DRAFT GCMRC CONTINGENCY PLAN FOR MONITORING UNANTICIPATED HIGH FLOWS FROM GLEN CANYON DAM IN GLEN AND GRAND CANYONS, ARIZONA

INTRODUCTION

The 1992 Grand Canyon Protection Act and the 1995 Glen Canyon Dam Environmental Impact Statement direct the Department of Interior to manage the Colorado River ecosystem in lower Glen Canyon and all of Grand Canyon through an adaptive management program. This program is designed to balance the tradeoffs between ecological and competing economic issues. Water storage, hydropower production, river running and trout fishing are the primary economic concerns, while protection of native fish, wildlife (some of which are endangered species), and archeologically and culturally significant sites are the primary environmental concerns (Bureau of Reclamation 1995). The Grand Canyon Monitoring and Research Center (GCMRC) was created in 1996 to provide information to the Adaptive Management Work Group (AMWG) regarding dam impacts on the Colorado River ecosystem. The AMWG, in turn, recommends management actions to the Secretary of the Interior, who considers and acts on those recommendations in relation to the recommendations of the Annual Operating Plan Work Group and the Law of the River.

The Colorado River ecosystem developed in response to annual flooding disturbance, and maintaining its ecological integrity depends, in large part, on management of flows and alluvial sediment distribution to rejuvenate native fish habitats, cultural sites and sandbars. The climate of the Grand Canyon region is unpredictable, and wet winters, such as occurred in 1982-83, 1984 and 1997, produce large snowpacks which melt and fill the Upper Basin's reservoirs to capacity. Releases at or above Glen Canyon Dam powerplant capacity (31,500 cfs) have occurred fairly regularly since the closure of the dam in 1963 (Table 1), and planned high flows recently have been used to restore ecosystem components and processes downstream (e.g., GCMRC 1997).

High flows may be used intentionally for ecosystem restoration purposes during high inflow years, but high flows may also be necessary when reservoir inflow exceeds storage capacity. High flows, particularly unanticipated high flows, may result in excessive sediment transport from Grand Canyon, and therefore management strategies involving high flows will range from ecosystem enhancement to impact mitigation. Furthermore, planned flooding for restoration purposes is not an ecological panacea: flooding negatively affects some terrestrial species of concern, and potentially recreation, in this ecosystem (GCMRC 1997).

With these caveats, high flow impacts may need to be assessed on an event-driven basis, to provide evaluation of short-term and longer-term resource effects. Adequate monitoring of unanticipated events requires scientifically credible comparison of pre-event and post-event resource conditions, particularly in the near future because our understanding of high flow impacts on the wide array of resources in Grand Canyon is

limited. However, through time and as adaptive management provides greater insight into system responses to high flows, such events may require less intensive monitoring. In the near future, the GCMRC recommends that concerted scientific study of high flow impacts is needed to improve understanding of the benefits and impacts in relation to stakeholder objectives, particularly with respect to flow magnitude, duration, frequency, and triggering criteria of future flows.

Table 1: Flows above powerplant capacity, planned high flows, and exceptionally low flows from Glen Canyon Dam, 1963 to 1997.

Year	Month	Peak Flow (cfs)
1965	May-June	65,000
1973	June	33,000
1977	Spring	Extreme low flows
1983	June-July	96,200
1984	June	50,000
1985	May	55,000
1986	June	48,000
1996	March/April	45,000
1997	August/September, November	30,700

The GCMRC initiated a pilot Contingency Monitoring Program in February 1997 to assess the impacts of anticipated high releases from Glen Canyon Dam on the physical, biological and cultural resources of the Colorado River ecosystem. The GCMRC recommends that a Contingency Planning Group subcommittee be formulated as part of the Technical Working Group to provide recommendations to the Adaptive Management Work Group regarding contingency planning issues. The present document expands upon the existing inter-agency monitoring and research program to stimulate discussion among the Contingency Planning Group regarding monitoring of future unanticipated exceptional releases (high or low) that vary from levels recommended in the Secretary's Record of Decision (5,000 cfs to 25,000 cfs).

The hydrographs associated with unanticipated high or low flows may or may not be subject to planning, and may require rapid response by the subcommittee and the TWG. Elements of potential planning may involve the magnitude, duration, and timing of high flows. Flow magnitude is assumed to be associated with maximum ROD levels, but may also involve additional flow peaks of <45,000 cfs, or in the vicinity of 45,000 cfs, 60,000 cfs, 75,000, or higher flows, in conjunction with maximum ROD flows. How flow peaks are framed within the overall high flow hydrograph also requires discussion: the present strategy may involve an initial flow peak followed by prolonged lower flows. The amount of time prior to implementation will be important in relation to scientific

evaluation of unanticipated events, and numerous legal issues are presently apparent with flows >45,000 cfs (e.g., impacts on endangered species and cultural resources). These issues and the physical, biological and cultural triggering criteria should be considered together by the subcommittee.

The objectives of this document are to provide a framework for monitoring the immediate and longer term impacts of unanticipated exceptional releases from Glen Canyon Dam on the Lake Powell and Grand Canyon ecosystems.

PRELIMINARY RESOURCE ASSESSMENT

Presently, Glen Canyon Dam releases are managed so that unanticipated, exceptional flows, such as the high flows that occurred in 1983-1986, or the low flows that occurred in 1977, should be rare events. However, GCMRC recommends that a Contingency Planning Committee develop a contingency assessment plan in the event that such flows occur. The resource effects matrix identifying stakeholder concerns with high flow impacts under development by GCMRC may need to be expanded to consider each month of the year and a range of flows at 1000 cfs increments up to 5,000 cfs, and at 10,000 cfs increments above the ROD level (25,000 cfs). At minimum, this exercise will help identify information gaps regarding flow impacts on Colorado River ecosystem resources, and may assist in the management of unforeseen flow emergencies as well as the long-term assessment of high flows impacts under different antecedent conditions.

EVENT DOCUMENTATION

If time permits, the minimum documentation of an unanticipated high flow event should include low-level, true color, aerial still or videography photography of the river corridor prior to, during and after the flow peak. Photography should include the mouth areas of major tributaries for the purpose of understanding pool area effects of high flows.

RESOURCE ASSESSMENTS

The following resources are presented here because they are discussed in the Glen Canyon Dam Environmental Impact Statement, because they are included in the recently re-formulated Stakeholder Objectives, or because they may be of interest to stakeholders if unanticipated flows occur.

Lake Powell

On-going monitoring of Lake Powell limnology will provide description of impacts on the reservoir; however, additional limnological sampling may be warranted

immediately around high flows. In addition, impacts on Lake Powell cultural resource sites and recreation may be warranted.

Physical Resources

Flow and Sediment: Flow and sediment interactions have been a major focus of the existing monitoring and research program, and antecedent conditions are a primary concern prior to any high flow event. The status of the in-channel and bank-stored sediment supply will dictate whether a high flow event can be considered an enhancement or a mitigation event. On-going monitoring should continue to provide information. Assessment of flow stage and sediment transport should be conducted as soon as possible after the unanticipated flow. Exceptional low flows may also require monitoring.

Flow will be monitored at the existing USGS gages, and potentially at an additional, temporary/intermittent streamflow gage in upper Marble Canyon if it is added to the USGS gage network. Sediment transport data should be collected at each gage, as well as from the major gaged tributaries (e.g., the Paria and Little Colorado rivers) before (if possible), during and after the flow event.

The USGS cross sections from the Paria River to Badger Rapid, and near the Little Colorado River mouth, should be remeasured prior to, during (if possible), and after, the high flow event. These measurements should be repeated at 6 month intervals through the monitoring program, and reported within one year of the conclusion of the high flow event.

In the event of unanticipated high flows >45,000 cfs, recently aggraded debris fans and associated rapids will be monitored to determine the extent of reworking.

It is anticipated that flow and sediment transport modeling will eventually be incorporated into the management of this system, reducing the need for some of the field data collection that is presently required for adequate assessment of high flow impacts.

***Sand Bar Erosion*:** Sand bar erosion should be studied at all of the 34 sites presently being monitored before (if possible) and immediately following high flows. Prior and 6-month follow-up survey data may be part of the existing monitoring program, if timing is appropriate. The use of daily cameras may be a substitute for some field data collection activities, and may eventually provide remotely sensed monitoring data on sand bar erosion.

Aquatic Biological Resources

Water Quality - Temperature: Unanticipated high flows may require use of the spillways. Monitoring the impacts of high flows on mainstream water temperature may

be of interest to determining how selective withdrawal influences this important physical variable. The on-going monitoring program will accomplish this task without much additional effort.

Drift and Benthos: On-going monitoring provides sufficient data on the status (growth rates, composition, and standing biomass) of the aquatic foodbase; however, a comprehensive model of organic drift under high flows has yet to be produced. High flows in the near future should provide data towards that model, but will require field data collection. To that end, several monitoring issues may be addressed.

Mid-channel drift should be sampled 4 times daily (high, low, rising and falling hydrograph points) for three days prior to a high flow event (if possible), at regular intervals during the event, and four times daily for three days following the event. If time and funding permits, mainstream sampling should be conducted just downstream from Glen Canyon Dam, at Lees Ferry and just downstream from the Paria River (these could all be sampled by one team); just upstream from the Little Colorado River confluence and at Mile 65 upstream from Lava Chuar Rapid (by another team); and at Mile 225 near Diamond Creek by another team. Whether or not the Paria and Little Colorado rivers are flowing above baseflow levels, they should also be sampled on the same schedule by the appropriate teams. However, if conditions do not permit access to these stations, drift should be monitored at least at the U.S. Geological Survey streamflow gages.

Dissolved oxygen and organic carbon concentrations in the mainstream are likely to change during and after an unanticipated high or low flow. If time permits, a monitoring program for these variables may be implemented at Glen Canyon Dam, Lees Ferry, the Paria River, above and downstream from the Little Colorado River, and at Diamond Creek may be coupled with the organic drift analysis.

Native Fish: Native fish may be substantially affected by unanticipated high flows and, depending on the magnitude and timing of the unanticipated flow event, GCMRC may recommend analysis of impacts on native fish. On-going monitoring trips should be timed to take as much advantage of the unanticipated high flow event as possible. Prolonged high flows may result in ponding at the mouths of major tributaries, and additional analysis of native and non-native fish activities in tributary mouths should be conducted, particularly at the Paria and Little Colorado rivers.

Native Fish Habitats: Backwaters may be substantially rejuvenated by flows in excess of 45,000 cfs, and monitoring of those habitats may be warranted. Aerial photography may be used to determine habitat area, and land surveys may be used to document the extent of scour and rejuvenation. In addition, the area of tributary mouth pool area can be measured from the aerial photography, and measured with land surveys. Monitoring the distribution of shoreline habitat types may provide an evaluation of the extent of shoreline alteration under unanticipated high flows.

Trout: The Lees Ferry trout fishery should be sampled with electro-shocking before (if possible) and as soon after the unanticipated high or low event. Those data should be related to longer-term monitoring results. Analysis of trout redds also may be justified.

Other Non-Native Fish: Other non-native fish species should be studied in concert with the native fish monitoring (above); however, an additional assessment should include transport of non-native fish into the tailwaters through the spillways. The extent of this phenomenon and the survivorship of imported fishes may be evaluated.

Terrestrial Biological Resources

***Riparian Vegetation*:** Changes in wetland and riparian sand bar vegetation may result from flows in excess of 45,000 cfs. Therefore, aerial and on-the-ground monitoring are warranted for flows in excess of approximately 50,000 cfs. These data should be related to on-going monitoring data. Attention should be devoted to flood-related dispersal of non-native species.

Endangered Kanab Ambersnail: This endangered snail population may be substantially affected by flows in excess of 45,000 cfs. The Kanab Ambersnail Contingency Plan, proposed by the Kanab Ambersnail Work Group, should be implemented at the earliest possible time. This contingency plan calls for snail and habitat salvage prior to the high flow. If time does not permit, monitoring of the snail population and habitat should be conducted as soon as possible after the unanticipated high flow event, and the data related to existing monitoring data.

Southwestern Willow Flycatcher: Unanticipated high flows in excess of 45,000 cfs may affect historic nest stands or trees used by southwestern willow flycatchers, as well as the associated fluvial marshes in which they feed. The AMWG Technical Work Group should work with GCMRC to develop a contingency plan for the southwestern willow flycatcher in case of unanticipated high flow events.

Other Riparian Species: Depending on the timing of the flows, it may be appropriate to consider monitoring other native and non-native riparian species. Exceptional events during the growing season (especially May and June) may have long-lasting impacts on many populations about which little is presently known.

Cultural Resources

***NPS Cultural Resources*:** The on-going monitoring program should be sufficient to determine high flow impacts on sites for unanticipated high flows of $\leq$ 45,000 cfs. Additional analyses of individual sites will be required if flows exceed 45,000 cfs. Also, two projects on-going in 1998-1999 (Potochnick and Tompson, and Weile) may benefit from on-site analyses during high flow events.

Tribal Cultural Resources: The on-going monitoring program should be sufficient to determine high flow impacts on tribal archeological and ethnobotanical resources at unanticipated high flows $\leq$ 45,000 cfs. Additional analyses of individual sites will be required if flows exceed 45,000 cfs. Also, two projects on-going in 1998-1999 (Potochnick and Thompson, and Weile) may benefit from on-site analyses during high flow events.

Socioeconomic Resources

River Use: Trout fishing and day-use rafting economic impacts should be assessed in the Glen Canyon reach. Impacts on down-river whitewater boating also deserve attention, particularly if the river is closed because of high flows.

Power marketing information associated with unanticipated flow events should be compiled and reported to the AMMG. Monitoring these impacts and changes are the responsibility of Western Area Power Administration.

Safety: The National Park Service has claimed that river running safety is not an issue during low or high flows in Glen and Grand canyons. Because safety is everybody's business, it may benefit the AMWG to have the National Park Service develop a safety plan that can be used to advise upriver boaters, river runners and backcountry users of unanticipated high and low flow events. At present, no contingency monitoring plan regarding river running safety during high flows exists in Grand Canyon.

SCHEDULE

The need for impact assessment and public accountability during unanticipated flow events requires increased flexibility and coordination with respect to logisitics planning on the part of the AMWG, GCMRC, and the National Park Service. A TWG Contingency Planning Group should be developed to consider these issues and the logistics needed (e.g., helicopter access, river trip permitting, legal compliance issues, and funding to cover logistics).

REPORTING

Reporting of the event should be closely coordinated and extremely timely, as much attention will be focused on our collective response to emergency situations. Press releases, meetings with various groups, and chains of command need to be coordinated carefully.

BUDGET

Developing a logistics budget for unanticipated events should be the responsibility of the proposed Contingency Planning Group. The following are areas that may require monitoring and therefore logistics budgeting attention:

Aerial Photography and Analyses
Lake Powell Limnology
Streamgage Analyses
Mainstream Cross-sections
Sandbar Erosion
Water Chemistry (e.g., Dissolved Carbon Concentration)
Drift and benthos
Native Fish
Native Fish Habitat
Trout
Non-native Fish
Kanab Ambersnail
Southwestern Willow Flycatcher
Riparian Vegetation
Other Terrestrial Species
NPS Cultural Resources
Tribal Cultural Resources
Socioeconomics of River Use and Safety