Subject: Information Regarding Prioritization of Management Objectives and Information Needs

The expanding information needs creates an increasing demand upon GCMRC to accomplish all desired programs in a timely manner. To allow the Center to continue to address expanding needs, time related priorities were established for all information needs (Appendix B). The established priorities will permit the Center to stage-in over years 2000 to 2004, the various information needs currently specified by stakeholders. High time priority information needs will be initiated in year 2000, 2001 whereas other monitoring and research needs may be delayed for initiation until 2002 or 2003. It is anticipated that some monitoring and/or research activities on all information needs currently proposed by stakeholders can be initiated in the next 5 years. Because the information needs are now so extensive, and because many relate to annual or intermittent monitoring requirements, it is anticipated that less than a third of the information needs specified will actually be completed in the 5 year planning period. For example, much monitoring is expected to continue into an extended 10 year program.

It should be noted, that in the efforts by the fourteen stakeholders to set priorities from the perspective of time initiation of studies, no implication was made and/or is made regarding the value of a specific stakeholder information need. All objectives and information needs are valued by the stakeholders and no ranking was made regarding the differential absolute values of the various information needs. The prioritization relates only to the time value of some information needs versus others, that is, some of the information needs must be accomplished immediately whereas others could be delayed.

In Appendix B information needs are listed in a declining number of votes placed by the fourteen stakeholders who did the ranking evaluation. Those information needs ranking highest, between 8 and 14, were the information needs that this group of stakeholders felt needed to have monitoring and research activity started immediately, that is, within 2000 and 2001. Those information needs having a ranking of 0 to 4 are information needs that this 14 member stakeholder group generally felt could be delayed to 2002 or 2003 and still provide value to the Adaptive Management Process.

The rankings in Appendix B do not mean that those information needs ranked between 8 and 12 are more important (except for time value) than other information needs ranked lower. Neither do information needs ranked 0, 1 and 2 have less value to stakeholders. They simply have less time preference value for initiation in 2000 and 2001.

The prioritization developed by the stakeholders did accomplish for the GCMRC the objective of defining information needs that could be delayed in the research and monitoring process. If approved by the TWG and AMWG, the Center will use this information in programing monitoring and research from 2000-2004.

Looking at the various information needs prioritized by the stakeholders to start early, one notes that they are focused in areas of biology, especially endangered species. Also listed are cultural resources, the water quality program at Lake Powell and aquatic productivity. When this group of information needs is contrasted against information needs on hydro power, water flows, sediment,

trout, wildlife viewing, recreation, etc. we can see a general separation in time prioritization.

Criteria were developed prior to the ranking process. These were as follows:

1. GCMRC staff would not contribute to ranking votes, and would only offer technical clarification.

2. Ranking would only be on time preference for start of research or monitoring on a specific information need. No ranking would occur on objectives.

3. Votes by each stakeholder could only be cast for 55 information needs using two different methods. This was a constraint placed to make sure that greater focus was placed on picking the most critical time dependent information needs.

4. All information needs would be ranked by two methods:

   A. Method O was developed across all information needs regardless of category, i.e. biology or cultural resources. For example, a stakeholder could cast all 55 votes for biological information needs. O's were placed beside information needs for these 55 votes.

   B. Method X was developed to emphasize information needs within resource areas. Each stakeholder was asked to vote for at least 30 percent of information needs in each resource area. X's were placed for each of the 55 votes.

APPENDIX B

RANKING OF TIME PREFERENCES FOR INITIATING RESEARCH AND MONITORING ON INFORMATION NEEDS

Information Needs Prioritization April 23, 1998

Grouping by Resource Category

		X	O
Ecosytem Assessments			
MO 1:	Develop a conceptual model of the Colorado River ecosystem.		
IN 1.1	The conceptual model will be used to:....	14	7
A.1 - Aquatic Food Base			
MO 1:	Maintain and enhance the aquatic food base in the Colorado River ecosystem to support desired populations of native and non-native fish. At a minimum, maintain continuously inundated areas for Cladophora and aquatic invertebrates at or above 5,000		
IN 1.3	Determine the aquatic food base species composition, population structure, density, and distribution required to maintain desired populations of native and non-native fish in the Colorado River ecosystem.	10	10
IN 1.1	Determine status and trends in aquatic food base species composition and population structure, density and distribution and the influence of ecologically significant processes.	9	10
IN 1.2	Determine the effects of past, present, and potential dam operations on the aquatic food base species composition, population structure, density, and distribution in the Colorado River ecosystem.	9	10
MO 1:	Maintain and enhance the aquatic food base in the Colorado River ecosystem to support desired populations of native and non-native fish. At a minimum, maintain continuously inundated areas for Cladophora and aquatic invertebrates at or above 5,000		
IN 1.9 (App.)	Quantify and evaluate changes in river habitat caused by dam operations over time	4	2
IN 1.7 (App.)	Identify and characterize the available aquatic habitat of the Colorado River and significant tributaries, such as the LCR (riffle, run, pool, backwater, etc.)	3	1
IN 1.10 (App.)	Determine the effect of sediment exposure time on benthic community mortality	3	2
IN 1.8 (App.)	Develop a comprehensive aquatic habitat map (with GIS) for the river corridor at various water levels.	1	1
IN 1.11 (App.)	Effects of sediment removal and transport on hyporheic communities	0	0
IN 1.12 (App.)	Effects of selenium on benthic/hyporheic communities.	0	1
A.2 - Trout			
MO 2:	In the Colorado River downstream of Glen Canyon Dam to the confluence of the Paria river, sufficient ecological conditions (such as habitat, foodbase and temperature) should be maintained, which in conjunction with management by Arizona Game and Fish...		
IN 2.1	Determine ecosystem requirements, population character and structure to maintain naturally reproducing populations of Age II plus fish at 100,000 population levels in Glen Canyon.	9	8
IN 2.2	Determine trends in rainbow trout population size, character and structure in Glen Canyon.	5	5
IN 2.4	Determine the availability and quality of spawning substrates in the Glen Canyon reach, necessary to sustain the rainbow trout fishery.	4	4
IN 2.7	Determine the trophic relationship between trout and the aquatic food base including the size of the aquatic food base required to sustain the desired trout population in Glen Canyon.	4	3

		X	O
IN 2.6	Define criteria (e.g., temperatures, flow regimes, contaminants, metals, nutrients) for sustaining a healthy rainbow trout population in Glen Canyon.	3	4
IN 2.3	Evaluate harvested and field sampled rainbow trout to determine the contribution of naturally reproduced fish to the population in Glen Canyon.	1	2
IN 2.5	Determine the growth and condition of rainbow trout in Glen Canyon.	0	4

A.3 - Native Fish

MO 3/4: 3) Enhance the Little Colorado River population of HBC above 1987 levels determined by April/May hoop-net monitoring in the lower 1,200 meters of the Little Colorado River.... 4) Maintain or enhance levels of recruitment of HBC in the mainstem.....

IN 3/4.1	Determine adult HBC populations and evaluate life history schedules, population health, and reproductive success. (Fall 97 RPM 1)	10	10
IN 3/4.12	Determine impacts of flows on young HBC during study flows, and develop methods of detecting changes in numbers, to assist in establishing levels of incidental take. (RPM)	8	9
IN 3/4.3	Develop and implement a program to evaluate effects of factors limiting overwintering survival of young-of-year HBC in the Grand Canyon (Fall 97, RPM 1).	8	10
IN 3/4.2	Determine levels of recruitment of humpback chub in the mainstem and the LCR.	8	11
IN 3/4.13	Develop biological criteria governing the implementation of special flows that will assure that the level of incidental take of HBC is not exceeded. (RPM)	7	8
IN 3/4.8	Determine effects on physical habitat used by young fishes, food base, and direct effect on larval, juvenile, and adult native and non-native fishes of 1996 BHBF. Develop methods to detect changes in numbers of HBC...	6	7
IN 3/4.7	Determine origins of fish food resources, energy pathways, and nutrient sources important to their production, and the effects of Glen Canyon Dam operations on these resources. (RPM 1.C.vi) Evaluate linkages....	6	7
IN 3/4.5	Develop a habitat suitability and availability index, which may include backwaters and near shore habitat, using existing data for HBC. Determine the effects of mainstem hydrology....	6	10
IN 3/4.9	Develop a method to determine the number ~~of HBC~~ suspected to be lost during special flows and the relationship of this loss to the Grand Canyon population. (T&C 2)	5	6
IN 3/4.14	Evaluate all test flows in RPM, using monitoring and research programs and, determine potential impacts to threatened and endangered fish.	4	5
IN 3/4.11	Acquire an understanding of the frequency of HBC year classes in the system susceptible to being transported downstream into unfavorable habitats and impact of flows on that year class. (T&C 2)	3	6
IN 3/4.10	Develop a strategy to sustain notable year classes of HBC that are susceptible to being transported downstream into unfavorable habitats. (T&C 2)	2	4
IN 3/4.6	Evaluate impacts of sampling methods and recreation use (e.g., habitat change, hooking mortality) on humpback chub populations.	1	2
IN 3/4.4	Determine and identify surrogate native or non-native fishes for evaluation of health factors for HBC and investigate trends in diseased fish.	0	2

MO 5: Remove jeopardy for the HBC in the Colorado River ecosystem (B.O. 1994).

IN 5.3	Determine the effects of dam operations, including installing a selective withdrawal structure for thermal modification in the mainstem of the Colorado River downstream of Glen Canyon Dam, on...	14	14
IN 5.2	Determine the anticipated effects on HBC and other native populations which may result from installing a selective withdrawal structure for thermal modification in the mainstem of the Colorado River downstream of Glen Canyon Dam. Determine the range...	10	10
IN 5.5	Evaluate when to release warmer temperature water, what seasonal pattern of releases to use to avoid establishment of permanent backwater areas, and how best to use floods, to limit expansion or invasion of non-native fish species. (RPM 1B)	9	9
IN 5.1	Determine a set of possible temperature changes in the mainstem Colorado River resulting from implementing selective withdrawal (RPM 1.B.i).	2	6

		X	O
IN 10.6	Evaluate the effects of various flow regimes, including beach/habitat building flows, habitat maintenance flows, and endangered fish research flows on the distribution and abundance of native and non-native fishes in the Colorado River ecosystem and ...	2	6
IN 10.5	Identify existing and potential sources of interaction (predatory, competitive) between extant non-native fishes and native fishes of the Colorado River ecosystem and important tributaries	2	6

MO 8: Achieve healthy, self-sustaining populations of flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem, with special emphasis on flannelmouth sucker in Glen Canyon based upon the capability of the habitat to support ...

IN 2. (App.)	Determine the origin of adult Flannelmouth Suckers/native fish that are attempting to spawn in the mainstem Colorado River within Glen Canyon? Are the old pre-dam adults? Are the post-dam adults from the tributaries, i.e., Paria River, that find ...	2	2
IN 5. (App.)	Describe the specific role of flow levels and fluctuations on reproduction and survival of eggs, larvae, young-of-year, and adults. Specifically, determine the availability of moderate near-shore habitat that might be used by larvae, young-of-year, ...	2	3
IN 6. (App.)	Describe the relative importance of various tributaries to flannelmouth survival (spawning, recruitment, predation).	1	2
IN 1. (App.)	Establish whether Flannelmouth Suckers/native fish are actually spawning in the mainstem Colorado River within Glen Canyon under current conditions. If spawning occurs, do any eggs hatch or larvae survive? Determine the current and past...	1	3
IN 3. (App.)	Determine the location of all spawning beds within Glen Canyon (related to flows) and summarize the important characteristics. Determine the relative importance of Glen Canyon habitat in relationship to other mainstem habitat within Grand Canyon and...	1	3
IN 11. (App.)	Develop a Flannelmouth sucker conceptual model for the Colorado River ecosystem, i.e., food, habitat, predation.	1	2
IN 4. (App.)	Specifically determine the cause(s) for mainstem spawning failure within Glen Canyon..	1	2
IN 9. (App.)	Determine the fidelity of Flannelmouth suckers to certain areas and spawning beds.	0	1
IN 14. (App.)	Determine the effect of current selenium levels discharged from Glen Canyon Dam on native fish species.	0	0
IN 12. (App.)	What habitat modifications could be made to improve Flannelmouth sucker population levels and overall health, i.e., substrate modification, nursery habitat establishment (warm backwaters), flow modification, etc.	0	1
IN 13. (App.)	Assess the influence of non-native fish on native fish species.	0	2
IN 8. (App.)	Determine the optimal habitat conditions for flannelmouth sucker. reproductions, survival, recruitment, etc., i.e., temperature, flow, food, shelter. What habitat factors in the mainstem attract adult Flannelmouth suckers to spawn? What is the ...	0	1
IN 7. (App.)	What is the food source in the mainstem now? Is there a sufficient food base for adequate growth and a healthy population in the mainstem? What was historic food source?	0	0
IN 10. (App.)	Determine if possible the current and historic use of Flannelmouth sucker habitat for spawning, foraging, cover, etc., within the Colorado River and Paria Rivers as well as other tributaries.	0	0

B. Terrestrial and riparian resources

MO 11: Protect, restore, and enhance survival of native and special status species (federal, tribal, and state designations). Ensure that the required habitat for these species is preserved.

IN 11.1	Define and specify ecology of native faunal components, especially threatened and endangered species; including evolutionary and environmental changes, natural range of variation, linkages, interdependencies, and requirements.	9	9
IN 11.6	Evaluate/monitor leopard frog populations within Glen Canyon. Determine effects of dam operations on these populations (flooding, desiccation, loss of habitat).	8	6
IN 11.4	Identify and characterize riparian wildlife habitat types along the river corridor.	7	5
IN 11.2	Determine species population to detect departures from natural range of variation.	6	4
IN 11.3	Determine changes, declines in special status species and characterize ecosystem changes to benefit species.	4	2

		X	O
IN 5.4	Evaluate effects of withdrawing water on the heat budget of Lake Powell, effects of potentially warmer inflow into Lake Mead, and the concomitant effects on the biota within both reservoirs. Evaluate the temperature profiles along with heat budget. .	2	7
MO 6:	Establish a second spawning aggregation of HBC downstream of Glen Canyon Dam (RPM 4).		
IN 6.1	Develop criteria for defining self-sustaining populations of HBC.	8	9
IN 6.2	Assess feasibility of establishing a second population of HBC downstream of Glen Canyon Dam including other current aggregations.	7	9
MO 7:	Remove jeopardy for the Razorback Sucker in the Colorado River ecosystem.		
IN 7.1	Determine opportunities to establish RBS in the Grand Canyon (e.g., possible development of spawning and rearing areas). (RPM 3)	5	7
MO 8:	Achieve healthy, self-sustaining populations of flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem, with special emphasis on flannelmouth sucker in Glen Canyon based upon the capability of the habitat to support ...		
IN 8.1	Determine the status of flannelmouth sucker, bluehead sucker, and speckled dace in the Colorado River ecosystem, with special emphasis on flannelmouth sucker in Glen Canyon.	8	9
IN 8.5	Determine and define impacts of alternative flow regimes on native fish population character and structure.	4	7
IN 8.6	Determine requirements to maintain/enhance self-sustaining populations of native fish.	4	7
IN 8.2	Determine population dynamics, distribution, and other life history traits of native fish species.	4	7
IN 8.4	Determine historic and current ecosystem requirements (habitat, spacing, food source, interdependencies, etc.) of native fish species.	2	5
IN 8.3	Determine historic and current character and structure of native fish populations.	1	3
MO 9:	Attain riverine conditions, including appropriate habitat, that support all life stages of endangered and native fish species.		
IN 9.3	Determine relationships among tributary hydrology, reproductive success of fishes, and the abundance of fishes in mainstem rearing habitats (RPM 1.c.ii).	3	7
IN 9.1	Design experimental flows and studies to include high steady flows in the spring and low steady flows in the summer and fall during low water years (RPM 1.A) Improve the mean for determining the definition of a Alow water year@ that would initiate...	2	3
IN 9.4	Assess biotic interactions between native and non-native fishes, particularly those that occur in nearshore rearing habitats affected by dam operations (RPM 1.C.iv).	1	6
IN 9.2	Quantify to the extent possible the effects of spring high steady flows and summer and fall low steady flows on endangered and native fish (RPM 1.a).	1	5
MO 10:	Minimize, to the extent possible, competitive and predatory interactions between native and non-native fishes.		
IN 10.1	Define areas and conditions of existing and potential interactions	5	6
IN 10.2	Determine key attributes associated with competitive and predatory interactions	3	4
IN 10.3	Determine methods for minimizing competitive and predatory interactions with or without isolation	3	3
IN 10.4	Determine the species composition, relative abundance, and size class structure of non-native fishes in the Colorado River ecosystem and important tributaries	2	5

		X	O
IN 11.5	Develop a comprehensive wildlife habitat map (using remote sensing and GIS) for the river corridor for high priority species (mammals, amphibians, reptiles, birds).	4	5
IN 11.8	Identify and evaluate other sensitive amphibian and aquatic reptilian species, i.e., red spotted toads, Woodhouses toads, canyon tree frogs.	3	2
IN 11.7	Determine feasibility of establishing other populations of leopard frogs within the river corridor.	1	1
MO 12:	Maintain a natural age-class distribution of wildlife species throughout the majority of natural range in Glen and Grand Canyons, emphasizing the need to recruit into breeding age classes.		
IN 12.1	Identify terrestrial species potentially affected by dam operations and determine effects on distribution, abundance, and population structure.	8	6
IN 12.4	Assess natural range and age class disruption, changes, constraints, probable long-term viability implications to species; assess alternate habitat, ecology associations (specifically age class); and ecosystem associations.	2	2
IN 12.2	Determine species' natural ranges (pre and post dam).	1	1
IN 12.5	Determine impacts of alternative operating criteria on ecosystem and ecology requirements of species.	1	1
IN 12.3	Determine historic age class distribution (pre and post dam).	0	0
MO 13:	Protect, restore, and enhance survival of native and special status avifauna.		
IN 13.2	Determine impacts of dam operations on avifauna food chain associations.	8	6
IN 13.1	Define and evaluate food chain associations, interdependencies, requirements, etc. for native avifauna, including the Peregrine Falcon, Southwestern Willow Flycatcher, and other special status species (e.g., Yellow-billed Cuckoo).	7	7
IN 13.5	Determine bald eagle habitat utilization and foraging patterns and their relationship to dam operations and perform additional bald eagle monitoring where deemed feasible. (Conservation Recommendation 4)	3	3
IN 13.4	Study peregrine falcon population dynamics and determine their relationship to the changing riparian ecosystem for meeting life stage requirements. (Conservation Recommendation 3)	2	2
IN 13.3	Determine peregrine falcon breeding sites in Glen Canyon and Grand Canyon.	1	1
MO 14:	Sustain populations of Kanab ambersnail wherever they currently exist within the Colorado River ecosystem.		
IN 14.6	Evaluate and monitor KAS populations within the Colorado River ecosystem. Determine ecological characteristics susceptible to changes in dam operations, i.e., population size, habitat needs, life history requirements.	10	11
IN 14.1	Determine specific habitat characteristics required by the KAS. (T&C 3–p.41)	8	9
IN 14.3	Complete a census of the population and characterize the habitat. Once habitat requirements are determined, other potential habitat sites within the Grand Canyon corridor will be surveyed to determine species presence and recovery potential...	8	8
IN 14.4	Survey KAS habitat before and after any flow greater than 25,000 cfs to determine population and its species response to disturbance and ability to recover. (T&C 4, p.42; and RPM)	7	7
IN 14.2	Determine special flow impacts on Kanab ambersnail to assure that the level of incidental take is not exceeded. (I. T. - p.40)	7	7
IN 14.5	Determine Kanab Ambersnail life history schedule for populations in the Colorado River ecosystem. (Conservation Recommendation 5)	7	7
IN 14.7	Determine changes in populations, health, and character of Kanab ambersnail.	6	5

		X	O
MO 15:	Establish or discover and ensure the continued existence of a second population of Kanab Ambersnail in Arizona.		
IN 15.1	Determine genetic similarities and differences among populations of Kanab ambersnail.	5	7
IN 15.2	Investigate the transplant success of vegetation important to the Kanab ambersnail: a) Investigate success of temporarily removing Mimulus..., b) Investigate success of temporarily/permanently relocating Mimulus..	4	6
MO 16:	Maintain, enhance or restore vegetative communities made up of diverse groups of native riparian and upland species with special emphasis on preservation of unique plant communities and special status species at different stages of succession...		
IN 16.1	Determine distribution and abundance of native and non-native riparian and upland vegetation, including federal-, state- and tribal-listed sensitive species, old high water zone, new high water zone, and nearshore marshes.	6	5
IN 16.6	Evaluate impacts of dam operations on establishment of and impacts from exotic plant species.	5	4
IN 16.2	Identify and quantify the OHWZ (above 150,000 cfs) and NHWZ (between 45,000 and 150,000 cfs) vegetation types (communities) within the Colorado River ecosystem.	5	4
IN 16.4	Determine the effects of current and proposed dam operations on these communities.	4	4
IN 16.5	Determine the ecology of the principal woody species (reproduction, establishment) within the OHWZ. Quantify the effects of dam operations on this ecology.	2	2
IN 16.3	Determine change in extent or abundance of the OHWZ and NHWZ plant communities. Link monitoring to site specific studies to determine species diversity.	0	0

Cultural Resources

MO 1:	Conserve in situ all the downstream cultural resources and take into account Native American cultural resource concerns in the Colorado River ecosystem.		
IN 1.1	Monitor cultural sites potentially impacted by Glen Canyon Dam operations to determine present condition and rate of change to assess: types of degradation, threats; rates of degradation; define immediacy of threats to resources; protection....	13	12
IN 1.3	Characterize all cultural resource sites as to the specific associated management/research needs, i.e.; preservation, stabilization, documentation, etc.; under alternative operating criteria	7	7
IN 1.4	Preservation, stabilization and/or documentation of cultural resources as impacted by sediment resources associated with alternative operating criteria	5	6
IN 1.2	Develop data systems to assess variable risk of damage/loss of differing resources/sites from preferred and alternative strategies and operating criteria	4	6
IN 1.6	Evaluate flood terrace stability necessary to maintain cultural resources and terraces at pre-dam conditions	2	6
IN 1.5	Preservation, stabilization of flood terraces holding cultural resources	2	5
IN 1.7	Evaluate methodology for correlating recreational sites use and cultural resource impacts.	0	1
MO 2:	If in situ conservation is not possible, design mitigative strategies that integrate the full consideration of the values of all concerned tribes with a scientific approach.		
IN 2.1	Characterize through scientific study and data development all assumed historical and current values, including scientific values, of resources to tribal nations and to general public	9	9
IN 2.2	Develop research designs and costs associated with data recovery	2	5
MO 3:	Protect, and maintain physical access to and use of traditional cultural properties and other cultural resources, where such access and use may be impacted by dam operations.		

		X	O
IN 3.1	Characterize historic and current traditional cultural associations of all sites associated with impacts of dam operating criteria	6	9

MO 4: Maintain and integrate all appropriate cultural data recovered from monitoring, remedial, and mitigative action and incorporate these data into the evolving research designs and mitigative strategies for understanding the human occupation and use

IN 4.1	Develop evolving research designs and/or other methods including synthesis of existing available data and GIS for understanding human occupation and use.	5	7

Socioeconomic (Hydropower)

MO 1: Maximize the value of long-term power and energy generation within the criteria and operating plans established by the Secretary under Section 1804 of the Grand Canyon Protection Act1.

IN 1.1	Continue to monitor the amount of revenues collected from the generation of electrical power at the Glen Canyon Power plant.		
IN 1.2	Continue to account for the financial/economic cost of the operational changes at Glen Canyon Dam due to the ROD including rate impacts to CRSP long-term firm electrical customers.		
IN 1.3	Calculate the financial costs of research flows so that these costs can be declared Anon-reimbursable@ (as defined by Section 1804 of the Grand Canyon Protection Act)		
IN 1.4	Evaluate difficulties in operating an integrated electrical system, including regulating a load control area		

Water Resources

MO 1: The Secretary shall Operate Glen Canyon Dam in a manner fully consistent with the Record of Decision and subject to the ALaw of the River,@ including but not limited to the following: Grand Canyon Protection Act of 1992, the Colorado River...

IN 1.1	Annually collect and report Glen Canyon Dam flow release information.		

MO 2: Maintain water quality at levels appropriate to support physical, biotic, and human resource needs of various ecosystems downstream of Glen Canyon Dam as mandated by the Grand Canyon Protection Act and incorporated into the Record of Decision.

IN 2.1	Monitor water quality, composition and temperature and compare to applicable standards. a)Quantify current selenium levels..., b) Determine/quantify the dynamics of major cations, anions and nitrate/phosphate ratios resulting from dam operations.	9	9
IN 2.2	Evaluate feasibility of short term or long term changes of water temperature through selective withdrawal.	6	6

Sediment Resources

MO 1: Maintain a long-term balance of river-stored sand to support maintenance flow (in years of low reservoir storage), beach/habitat-building flow (in years of high reservoir storage), and unscheduled flood flows. Maintain system dynamics and....

IN 1.2	Define minimal levels of river stored sediments necessary to maintain long term sandbar, backwater, instream sediment deposits	11	9
IN 1.3	Develop procedures to monitor and predict impacts of alternative operating criteria (flow regimes) on river stored sediment, and impacts in select reaches	10	7
IN 1.4	Measure and model sediment contributions from all contributing sources, including tributary and high terrace sources	10	8
IN 1.1	Define historical and current (character and structure) levels of river stored sediment in system and associated flow regimes	7	5
IN 1.5	Evaluate the geology/geomorphology within Glen Canyon to: (1) determine historical changes in size and extent of beaches, sandbars and backwaters, (2) quantify sediment (size class and quantity) input from side channels, (3) understand bed morphology...	6	5

MO 2: As a minimum for each reach, maintain the number and average size (area and thickness) of sandbars and backwaters between the stages associated with flows of 8,000 and 45,000 cfs that existed during the 1990/91 research flows.

		X	O
IN 2.6	Determine implications of dam operating criteria on beach and sandbar and backwater character and structure, including suitability of camping beaches	8	6
IN 2.3	Monitor future changes in sediment and define balances (channel, banks, bars) and hydraulic processes necessary to maintain 1990/91 sandbar levels	5	3
IN 2.7	Comprehensively quantify the extent and location of existing sandbars, beaches and backwaters along the Colorado River corridor	5	2
IN 2.4	Evaluation of flow regime impacts on terrace and cultural resources	3	2
IN 2.5	Evaluate historical sandbar/backwater change, and develop methods for predefining beach and sandbar change under operating criteria	3	3
IN 2.2	Working with various resource agencies and specialists, select most appropriate flow levels/regimes to determine baseline for comparisons for all resources	2	3
IN 2.1	Characterize sandbar/backwater baselines and character and structure in 1990/91	1	1
IN 2.8	Assess the effects and use of the spillways on bed morphology in the front of the dam and its effects on power production and biota	1	1
MO 3:	Periodically increase the average size of sandbars above the 20,000 cfs river stage and number and average size of backwaters to the amounts measured during the high period of 1990/91 or the 1996 test of the beach/habitat-building flow in as many		
IN 3.4	Define all linkages, associations, interdependencies, etc., of physical sediment resource and backwater resources to biotic entities	8	7
IN 3.3	Define changes between 1990/91 and 1996 in sediment and backwater resources character and structure associated with dam operating criteria	4	3
IN 3.5	Define processes necessary to maintain backwaters at 1990/91 or 1996 levels	3	2
IN 3.1	Define 1996 and 1990/91 backwater ecosystems and associated flow regimes	3	4
IN 3.2	Define historical variation in backwater number and character	2	3
MO 4:	Maintain system dynamics and disturbance by redistributing sand stored in the river channel and eddies to areas inundated by river flows up to 45,000 cfs in as many years as possible when BHBF hydrologic and resource criteria are met.		
IN 4.2	Develop methodologies to define future flow regimes to maximize benefit to sediment and backwater character and structure	6	4
IN 4.1	Define character and structure of all beaches and backwaters in system after 1996 test flows	6	6
IN 4.3	Develop an assessment of dam operation impacts on range of variation in sediment and other resources within Colorado River ecosystem and the associated processes that created these ranges	5	5
IN NH5.	Develop an understanding of bed morphology dynamics within Glen Canyon	4	2
IN NH1.	Quantify the available sediment in the river channel within the Glen Canyon reach to build beaches within Marble Canyon	3	3
IN NH8.	Comprehensively quantify the extent and location of existing sandbars and beaches along the river corridor	3	2
IN NH7.	Summarize the historical changes in river banks and sandbars within the Glen Canyon reach and determine long term changes in size	2	0
IN NH3.	Quantify the sediment inputs within the Glen Canyon reach from unregulated side channels	2	2
IN NH4.	Assess the impact of current and anticipated dam operations on the high terraces within Glen Canyon. Define the relative importance of natural erosion of high terraces as compared to that experienced due to current dam operations	1	2

		X	O
MO 4:	Maintain flows and habitat suitable for quality cold water fishery opportunities in Glen Canyon.		
IN 4.1	Determine flow regimes necessary to maintain fish populations of 100,000 adult Trout (age class II plus)	7	2
MO 5:	Maintain flows and habitat suitable for waterfowl sport hunting and wildlife viewing opportunities in Glen Canyon.		
IN 5.1	Define pattern of waterfowl hunting use and satisfaction and other wildlife use and conflicts to other uses	2	1

Lake Powell

MO 1:	Prevent unacceptable effects on the water quality (physical, chemical, biological) of Lake Powell due to dam operations and ensure that fully informed AMWG decisions are possible both now and in the future.		
IN 1.1 (Phys)	Determine the effect of current dam operations on reservoir water quality, including but not limited to the following...	14	10
IN 1.1 (Biol)	Determine the impacts of dam operations and resulting water quality on primary and secondary productivity of Lake Powell, including:...	12	5
IN 1.2	Describe and quantify the effects of elevated levels of selenium on the primary productivity of Lake Powell	0	1
MO 2:	Protect Lake Powell aquatic ecosystem from unacceptable impacts due to dam operations and subsequent effects, including but not limited to: temperature, reservoir surface elevations, elevated selenium levels, advective flow patterns, predator/prey		
IN 2.1	Determine the effects of water temperature caused by dam operations	9	1
IN 2.6	Determine the effects of fish movements caused by dam operations	5	1
IN 2.2	Determine the effects of fluctuations in the reservoir surface elevations caused by dam operations	1	0
IN 2.4	Determine the effects of advective flow patterns on Lake Powell aquatic ecosystem caused by dam operations	1	0
IN 2.5	Determine the effects of predator/prey relationships caused by dam operations	1	1
IN 2.3	Determine the effects of elevated selenium levels caused by dam operations	0	0

		X	O
IN NH6.	Determine the relative importance of sediment grain size within Glen Canyon compared to downstream reaches	1	1
IN NH2.	Determine the relative importance of high terrace erosion to beach building within the Glen Canyon reach	1	1

GIS

MO 1: (Management Objective to be added)

IN 1.2	Develop an integrated data/GIS structure for the storage and retreival of all GCMRC studies	2	0
IN 1.1	Develop a comprehensive GIS base map for topography, geology and soils for the Colorado River ecosystem	1	1

Recreation

MO 1: Provide quality recreation experiences consistent with other resource objectives.

IN 1.3	Characterize procedures to mitigate those aspects of flows that detract from recreational character of river	10	4
IN 1.1	Determine criteria and aspects that are important to or detract from recreational experience	9	4
IN 1.2	Determine the impacts of scientific study on recreational experience	5	2
IN 1.4	Determine angler satisfaction, use and harvest	3	2
IN 1.5	Determine potential impacts of increased heavy metals on sport fishing	0	0

MO 2: Maintain flows and sediment processes that create an adequate quantity, distribution and variety of beaches for camping, as long as such flows are consistent with management of natural recreation and cultural resource values (other natural resource...

IN 2.1	Determine adequate beach quantity, quality, character and structure for camping throughout system	10	1
IN 2.2	Evaluate impacts of operating criteria on establishing and maintaining adequate beaches and distribution of other resources, quality, character and structure	8	6
IN 2.3	Develop methodology to evaluate distribution, quantity and quality changes in all campable beaches through time	3	1
IN 2.4	Develop systems models to predict flow regimes for building and maintaining beaches	2	2

MO 3: Maintain flows that minimize impacts to navigability by authorized water craft and for boaters, waders, and campers in the riverine corridor.

IN 3.1	Determine if operating criteria maintains safe and adequate powercraft navigability in Glen Canyon and upper Lake Mead	3	1
IN 3.2	Evaluate effects of operating criteria on recreation safety	3	3
IN 3.5	Develop methodology to evaluate potential conflicts of day rafting and other resources (e.g., bank degradation, sport fishing, bird watching, etc.)	1	2
IN 3.3	Determine if operating criteria maintains whitewater raft navigation in Grand Canyon	1	2
IN 3.4	Define ecosystem and other resource impacts of flow regimes required to maintain navigation	0	1

APPENDIX C

OUT YEAR BUDGET PROTOCOL FY98, 99 & 2000 BUDGET

FY2000 BUDGET SCENARIOS

APPENDIX C

A Protocol for Out Year Budget Planning in the Adaptive Management Program.

- Management Objectives, Information Needs and Strategic Plan will drive the budget process

- The TWG will review unresolved Information Needs and GCMRC Accomplishments annually (September)

- AMP Strategic Plan and/or AMP Annual Plan and proposed budget (GCMRC & Reclamation) will be submitted to the TWG by GCMRC for review and recommendation. Plans are to include complete AMP programs and budget (December)

- The TWG and GCMRC advances the Strategic and/or Annual Plan and Out Year Budgets to the AMWG for review (January)

- The AMWG recommends to the Secretary's Designee the final Strategic and/or Annual Plan with associated Out Year Budget(s) for approval

PROPOSED PROGRAM ESTIMATES

GRAND CANYON ADAPTIVE MANAGEMENT PROGRAM

Program Area	FY1998	FY1999	FY2000B
I. Bureau Administration of AMWG	104,000	132,000	114,000
II. Bureau Administration of TWG	244,000	57,000	93,000
III. Bureau Administration of SAB	2,750	60,000	60,000
IV. Bureau Support			
A. Support Services	262,000	242,000	243,000
B. Programmatic Agreements	799,000	902,000	1,006,000
V. Bureau/Native American Support (Appropriat	50,000	50,000	50,000
Subtotal (I-V)	1,461,750	1,443,000	1,566,000
VI. GCMRC Program and Operating Cost			
A. Operations, Personnel, Contract Services	1,921,000	1,922,000	2,083,000
B. Physical Resources Science	1,175,000 [1]	1,175,000 [1]	700,000 [2]
C. Biological Resources Science	1,390,000 [1]	1,390,000 [1]	1,500,000 [2]
D. Cultural Resources Science	388,000 [1]	390,000 [1]	300,000 [2]
E. Socioeconomic Resources Science Progra	63,000	63,000	0
F. Information Technologies Program	408,000	408,000	300,000
G. Lake Powell Program			
CRSP Revenues	200,000	250,000	325,000
Bureau Appropriations	50,000	0	0
H. Remote Monitoring Technology	0	0	400,000
I. Independent Review Panels	246,000	243,000	150,000
J. Logistics	0	0	600,000 [2]
TOTAL	7,302,750	7,284,000	7,924,000

[1] In FY98 and FY99 logistics support is included in these funding levels

[2] Logistics is proposed as a separate line item in FY2000; i.e., line item J

PROPOSED PROGRAM ESTIMATES

GRAND CANYON ADAPTIVE MANAGEMENT PROGRAM

Program Area	FY 2000A	FY2000B	FY2000C
I. Bureau Administration of AMWG	114,000	114,000	114,000
II. Bureau Administration of TWG	93,000	93,000	93,000
III. Bureau Administration of SAB	60,000	60,000	60,000
IV. Bureau Support			
A. Support Services	243,000	243,000	243,000
B. Programmatic Agreements	1,006,000	1,006,000	1,006,000
V. Bureau/Native American Support (Appropriations)	50,000	50,000	50,000
Subtotal I-V	1,566,000	1,566,000	1,566,000
VI. GCMRC Program and Operating Cost			
A. Operations, Personnel, Contract Services	1,950,000	2,080,000	2,150,000
B. Physical Resources Science	700,000	700,000	950,000
C. Biological Resources Science	1,200,000	1,500,000	1,850,000
D. Cultural Resources Science	200,000	300,000	450,000
E. Socioeconomic Resources Science Program	0	55,000	90,000
F. Information Technologies Program	250,000	320,000	510,000
G. Lake Powell Program	175,000	325,000	440,000
H. Remote Monitoring Technology	400,000	400,000	400,000
I. Independent Review Panels	150,000	150,000	250,000
J. Logistics	600,000	600,000	700,000
TOTAL	7,191,000	7,996,000	9,356,000

Resource Category	Mgt Obj	Info Need	O	X
A.3 - Native Fish	MO 3/4:	IN 3/4.13	8	7
Sediment Resources	MO 1:	IN 1.4	8	10
A.3 - Native Fish	MO 3/4:	IN 3/4.8	7	6
A.3 - Native Fish	MO 3/4:	IN 3/4.7	7	6
Sediment Resources	MO 1:	IN 1.3	7	10
B. Terrestrial and riparian resour	MO 13:	IN 13.1	7	7
A.3 - Native Fish	MO 8:	IN 8.2	7	4
B. Terrestrial and riparian resour	MO 14:	IN 14.2	7	7
Cultural Resources	MO 1:	IN 1.3	7	7
B. Terrestrial and riparian resour	MO 14:	IN 14.4	7	7
B. Terrestrial and riparian resour	MO 14:	IN 14.5	7	7
B. Terrestrial and riparian resour	MO 15:	IN 15.1	7	5
Sediment Resources	MO 3:	IN 3.4	7	8
A.3 - Native Fish	MO 5:	IN 5.4	7	2
Ecosytem Assessments	MO 1:	IN 1.1	7	14
A.3 - Native Fish	MO 9:	IN 9.3	7	3
A.3 - Native Fish	MO 8:	IN 8.6	7	4
A.3 - Native Fish	MO 8:	IN 8.5	7	4
A.3 - Native Fish	MO 7:	IN 7.1	7	5
Cultural Resources	MO 4:	IN 4.1	7	5
Cultural Resources	MO 1:	IN 1.2	6	4
Sediment Resources	MO 4:	IN 4.1	6	6
B. Terrestrial and riparian resour	MO 15:	IN 15.2	6	4
Sediment Resources	MO 2:	IN 2.6	6	8
Water Resources	MO 2:	IN 2.2	6	6
A.3 - Native Fish	MO 10:	IN 10.5	6	2
Cultural Resources	MO 1:	IN 1.4	6	5
A.3 - Native Fish	MO 10:	IN 10.1	6	5
A.3 - Native Fish	MO 3/4:	IN 3/4.9	6	5
A.3 - Native Fish	MO 3/4:	IN 3/4.11	6	3
A.3 - Native Fish	MO 5:	IN 5.1	6	2

Information Needs Prioritization - Overall Rankings Across Resource Categories

Resource Category	Mgt Obj	Info Need	O	X
A.3 - Native Fish	MO 5:	IN 5.3	14	14
Cultural Resources	MO 1:	IN 1.1	12	13
A.3 - Native Fish	MO 3/4:	IN 3/4.2	11	8
B. Terrestrial and riparian resour	MO 14:	IN 14.6	11	10
A.3 - Native Fish	MO 3/4:	IN 3/4.5	10	6
A.1 - Aquatic Food Base	MO 1:	IN 1.1	10	9
A.1 - Aquatic Food Base	MO 1:	IN 1.2	10	9
A.1 - Aquatic Food Base	MO 1:	IN 1.3	10	10
A.3 - Native Fish	MO 3/4:	IN 3/4.1	10	10
A.3 - Native Fish	MO 3/4:	IN 3/4.3	10	8
A.3 - Native Fish	MO 5:	IN 5.2	10	10
Lake Powell	MO 1:	IN 1.1 (Phys)	10	14
A.3 - Native Fish	MO 6:	IN 6.1	9	8
A.3 - Native Fish	MO 6:	IN 6.2	9	7
Cultural Resources	MO 3:	IN 3.1	9	6
Cultural Resources	MO 2:	IN 2.1	9	9
A.3 - Native Fish	MO 5:	IN 5.5	9	9
B. Terrestrial and riparian resour	MO 11:	IN 11.1	9	9
A.3 - Native Fish	MO 8:	IN 8.1	9	8
B. Terrestrial and riparian resour	MO 14:	IN 14.1	9	8
Sediment Resources	MO 1:	IN 1.2	9	11
Water Resources	MO 2:	IN 2.1	9	9
A.3 - Native Fish	MO 3/4:	IN 3/4.12	9	8
A.2 - Trout	MO 2:	IN 2.1	8	9
B. Terrestrial and riparian resour	MO 14:	IN 14.3	8	8

Resource Category	Mgt Obj	Info Need	O	X
Sediment Resources	MO 3:	IN 3.1	4	3
A.2 - Trout	MO .2:	IN 2.5	4	0
A.2 - Trout	MO 2:	IN 2.4	4	4
A.2 - Trout	MO 2:	IN 2.6	4	3
A.3 - Native Fish	MO 9:	IN 9.1	3	2
B. Terrestrial and riparian resour	MO 13:	IN 13.5	3	3
Recreation	MO 3:	IN 3.2	3	3
A.3 - Native Fish	MO 8:	IN 3. (App.)	3	1
Sediment Resources	MO 2:	IN 2.2	3	2
A.3 - Native Fish	MO 8:	IN 5. (App.)	3	2
A.3 - Native Fish	MO 8:	IN 1. (App.)	3	1
Sediment Resources	MO 4:	IN NH1.	3	3
A.3 - Native Fish	MO 8:	IN 8.3	3	1
Sediment Resources	MO 2:	IN 2.3	3	5
A.2 - Trout	MO 2:	IN 2.7	3	4
Sediment Resources	MO 2:	IN 2.5	3	3
Sediment Resources	MO 3:	IN 3.3	3	4
Sediment Resources	MO 3:	IN 3.2	3	2
A.3 - Native Fish	MO 10:	IN 10.3	3	3
Recreation	MO 3:	IN 3.3	2	1
Recreation	MO 2:	IN 2.4	2	2
B. Terrestrial and riparian resour	MO 11:	IN 11.3	2	4
A.3 - Native Fish	MO 8:	IN 13. (App.)	2	0
A.3 - Native Fish	MO 8:	IN 11. (App.)	2	1
Recreation	MO 1:	IN 1.4	2	3
Recreation	MO 3:	IN 3.5	2	1
Recreation	MO 4:	IN 4.1	2	7
A.2 - Trout	MO 2:	IN 2.3	2	1
A.1 - Aquatic Food Base	MO 1:	IN 1.10 (App.)	2	3
A.3 - Native Fish	MO 8:	IN 2. (App.)	2	2
A.3 - Native Fish	MO 8:	IN 4. (App.)	2	1

Resource Category	Mgt Obj	Info Need	O	X
Recreation	MO 2:	IN 2.2	6	8
A.3 - Native Fish	MO 9:	IN 9.4	6	1
Cultural Resources	MO 1:	IN 1.6	6	2
B. Terrestrial and riparian resour	MO 13:	IN 13.2	6	8
B. Terrestrial and riparian resour	MO 12:	IN 12.1	6	8
B. Terrestrial and riparian resour	MO 11:	IN 11.6	6	8
A.3 - Native Fish	MO 10:	IN 10.6	6	2
Cultural Resources	MO 2:	IN 2.2	5	2
A.2 - Trout	MO 2:	IN 2.2	5	5
Sediment Resources	MO 1:	IN 1.1	5	7
A.3 - Native Fish	MO 3/4:	IN 3/4.14	5	4
Cultural Resources	MO 1:	IN 1.5	5	2
A.3 - Native Fish	MO 8:	IN 8.4	5	2
A.3 - Native Fish	MO 9:	IN 9.2	5	1
B. Terrestrial and riparian resour	MO 11:	IN 11.5	5	4
B. Terrestrial and riparian resour	MO 14:	IN 14.7	5	6
A.3 - Native Fish	MO 10:	IN 10.4	5	2
B. Terrestrial and riparian resour	MO 11:	IN 11.4	5	7
B. Terrestrial and riparian resour	MO 16:	IN 16.1	5	6
Sediment Resources	MO 4:	IN 4.3	5	5
Sediment Resources	MO 1:	IN 1.5	5	6
Lake Powell	MO 1:	IN 1.1 (Biol)	5	12
A.3 - Native Fish	MO 10:	IN 10.2	4	3
Recreation	MO 1:	IN 1.1	4	9
A.3 - Native Fish	MO 3/4:	IN 3/4.10	4	2
Recreation	MO 1:	IN 1.3	4	10
B. Terrestrial and riparian resour	MO 16:	IN 16.2	4	5
B. Terrestrial and riparian resour	MO 11:	IN 11.2	4	6
B. Terrestrial and riparian resour	MO 16:	IN 16.4	4	4
B. Terrestrial and riparian resour	MO 16:	IN 16.6	4	5
Sediment Resources	MO 4:	IN 4.2	4	6

Resource Category	Mgt Obj	Info Need	O	X
A.3 - Native Fish	MO 8:	IN 6. (App.)	2	1
A.3 - Native Fish	MO 3/4:	IN 3/4.6	2	1
A.3 - Native Fish	MO 3/4:	IN 3/4.4	2	0
A.1 - Aquatic Food Base	MO 1:	IN 1.9 (App.)	2	4
Sediment Resources	MO 3:	IN 3.5	2	3
Sediment Resources	MO 4:	IN NH5.	2	4
Sediment Resources	MO 4:	IN NH8.	2	3
Sediment Resources	MO 4:	IN NH4.	2	1
Sediment Resources	MO 4:	IN NH3.	2	2
B. Terrestrial and riparian resour	MO 13:	IN 13.4	2	2
B. Terrestrial and riparian resour	MO 16:	IN 16.5	2	2
B. Terrestrial and riparian resour	MO 12:	IN 12.4	2	2
Recreation	MO 1:	IN 1.2	2	5
B. Terrestrial and riparian resour	MO 11:	IN 11.8	2	3
Sediment Resources	MO 2:	IN 2.7	2	5
Sediment Resources	MO 2:	IN 2.4	2	3
A.1 - Aquatic Food Base	MO 1:	IN 1.7 (App.)	1	3
Lake Powell	MO 2:	IN 2.6	1	5
A.3 - Native Fish	MO 8:	IN 9. (App.)	1	0
Sediment Resources	MO 2:	IN 2.8	1	1
A.3 - Native Fish	MO 8:	IN 8. (App.)	1	0
Sediment Resources	MO 4:	IN NH2.	1	1
A.1 - Aquatic Food Base	MO 1:	IN 1.12 (App.)	1	0
Sediment Resources	MO 2:	IN 2.1	1	1
Recreation	MO 2:	IN 2.1	1	10
A.1 - Aquatic Food Base	MO 1:	IN 1.8 (App.)	1	1
B. Terrestrial and riparian resour	MO 11:	IN 11.7	1	1
A.3 - Native Fish	MO 8:	IN 12. (App.)	1	0
B. Terrestrial and riparian resour	MO 12:	IN 12.2	1	1
Lake Powell	MO 2:	IN 2.5	1	1
Recreation	MO 3:	IN 3.4	1	0
Recreation	MO 3:	IN 3.1	1	3

Resource Category	Mgt Obj	Info Need	O	X
B. Terrestrial and riparian resour	MO 13:	IN 13.3	1	1
Sediment Resources	MO 4:	IN NH6.	1	1
Recreation	MO 5:	IN 5.1	1	2
B. Terrestrial and riparian resour	MO 12:	IN 12.5	1	1
Recreation	MO 2:	IN 2.3	1	3
Lake Powell	MO 1:	IN 1.2	1	0
Lake Powell	MO 2:	IN 2.1	1	9
Cultural Resources	MO 1:	IN 1.7	1	0
GIS	MO 1:	IN 1.1	1	1
A.3 - Native Fish	MO 8:	IN 10. (App.)	0	0
A.3 - Native Fish	MO 8:	IN 7. (App.)	0	0
Recreation	MO 1:	IN 1.5	0	0
A.3 - Native Fish	MO 8:	IN 14. (App.)	0	0
GIS	MO 1:	IN 1.2	0	2
B. Terrestrial and riparian resour	MO 16:	IN 16.3	0	0
Sediment Resources	MO 4:	IN NH7.	0	2
A.1 - Aquatic Food Base	MO 1:	IN 1.11 (App.)	0	0
Lake Powell	MO 2:	IN 2.2	0	1
Lake Powell	MO 2:	IN 2.3	0	0
Lake Powell	MO 2:	IN 2.4	0	1
B. Terrestrial and riparian resour	MO 12:	IN 12.3	0	0
Socioeconomic (Hydropower)	MO 1:	IN 1.1		
Socioeconomic (Hydropower)	MO 1:	IN 1.2		
Socioeconomic (Hydropower)	MO 1:	IN 1.3		
Socioeconomic (Hydropower)	MO 1:	IN 1.4		
Water Resources	MO 1:	IN 1.1		