations, and State agencies to meet AMP goals.

M.O. 12.11 Maintain or attain participation from externally funded investigators that can help address the information needs and meet AMP goals.

Sequence Order	Category	Research IN
4.5	A	**RIN 12.11.1** What are the most effective methods to maintain or attain the participation of externally-funded investigators?

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Appendix 1
Process for Developing the Information Needs

The INs have been developed thorough a collaborative process led by the Grand Canyon Monitoring and Research Center (GCMRC). This process was initiated with GCMRC developing a draft set of INs for review and comment at a meeting of the Technical Work Group (TWG) and principal investigators held at the Phoenix Airport on April 3, 2001. A second meeting to discuss cultural INs was held in Flagstaff on May 8, 2001. Following these meetings, GCMRC revised the INs and discussed them at the May TWG meeting. Following this meeting the INs were put in a table and electronically mailed to the TWG for additional comment. Very few comments were provided by the TWG. At this point, the INs and the process for developing the INs was discussed in a number of conference calls and it was agreed that the INs would be reformatted into the nested outline form used in the current document. It was also agreed that the reformatted INs would be mailed to the TWG for review and comment and that a second workshop for reviewing and revising the INs would be held at GCMRC on August 8-9, 2001.

This current document results from the work conducted at the August 8-9, 2001 INs workshop and the subsequent review at the September 6 TWG meeting. On the first day of the August 8-9 INs workshop the TWG, PIs, and GCMRC staff divided into 4 concurrent breakout groups and reviewed the draft INs. Each group addressed the following questions during their review:

1) Do the INs for a given MO provide the information that is needed to address that MO? If not, please indicate how they should be revised and what should be added or deleted.

2) Are the INs written at the appropriate level of detail and correctly categorized with respect to the categories of "core monitoring," "effects monitoring," and "research"?

3) Taken together as a set do the INs and MOs represent the information needed to address a given goal?

On the second day of the August 8-9 INs workshop, a representative of each breakout group presented their proposed changes to the group as a whole. In response to these comments, the INs were either modified or the comments were captured in a table for subsequent consideration. The revised draft and the comments table were e-mailed to the TWG on August 20 for review prior to the September 6-7, TWG meeting. The National Park Service, Colorado River Energy Distributors Association, and Western Area Power Administration provided written comments on the INs. The INs were subsequently reviewed and revised at the September 6, 2001 TWG meeting.

A revised Draft INs document was e-mailed by GCMRC to the TWG on Friday September 14, 2001. Recommendations for deleting INs, for specific language

changes to the existing INs, or specific language for adding new INs were provided by TWG members to GCMRC by October 5, 2001. These were collated into a comments table, organized sequentially beginning with comments on the first IN, and sent back to the TWG on October 12 for review prior to an October 22-23 ad-hoc TWG workshop to revise the INs. At the October 22-23 TWG workshop, the first day was spent discussing overarching concerns relating to the scope of the AMP as expressed in the Goals and Management Objectives and concerns over the definitions used in the document. Only the INs for Goal 11, Cultural Resources were addressed. It was also agreed that a small group would work on revising the definitions and would send them to GCMRC. The definitions agreed to by the small group are included in this document. On the second day, INs for Goals 7, 8, 9, and 10 were addressed.

GCMRC has taken all of the comments included in the October 12th table and added changes agreed to at the October 22nd meeting to forge a November 2nd Draft of the Information Needs. The November 2nd Draft was sent to the TWG for review at the November 13-14 TWG meeting. Limited detailed review occurred at the November 13-14 meeting with the majority of the time being spent on over arching issues. As a result, TWG members were asked to submit their comments to GCMRC by close of business November 16th. Another draft, dated November 26th that included those comments as red-line and strike-out changes to the November 2nd draft was mailed to the TWG for review on November 26th. The TWG was asked to provide GCMRC with their final comments by December 7th. This FINAL DRAFT incorporates comments received by GCMRC as of December 7th.