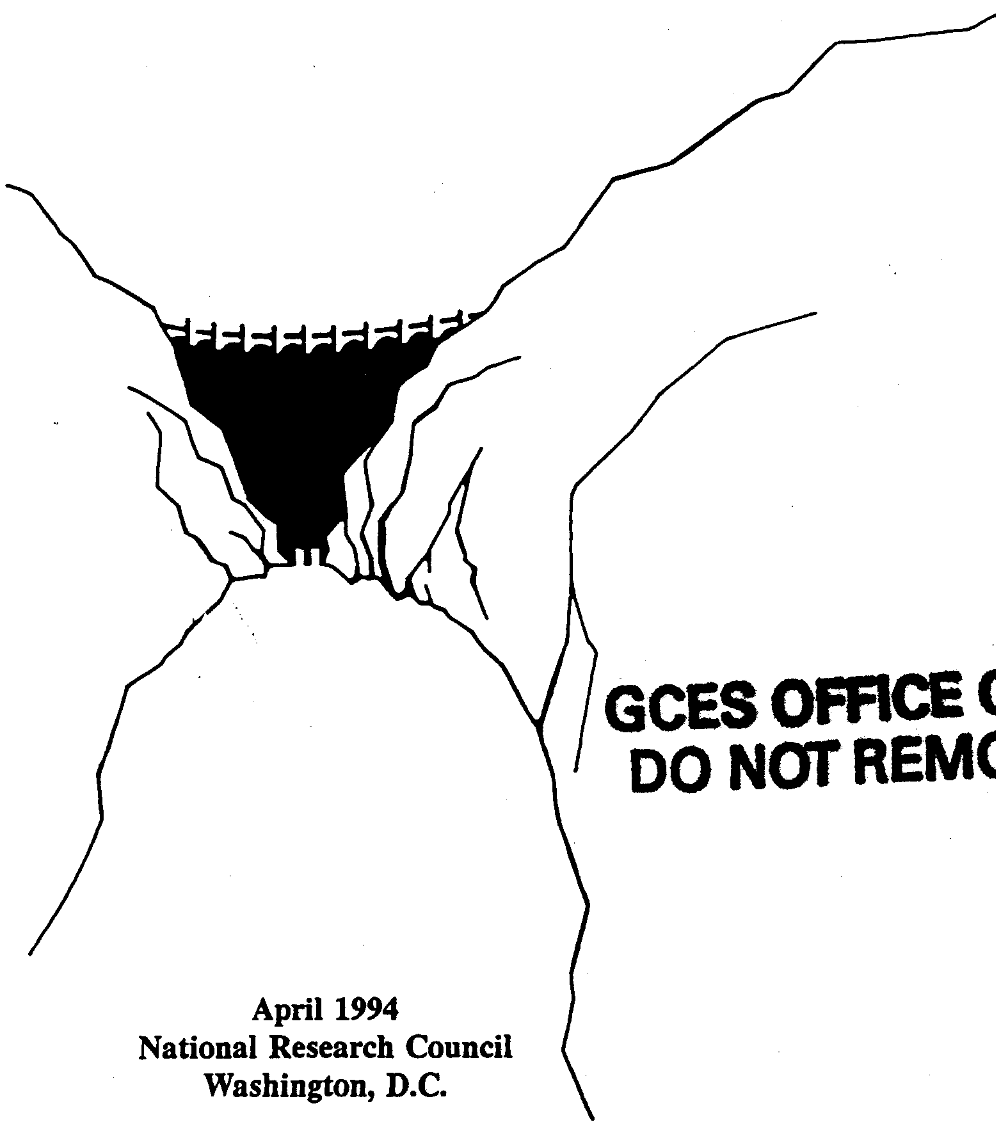
Review of the Draft Environmental Impact Statement on Operation of Glen Canyon Dam



April 1994
National Research Council
Washington, D.C.

Review of the Draft Environmental Impact Statement on Operation of Glen Canyon Dam

Committee to Review the
Glen Canyon Environmental Studies

Water Science and Technology Board

Commission on Geosciences, Environment, and Resources

National Research Council

April 1994
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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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Contents

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Background

At the request of the Bureau of Reclamation, the National Research Council (NRC) began a review of the Bureau's Glen Canyon Environmental Studies (GCES) in 1986 under direction of the NRC's Water Science and Technology Board. The committee conducting the review has provided the Bureau of Reclamation with a formal review of GCES Phase I (NRC 1987), a symposium and report focusing on Colorado River ecology in relation to dam management (NRC 1991), a review of the Bureau's draft long-term monitoring plan for the Colorado River below Glen Canyon Dam (NRC 1994), and several letter reports commenting on a range of issues such as power and economic studies, interim flow recommendations, and Bureau of Reclamation management responsibilities related to the GCES. In addition, the committee sponsored a workshop in 1993 on long-term monitoring of the Colorado River and has provided extensive advice and review of work plans and study products of the GCES.

The Draft Environmental Impact Statement (DEIS) for the Operation of Glen Canyon Dam, which was issued for review in January 1994, is not part of the GCES. However, the GCES provided much of the background information for the DEIS. For this reason, the Bureau of Reclamation requested that the NRC Committee review and comment on the DEIS, which is the subject of this report.

ORIGIN OF THE DRAFT EIS

In July of 1989, the Secretary of Interior directed the Bureau of Reclamation to prepare an EIS that would reevaluate the operations of Glen Canyon Dam. The purpose of the reevaluation was to show how operational changes might minimize adverse effects of the Dam on the environmental and cultural resources in Glen and Grand Canyons. In addition, the Grand Canyon Protection Act of 1992 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 Recreational Area were established, including, but not limited to natural and cultural resources and visitor use." Section 1804(a) of the Act requires the Secretary to complete an EIS on Glen Canyon Dam operations no later than October 1994.

DESCRIPTION OF ALTERNATIVE OPERATIONS OF GLEN CANYON DAM

The various alternatives described in the DEIS are summarized in Figure 1, which was taken from the Glen Canyon Dam EIS Summary.

UNRESTRICTED FLUCTUATING FLOWS	
No Action	Maintain fluctuating releases and provide a baseline for impact comparison.
Maximum Power-plant Capacity	Permit use of full powerplant capacity.
RESTRICTED FLUCTUATING FLOWS	
High	Slightly reduce daily fluctuations from historic no action levels.
Moderate	Moderately reduce daily fluctuations from historic no action levels; includes habitat maintenance flows.
Modified Low (Preferred Alternative)	Substantially reduce daily fluctuations from historic no action levels; includes habitat maintenance flows and endangered fish research.
Interim Low	Substantially reduce daily fluctuations from historic no action levels; same as interim operations.
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.

Figure 1. Glen Canyon Dam EIS alternatives.

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Summary of Conclusions and Recommendations

GENERAL COMMENTS

In general the DEIS is well organized, clearly presented, well illustrated, and comprehensive in scope and coverage. In addition, the DEIS for the most part reflects good use of the presently available information. However, it contains several serious errors of omission (non-use values, long-term monitoring, temperature control), and it does not provide a sound technical rationale for selection of a preferred alternative. In addition, the DEIS introduces flood control through structural changes in Glen Canyon Dam that have been under consideration for only a short time. Also, the conclusions on cultural values are not entirely validated by the evidence presented in the DEIS. Finally, the power resource analyses are severely flawed because the cost estimates associated with the analyses are based on calculation procedures that misrepresent the true cost of operational alternatives.

SELECTION OF A PREFERRED ALTERNATIVE

The DEIS lists Modified Low Fluctuating Flows as a preferred alternative. The committee agrees with the reasons that are given in the DEIS for the selection of Modified Low Fluctuating Flow over the No Action, Maximum Power Plant Capacity, High Fluctuating Flow, Moderate Fluctuating Flow, and Interim Low Fluctuating Flow alternatives. In addition, the committee finds that the DEIS has made a good case for elimination of the Existing Monthly Volume Steady Flow and Year-Round Steady Flow alternatives. However, the DEIS does not make a clear, scientifically-based argument for the selection of Modified Low Fluctuating Flow over the Seasonally Adjusted Steady Flow alternative. As shown by the Comparison of Alternatives and Impacts, Table II-7 of the DEIS (pages 54-61), Seasonally Adjusted Steady Flow offers advantages for a wide range of resources and environmental concerns. The sole significant disadvantage for the Seasonally Adjusted Steady Flow alternative by comparison with Modified Low Fluctuating Flow is reduced efficiency in hydropower production. The DEIS does not specifically state that the greater power production efficiency of the Modified Low Fluctuating Flow alternative outweighs the environmental and recreational benefits of Seasonally Adjusted Steady Flow.

During preparation of the preliminary DEIS, the U.S. Fish and Wildlife Service (USFWS) raised objections to alternatives that involve fluctuating flow (see Attachment 4, page 11 of the DEIS). These objections are based primarily on the principle that fluctuating flows cause frequent inundation of backwaters with pulses of cold water from the main stem of the Colorado River below Glen Canyon Dam. Because warm aquatic refuges are scarce below Glen Canyon Dam, and because such refuges are likely to favor the maintenance and propagation of native fishes, fluctuating flows may not be consistent with the protection of endangered species.

The DEIS reflects an agreement between the USFWS and the Bureau of Reclamation according to which the Dam will be operated with fluctuating flows, provided that USFWS is authorized to direct some experimental changes in flow and that it also receives support for detailed studies of the responses of endangered species to experimentally scheduled steady flows. The special studies seem well justified, although arguably they should already have occurred over the 10-year history of GCES. Even though the studies may be useful, the compromise will preclude routine use of Seasonally Adjusted Steady Flows in the future unless there is yet another EIS. In view of the advantages of Seasonally Adjusted Steady Flows as already documented by the DEIS (Summary Table II-7), and the clear possibility that steady flows would be favorable to the maintenance of endangered fishes, the absence of a well-stated rationale for precluding steady flows in favor of fluctuating flows is a serious weakness in the DEIS.

In addition, the DEIS proposes the incorporation of adaptive management into the preferred alternative. Adaptive management, while not defined in all of its particulars, clearly is intended to allow changes of operations in ways that will benefit environmental resources. However, the scope for adaptive management is very narrowly constrained by the preferred alternative. A broader preferred alternative would give greater scope for adaptive management and could allow operations to occupy any position on a sliding scale between Modified Low Fluctuating Flows and Seasonally Adjusted Steady Flows in response to new environmental information on endangered fishes or other environmental resources.

DETAILED LONG-TERM MONITORING PLAN NEEDED

The DEIS is deficient in excluding specific plans and commitments for long-term monitoring, which should encompass both structural and functional attributes of environments subject to influence by operations of Glen Canyon Dam. The final EIS should include a monitoring plan specifying the collection of environmental data that can be used in adaptive management and in continuing analyses of the effects of dam operations. The final EIS should also provide details on the proposed management and budgetary arrangements to assure an adequate monitoring program (NRC 1994).

FAILURE TO INCORPORATE NON-USE VALUES

The DEIS is deficient in excluding a full analysis of non-use values. Estimation and analysis of non-use values should be completed and considered as part of the final EIS. The explanation of the principle and rationale for non-use values in the DEIS is excellent, but it should be accompanied by studies documenting the magnitude of non-use values, which may figure importantly in final justification of a preferred alternative.

FLOOD CONTROL AND STRUCTURAL CHANGES IN GLEN CANYON NEED MORE STUDY

The DEIS (page 36) proposes flood control measures that include structural modification of spillway gates for Glen Canyon Dam. While fluctuating flows, beach-building flows, and habitat maintenance flows have been subject to discussion and analysis for several years, the flood control proposal has appeared for the first time in this DEIS. It may not have been subject to sufficient analysis. The DEIS makes a good case that beach-building flows and habitat maintenance flows are useful and that they should be scheduled as part of the preferred alternative. However, flows above 45,000 cfs are treated as entirely detrimental, as reflected by their suppression to frequencies of about one per century. While frequent uncontrolled floods would be undesirable, the DEIS does not make a good case for such rigorous suppression of floods. In fact, it is clear from the discussion of sediment transport that channel obstructions arising through debris flows may be moved efficiently only by very high flows. Flood flows at intervals closer than once per century may be environmentally beneficial in maintaining a channel configuration that is consistent with recreational use and in reconfiguring vegetation or beaches. Flood flows may also be beneficial in removing potential accumulated toxic substances associated with sediments. These issues have been insufficiently analyzed in the DEIS.

STUDIES OF TEMPERATURE CONTROL OVERDUE

Temperature control by use of a multiple outlet withdrawal structure or temperature control curtain may be a valuable asset for numerous environmental resources, including endangered fishes. Temperature manipulation opens up the possibility not only for enhancement of growth among warmwater species currently in the river system, but also for reintroduction of former resident species, particularly endemic species that have been lost but are still available from other areas or from cultured stocks. The reestablishment of lost populations of endangered species might add considerable value to the capability for temperature manipulation, but has not yet been studied in relation to dam operations at Glen Canyon Dam. Disadvantages to higher temperatures, which might include change in the balance of species detrimental to trout or humpback chub, also need to be considered, but cannot be evaluated on the basis of information that is now available (NRC 1987). Studies of temperature control are long overdue and should have been included in the DEIS.

POWER RESOURCES ANALYSES FLAWED

The analysis of power resources is severely flawed by use of incorrect and misleading discounting procedures in the estimation of power revenue costs for various operational alternatives, and by questionable assumptions about the value of off-peak energy. Economic and financial costs of alternatives are consistently overstated as a result of this flaw (see specific comments in this report, pages 13-20). In addition, for some of the utilities that receive power from Glen Canyon, energy conservation is not considered as an alternative that could reduce the cost of replacing any peak output foregone as a result of modifying the flows.

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Specific Comments

CHAPTER II: DESCRIPTION OF ALTERNATIVES

1. Page 30 states that the Bureau of Reclamation would implement changes in operating criteria in order to comply with the Endangered Species Act. These changes would come in response to studies of endangered fish under the direction of the U.S. Fish and Wildlife Service. According to the DEIS, these changes would be implemented under the adaptive management plan. This statement is misleading without significant additional qualification. Adaptive management can occur only within the scope of the preferred alternative. If the preferred alternative is limited to Modified Low Fluctuating Flows, significantly steadier flows for the maintenance of endangered fish will not be possible without another EIS, even if the studies of the U.S. Fish and Wildlife Service show that steady flows do favor the expansion and maintenance of endangered fishes. This is a serious defect of the preferred alternative.

2. Page 34 deals with adaptive management. The concept of adaptive management as presented here is sound, and the means by which it will be organized seems reasonable. However, the scope for adaptive management is severely constrained by the preferred alternative. Broadening of the preferred alternative would make adaptive management more meaningful.

3. Page 37. There is no outline of the scientific evidence for designing a useful beach-building flow. Why should particular magnitudes and durations be used? Research is available on this point, but it is not included in the DEIS.

4. Page 49. The addition of more peaking capacity at Hoover Dam has been suggested as a possible replacement for capacity that would be foregone at Glen Canyon Dam under restricted flow alternatives. The EIS team considered the Hoover

alternative, but eliminated it from detailed consideration. The basis of this decision was that Hoover modifications are already under consideration by Arizona and Nevada utilities and thus may not be available for use in the area receiving power from Glen Canyon Dam. However, it has been reported that the Hoover Modification project is no longer fully subscribed and has been put on hold due to lack of firm commitments from the utilities that would receive its output (Nevada Power 1992). The final EIS should report on the status of this project and discuss the possibility that it could be used as a replacement for peaking power at Glen Canyon Dam and to mitigate any adverse effects resulting from changes at Glen Canyon Dam.

5. Page 50. The summary comparison of alternatives on page 50 states that Moderate and Modified Low Fluctuating Flow regimes are similar in their environmental effects to Seasonally Adjusted Steady Flows. However, this statement is at variance with information in the DEIS. For example, the DEIS Summary Table II-7 (pages 54-61) shows substantial differences between Seasonally Adjusted Steady Flows and all of the fluctuating flow regimes.

6. Page 51. It is not clear why the National Park Service has omitted from its objectives the maintenance of flows that reflect, subject only to legal constraint, the pre-dam hydrologic regime of the Colorado River. Part of the responsibility of the NPS is the protection and maintenance of the natural values of park landscapes. In this case it is the responsibility of the NPS to preserve natural features of the river to the extent possible. This point also applies to studies of temperature control by use of a multiple outlet withdrawal structure.

7. Page 51 states that all of the alternatives would accomplish objectives of the Bureau of Reclamation for Colorado River Storage Project (CRSP) reservoirs. This seems impossible, given that one objective is enhancement of fish and wildlife and other environmental factors (page 51). The DEIS itself shows that alternatives differ substantially in their capacity to enhance these resources. This statement therefore seems indefensible.

8. Page 51. In the section on fish, the DEIS states that none of the alternatives appear to increase spawning habitat for native fish. There is insufficient scientific evidence in the DEIS or in the underlying studies to support this statement. It is probable that the existence of steady flows during the spawning season would make additional spawning sites available, and thus would increase survival of larval fish.

9. Page 53. In the section on recreation, the DEIS states that the National Park Service, as well as the Hualapai and Navajo, favor wilderness conditions. These same entities find fluctuating flows consistent with their goals. Clearly, fluctuating flows are

less reflective of wilderness conditions than seasonally adjusted flows. This appears to be a logical inconsistency. As pointed out on page 144 of the DEIS, regular daily fluctuations in flow make the river seem somewhat unnatural.

10. Pages 58-61. Table II-7 of the DEIS presents summary data on recreation and power resources, as well as effects on wholesale and retail power rates. This information is drawn from Chapter IV of the DEIS; comments on Chapter IV are applicable to Chapter II as well. Weaknesses and concerns noted below for recreation and hydropower analyses in Chapter IV also apply directly to the numbers presented in Chapter II, Table II-7, of the DEIS.

CHAPTER III: AFFECTED ENVIRONMENT

1. Page 76. The DEIS states that determinations of scope for the DEIS revealed many misconceptions about changes in river levels caused by daily flow fluctuations, but there is no support for this statement. Appendix B of the DEIS outlines some basic principles, but does not describe the misconceptions.

2. Page 83. The DEIS is generally handicapped by a very weak base of information on lake sediments. Not only are the quantities of sediments poorly documented, but also the quality of sediments with respect to toxic substances is not sufficiently well known and no studies have been made of the probability for mobilization of toxic substances as affected by reservoir operating regimes or changing reservoir conditions.

3. Page 83. The term "sediment" generally refers to the full range of sizes. However, the DEIS sometimes refers to sand as "sediment." This confusion of terms should be avoided. The DEIS should use "sediment" for all sizes, and "sand" for sediment of the sand size category.

4. Pages 86-87. The discussion about sand supply from the Paria and whether or not it exceeds the transport capacity of the main stem is flawed because it fails to take into account mesoscale fluctuations in supply from the Paria. The present period of low sediment yield (much storage on floodplains) is very different from conditions during the early part of the century (no floodplain storage, channel erosion). The calculations for the DEIS are based on present conditions, and do not take into account known conditions that might return. Decision makers should know that the numbers in the DEIS are not firm because there is considerable scientific evidence that tributaries, including the Paria, have changed even in the recent past (Hereford 1986, Graf 1987).

5. Page 95. The comparison between 1890 and 1990 conditions is meaningless. Variability occurs over periods as short as days or weeks. Images taken a century apart may not reveal general trends because each photographic record may or may not be representative of conditions for that year or decade.

6. Page 99. The DEIS shows that rapids will continue to increase in steepness and that their constriction coefficient will continue to be below the "natural" values. This is contrary to the boating safety conclusion in the DEIS summary, which says that the preferred alternative will improve boating safety.

7. Page 101. The statement in the DEIS about sediment quality in Lake Powell suggests that there is no useful information about this issue. This is not true -- on page 82 there are some preliminary statements, derived from the work of Kidd and Potter (1978) and Wood and Kimball (1987), about sediment quality in the lake. Also see NRC (1991). The published papers and unpublished data collected by the National Park Service provide some data on lake sediments (Wood and Kimball 1987).

8. Page 104. The text states that sand bars would tend to be stable under the preferred alternative, but all of the scientific evidence used in the DEIS shows that they would be dynamic, and that they would be eroded slowly until a beach-building flow occurs. Consequently, operations must allow for beach-building flows periodically if beaches are to be maintained.

9. Page 134. The "places of historical, cultural, and religious importance to the Navajo people" should be located and identified. There is no evidence that Navajos interacted with Havasupai "by the 1600's." Navajos were not as far west as the Grand Canyon until the 1880's (Euler 1974).

10. Page 135. The second paragraph is too generalized. Also, salt mines in Grand Canyon were not used by the Navajo.

11. Page 135. This section should provide some evidence that "Modern Southern Paiute peoples continue to use Grand Canyon...in traditional ways...."

12. Page 155. The DEIS states that the "Bennett Freeze" precluded the Navajos from developing recreational businesses on the river. They also note that the "Freeze" has been lifted. How are Navajo rights for future development of recreational business going to be managed? The importance of other Navajo economic interest in Canyon visitors appears to have been minimized. How many Navajos are employed by non-Navajo owned tourist business in the region? Canyon tourism is directly or indirectly more important economically to many of the tribes than indicated in the DEIS.

13. Navajo Tribal Utilities receives at least part of its power from Glen Canyon Dam. Thus the Navajo tribe and its members have a direct interest in power generation from the Dam. This interest and any similar interest of the other tribes need to be clearly defined in the final EIS.

CHAPTER IV: ENVIRONMENTAL CONSEQUENCES

1. Pages 167-168. Comparisons of alternatives in the DEIS are based on simulations using the Colorado River Simulation System (CRSS) computer model, which simulates the physical operation of Lake Powell. It includes water inflow, bank storage, and outflow to determine reservoir storage. The relative performance of the various alternatives is based upon the accuracy of the Lake Powell simulations. Questions concerning the Lake Powell simulations have been raised in the past (NRC 1991). In particular, the accuracy of the reservoir evaporation and the bank storage components of the water balance for Lake Powell were questioned. If those components are in error, the results of the long-term simulations for comparison of alternatives would be in question. In particular, the probability of an empty reservoir, the probability of spills, and the estimates of power revenues would be in error.

The Annual Operating Plan (Vickers and Ryan memo 1994) shows an adjustment of 6,507,000 acre-feet for October 1993 as compared to September 1993. This is an increase of 50% in bank storage, and is equal to about 25% of the contents of Lake Powell. This adjustment should be explained. Was this adjustment made prior to the simulations for the DEIS? Was this adjustment intended to close the water budget for the period of operation of the dam, or for a shorter period? Similar adjustments, although not so large, were noted for September to December 1989 (NRC 1991). The adjustments have an effect on estimates of water availability and on reservoir head, both of which affect projected power revenues.

2. Page 168. The DEIS states that salinity, nutrients, sediment, selenium, and mercury will tend to "increase in concentration" in Lake Powell. This statement is difficult to interpret and may be misleading. Lake Powell does store, through the accumulation of sediment, substantial amounts of nutrients, suspended solids, selenium, mercury, and many other substances that enter the reservoir. The DEIS states that these constituents would increase primarily in sediment and deep reservoir waters that rarely circulate. However, the lake also provides the biota with the opportunity to amplify contaminant concentrations in living organisms. More useful would be some synopsis of field data indicating the comparative concentrations of these substances at varying water depths in the reservoir, in bottom sediments, and in fish tissue. The vertical profiles of average concentrations have implications for variations in depth of withdrawal. In general, more detailed knowledge of the partitioning of substances, and particularly toxic

substances, between the sediments and waters of Lake Powell is needed as a means of anticipating the potential transport of toxic substances from Lake Powell to the Colorado River below Glen Canyon Dam.

3. Page 174. Page 174 contains a great deal of speculation on the relationship between aquatic productivity and phosphorus concentrations, expansion of *Oscillatoria* longitudinally, and the relationship between temperature and parasitic diseases of fish. Although these statements are given with some qualification and not as absolute fact, they probably should not be given at all, as specific field information does not support them. It is not clear on the basis of present information in the DEIS or the GCES what effect a 3°F change in temperature might have, except that it would be physiologically beneficial to warm-water fishes.

4. Page 174. Comments on higher concentrations of dissolved substances in Lake Powell may be misleading. The implication, which may be unintended, is that the water quality of Lake Powell might become unacceptable. Even if increases did occur in the amounts of dissolved substances, they might be very minor and insufficient to cause any concern.

5. Pages 183-186. The DEIS presents the concept that the transport of sediment is roughly equal to the amount that enters the system. The specific evidence for this conclusion in the DEIS is very weak. It is hard to believe that by chance the amount of sediment entering from a few tributaries would happen to be the same as the transport capacity of releases from a dam that has been designed to accommodate water delivery and power requirements and that these releases were just right to generate the needed stream power in appropriate quantities. The final EIS should explain how this can occur.

Table IV-6 shows that with the no-action alternative, the probability of gain in sediment is 50%. This follows logically from the reasoning outlined in the paragraph above, but the DEIS does not show the data to support this idea. However, a 50% probability is random. The DEIS should provide evidence that the system is random, given current operations.

6. Page 184, Table IV-6. In the table showing the effects of various alternatives on "Sediment, Riverbed Sand, (percent probability of net gain)" it is not very helpful to provide information on the values for 20 years and 50 years. This is because those probabilities are very similar to each other for most cases (only 9 percentage points difference between 20 years and 50 years.) This situation apparently arises because the curve relating time to probability rises rapidly for the year values 1 to about 10 or 15, and then flattens for greater periods. It would be more instructive for readers of the DEIS to know the probability of net gain for 1, 5, 10, and 50 years. The 5-year value is especially important because of the anticipated frequency of beach-building flows, which is 5 years.

7. Page 185. The committee does not agree with the conclusion that the reach from the Paria to the Little Colorado River (LCR) is most susceptible to short-term loss of sand. This would depend on the relationship between dam releases and sediment transport from the Paria. If the reach is susceptible to short-term losses, it is also susceptible to short-term gains. In addition, one paragraph states that the short-term corresponds to 20 years, but elsewhere the DEIS states that beach-building flows are likely to be once every 5 years, which indicates that 5 years should be the major planning unit for this sort of question.

8. Page 264, Table IV-17. The conclusion that "minor improvement" will occur with the preferred alternative for "whitewater boating safety" is not supported by the discussion of rapids in the DEIS. Page 98 of the DEIS has a clear explanation of the rapids dynamics, including the statement that since the closure of the dam, it is likely that rapids will continue to become steeper and constriction of the channel will be greater. Therefore, large boulders added to rapids by tributary debris will not be moved under the preferred alternative. Thus, boating safety will become an increasing problem and will not show a "minor improvement." The EIS should stress that the minor improvement in whitewater boating safety is not related to the condition of the rapids, which will tend to increase in size and will result in a decrease in boating safety under all alternatives.

9. Pages 264-302. Comments 9a-9b concern the manner in which benefits and costs are reported. Most prices in the economy increase over time, thus eroding the purchasing power of a dollar. Monetary valuations that include the effects of inflation are said to be in nominal or current dollars. Real or constant dollars are adjusted to remove the effects of inflation; they are calculated from the purchasing power at a given time and referenced to that date. For example, with 3% inflation, the goods that cost $1.00 (nominal) in 1993 will cost $1.03 (nominal) in 1994; both of these nominal amounts are equivalent to $1.00 in constant 1993 dollars.

Comments 9a-9b below also deal with estimates of annual benefits and costs. Such estimates will vary not only between alternatives, but also over the 50-year analysis period due to changing factors such as hydrology and the availability of alternative sources of electricity (pages 279-281, 290, DEIS). To facilitate summary comparisons, equivalent annual values of benefits and costs are reported in the DEIS. As stated on page 279 of the DEIS, equivalent annual value "is the amount of money which, if received each year, would yield an amount equal to the present worth of the varying 50-year series of payments."

a. Pages 264, 280-285 (Tables IV-17, VI-20-27). Data on annual recreation benefits are reported to be in units of "1991 $ millions." Footnote 1 to Table IV-20 specifies that this information has been calculated consistently with the power system analysis. The method used to calculate annual hydropower costs appears to yield data in nominal rather than constant (1991) dollars; the data for annual recreation benefits also appear to be in nominal dollars. In other words, over the 50-year period being analyzed, the estimated equivalent annual effects remain constant in nominal terms. Therefore, in constant dollars they are highest in the first year and decline steadily due to inflation. The annual effects should be recalculated consistently with the original notation, i.e., as constant 1991 dollars. This is standard practice; reporting in constant rather than nominal dollars eliminates the large effect of inflation over the 50-year period of analysis. The annual effects in constant 1991 dollars will be roughly half those calculated in nominal dollars.

b. Pages 288, 290-302. Data on annual economic and financial costs associated with hydropower are reported to be in units of "1991 $ millions." The method used to calculate these costs would also appear to yield nominal, rather than constant (1991) dollars.[1] It is important that this issue be resolved, so as to eliminate a substantial overstatement of the economic and financial costs associated with altered operations. For example, the DEIS (page 288) reports annual economic costs of $119 million for the Seasonally Adjusted Steady Flow alternative (based on contract rate of delivery). If this figure is in nominal dollars, its real value, when measured in constant 1991 dollars to eliminate inflation, will decline from $119 million in 1991 to $47 million in 2016, and to $18 million in 2041 at the end of the 50-year analysis period. Annual costs of $119 million in nominal dollars over 50 years are equivalent to annual costs of $70 million in constant 1991 dollars.

Reporting hydropower costs in nominal terms is even more problematic given their change through time. The costs associated with restricted flow alternatives are relatively low during the early part of the analysis period. Later they are expected to increase as the present substantial surplus generating capacity is exhausted (page 290). The discrepancy between short-term and long-term effects is greatly accentuated when

[1]The details of the calculation methodology are not provided in the DEIS, but they are documented in the report of the PRC (1993, e.g., on pp. V-6 and IX-1). Annual costs are calculated as follows: (1) the stream of annual nominal dollar costs is referenced to 1991 using an 8.5% *nominal* discount rate, (2) this present worth is then annualized using the appropriate factor for an 8.5% *nominal* discount rate (8.64% for a 50-year period). Annual effects in terms of constant 1991 dollars should be calculated with a *real* discount rate. Given the assumed 3.8% inflation rate (PRC 1993, p. III-13), the 8.5% nominal discount rate is equivalent to a 4.5% real discount rate. For a 50-year period, this yields a real annualization factor of 5.08%. Therefore, constant $ 1991 annual costs are approximately 41% less than those calculated on a nominal basis.

annual costs are measured in nominal dollars.[2] Such an approach has the effect of making real costs appear higher in the early years and lower later on. The credibility of the DEIS could be undermined if the public perceives an unduly large discrepancy between the final EIS's estimated hydropower costs and those experienced under interim flows. To clarify these issues, the final EIS should present quantitative information on this subject. Graphs should be included showing costs in constant 1991 $ for each year of the analysis period, for the various alternatives.[3]

10. Pages 288, 290-302. Data on wholesale and retail rates are reported as "1991 mills/kWh." The documentation on derivation of these data is difficult to interpret, but the wholesale rate data appear to be in terms of nominal, rather than constant (1991) dollars.[4] As noted on page 286, the calculation of retail rates is based on the data for wholesale rates. Therefore, the estimates of retail rates may also be in terms of nominal rather than constant dollars. To resolve this problem, the annual costs should be recalculated to provide data in constant dollars. This eliminates the effect of inflation and will provide information more easily comparable with other costs, if other data are also correctly provided in terms of constant 1991 dollars.

11. Pages 286-293. Accurate interpretation by reviewers will require that there be clear explanation of the nexus between estimated costs (economic, financial, wholesale, and retail rates). This is quite challenging, especially given the highly technical subject matter and the multitude of data. The DEIS does provide a good discussion of the differences between the economic and financial analyses and the role of transfer payments. However, the issues described in the following comments require additional clarification.

12. Pages 286-293. Economic costs are estimated under two different marketing arrangements: (1) hydrology and (2) contract rate of delivery (CROD). The results under the two arrangements can differ greatly, especially for the Seasonally Adjusted Steady Flow Alternative. The final EIS should provide guidance in interpreting these sometimes large discrepancies. To enhance the credibility of the final EIS, guidance in

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[2]To the extent that costs are expected to increase in the future, estimates of annual costs that are representative of the entire period will exceed those for the short-term, regardless of the method of measurement. However, this discrepancy will be smaller if costs are reported in terms of constant dollars.

[3]The PRC 1993 draft report (p. IV-30) provides a graph of annual nominal dollar costs during the first twenty years of the analysis period.

[4]As noted by the PRC 1993 draft report (p. VI-1-3 and IX-15), the wholesale rate calculations are based on WAPA's power repayment studies, which are conducted in current (nominal) dollars.

interpreting these sometimes large discrepancies should be provided.[5] See also comment 14, below.

13. Pages 286-293. The Power Resources Committee draft report (PRC 1993) indicates that the utility financial and wholesale and retail rate estimates are premised upon a CROD marketing arrangement. This should be noted in the final EIS, to facilitate interpretation of the relationship between these estimates and the estimates of economic costs under CROD. For example, this will assist reviewers in understanding Table IV-28 of the DEIS, where annual economic costs under CROD equals annual utility economic costs minus interutility transfers.

14. Pages 286-293. It is unclear whether all of the cost estimates based upon CROD marketing use consistent assumptions. Notably, the wholesale and retail rate analyses apparently assume that the Western Area Power Administration (WAPA) will continue current allocations of firm capacity and energy through 2004, with allocations then adjusted to take into account changes in Glen Canyon Dam operations (PRC 1993). The economic and financial analyses appear to assume that the amount of capacity and energy marketable by WAPA will be adjusted immediately based on changes in operations.[6] The final EIS should clearly indicate what assumptions have been made concerning timing of changes in CROD allocations. To the extent practical, consistent assumptions should be used in calculating the different types of cost analyses; any differences in assumptions should be clearly explained in the final EIS or supporting materials.

15. Pages 286-293. It is unclear to what extent the costs estimated under the various analyses are representing the same overall effects. There are three major concerns:

a. The estimates of wholesale and retail rates may reflect only short-term effects,[7] as opposed to the economic and financial analyses, which are based on a 50-year study period. If possible, the EIS should provide guidance as to whether

[5]The PRC 1993 draft report does provide some additional detail on this issue, but it is still difficult for even an expert reviewer to understand why the results for the two marketing approaches differ so markedly.

[6]Changes in Glen Canyon Dam operations are estimated to result in changes to the resource plan of WAPA's customers from 1991 onward (PRC 1993 draft report, pp. IV-18-30). This indicates that WAPA allocations are assumed to change prior to 2005; otherwise, prior to 2005, WAPA (rather than its customers) would have the responsibility of acquiring resources necessary in response to changes in the operation of Glen Canyon Dam.

[7]PRC 1993 draft report (p. VI-17). See also comment 14 above.

effects on long-term rates are likely to be higher or lower than those presented for the short term.

b. Approximately half of Glen Canyon Dam and other Salt Lake City Area Integrated Projects (SLCA/IP) firm power is allocated to 7 large wholesale customers, with the remainder going to a number of small systems (page 160, Power Resources Committee 1993 draft report, page ES-5-7). As noted on pages 292-293 of the DEIS, retail rates were estimated for small systems only, the economic and financial analyses include both large and small systems. Although detailed estimates were not prepared for the large systems, these effects will generally be smaller than those estimated for small systems.[8] The DEIS should have provided information about the relative magnitude of effects on large and small systems.

c. Small systems account for most of the total costs estimated in the economic and financial analyses (PRC 1993). This should be pointed out in the final EIS so as to facilitate comparison with the retail rate analyses and to clarify incidence of effects.

16. Pages 286-293. The estimates of economic and financial costs for small systems appear to have been substantially overstated in the DEIS due to a highly questionable assumption concerning the value of off-peak energy. It should be noted that this assumption is not technically justified or even identified in the DEIS or the 1993 Power Resources Committee draft report. The only documentation seems to be a brief discussion in two Power Resources Committee memos.[9] In considering this issue, it should be remembered that the Glen Canyon Dam operational restrictions modeled under the various alternatives have little or no effect on the total amount of energy produced; however, they do shift output from on-peak to off-peak periods when electricity is less valuable (page 290). In the analysis of small systems costs were assigned to energy that would have to be purchased on-peak to compensate for lost Glen Canyon Dam output.[10] It was also assumed that increased Glen Canyon Dam output off-peak would have absolutely no value. The only justification presented for this assumption is that "(T)his additional energy is not needed in the off-peak period because baseload units cannot be ramped down to accommodate the additional energy" (Buttorff and

[8]Relative to large systems, small systems typically rely much more heavily upon Glen Canyon Dam and other SLCA/IP projects (PRC 1993 draft report, pp. ES-17, 19).

[9]Rosenkrans, S. 1993. Review of Power Modeling Done by Stone & Webster (Memorandum to PRC, April 7, 1993). Environmental Defense Fund, Oakland, California; and Buttorff, L. 1993. S. Rosenkrans's Memo Dated April 6, 1993 (Memorandum to PRC, April 7, 1993). Stone & Webster Management Consultants, Inc., Englewood, Colorado. The later memo was attached to the copy of PRC 1993 draft report provided to the National Research Council.

[10]These costs were estimated by modeling the operation of the utilities that are the small systems' auxiliary (non-WAPA) suppliers (PRC 1993 draft report, pp. IV-112-13, IV-34-35).

Rosenkrans memo 1993).[9] It is true that some baseload generation (especially from nuclear and coal plants) is restricted in its ability to reduce output quickly, thus reducing associated fuel and other operating costs. However, extensive analysis would be required to justify the assumption in the DEIS that additional off-peak energy has no value. This is a particularly questionable assumption given the 50-year length of the analysis period. Presumably within such an extended period, adjustments would be made in the operation of existing plants and in the choice of new generation, so as to take advantage of additional off-peak output from Glen Canyon Dam. Moreover, this assumption does not appear to be consistent with those made for analyses of large systems and wholesale analyses. The Power Resources Committee draft report (1993, pages VI-6-8) reports for the large systems analysis that a value of approximately $0.015/kWh (constant 1991 $) was assigned to all economy energy purchases and sales made by WAPA.[11]

As noted above, the cost of additional on-peak energy required by small systems was estimated by detailed modeling of the larger utilities that would supply such energy. The DEIS should have presented revised estimates of small-system economic and financial costs, incorporating a value for off-peak energy established directly by stimulation in these same models. These models, which were utilized for extensive simulation of the large systems, already incorporate the required assumptions concerning operational constraints on baseload plants and other factors affecting the value of off-peak energy (PRC 1993). It is important that this issue be resolved for the final EIS to eliminate what appears to be a substantial overstatement of the economic and financial costs associated with altered Glen Canyon Dam operations. This problem is especially serious because the magnitude of any upward bias in costs will increase as more energy is shifted from peak to off-peak. Thus, comparisons of the relative cost of different alternatives could be distorted. For example, the upward bias might be on the order of $6 million per year in constant 1991 dollars for Low Fluctuating Flows, and as high as $12 million in 1991 $ annually for Seasonally Adjusted Steady Flows.[12] Moreover, any assumed costs could be reduced by expanded energy conservation. See comments 22-23, below.

17. Pages 287, 294-298, 300, E-13-14. Power operations involve complex engineering and other considerations that are generally not well understood outside the

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[11]It is unclear to what extent these economy transactions will occur during off-peak periods. Still, there is no indication in the report of the PRC 1993 draft report that the assumed values have been applied solely to on-peak transactions.

[12]These estimates were calculated as follows. The PRC 1993 draft report (p. IV-37) reports that small systems allocation of Glen Canyon Dam and other SCLA/IP firm power would be reduced by 234.5 kW under Low Fluctuating Flows and 448.3 kW under Seasonally Adjusted Steady Flows, for Contract Rate of Delivery Marketing. The amount of energy shifted from peak to off-peak is equivalent to a 20% capacity factor, or approximately 350 GWh for every 200 MW of capacity lost (Buttorff 1993, p. 2; Rosenkrans 1993). Finally, a value of $0.015/kWh (constant 1991 $) has been assumed for off-peak energy based on the price assigned to WAPA economy energy purchases and sales (PRC 1993 draft report, pp. VI-6-8).

utility community. The DEIS identifies a number of concerns relating to changes in Glen Canyon Dam operations. As specified in comments below, the discussion of these issues should be modified to assist reviewers in assessing the potential effects.

18. Pages 294-298. A variety of potential effects on costs are discussed qualitatively. Financial effects associated with reduced ability to provide emergency assistance from Glen Canyon Dam are quantified in Tables IV-31 and IV-32. It is unclear to what extent these costs are additive or comparable to any of those estimated in the various cost analyses (economic, financial, wholesale and retail rates).

19. Pages 294-298. Reviewers unfamiliar with utility system operations may be left with the impression that changes in Glen Canyon Dam operations will be allowed to compromise acceptable standards of utility system reliability. It should be clarified that reliable power system operation will be maintained under various Glen Canyon Dam operational regimes. To the extent that the costs associated with maintaining reliability (such as the costs of adding new combustion turbines and transmission lines) are not already included, the DEIS should have indicated the magnitude of these potential costs.

20. Page 295. The DEIS states that "system efficiency" would be reduced under fluctuating flow alternatives. This term should be defined or explained in the final EIS.

21. Pages 285-302. The sources of the hydropower cost estimates should be better documented. It appears that much, but certainly not all, of the data come from the 1993 draft Power Resources Committee report.[13] However, sources are not clearly indicated in the DEIS. Documentation for other sources, including revision of the cost estimates subsequent to the preparation of the Power Resources database (1993) should have been provided to facilitate review of the DEIS.

22. Pages 285-302. The DEIS should have indicated how costs may vary depending upon the actual evolution of factors such as load growth and fuel prices. The 1993 Power Resources Committee draft report, Chapter VII, provides detailed sensitivity analyses that could have been summarized briefly. The DEIS should have indicated how potential reductions in the demand for electricity as a result of altered Glen Canyon Dam operations and increased price of electricity have been considered in the cost analysis. Such effects have not been incorporated into the base case analyses. Instead, they have been dealt with through sensitivity analyses, which indicate that lower electricity demand would result in substantially lower costs associated with changes in Glen Canyon Dam operations (PRC 1993).

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[13]For example, p. 287 notes that cost estimates based on CROD marketing have been updated to include the effects of habitat maintenance flows. The draft report of the PRC (1993, p. ES-8, II-4) clearly states that the effects of such flows have not been considered.

23. Pages 285-302. The DEIS does not explain that, in some cases, energy conservation programs were not considered as an alternative that could reduce the cost of replacing existing Glen Canyon Dam power. Notably, it was assumed that small systems would implement no conservation programs in response to changes at Glen Canyon Dam (PRC 1993). Such programs were generally considered in the large systems analysis and they reduced the costs associated with restrictions in Glen Canyon Dam operations (PRC 1993). However, it was assumed that no additional conservation beyond that already planned could be implemented at the Salt River Project (PRC 1993). The failure to fully consider energy conservation is a weakness in the analysis.

24. Page 287. The DEIS indicates that Glen Canyon Dam has the "ability to generate electricity without pollution or using nonrenewable resources." Given that Glen Canyon Dam has environmental effects on terrestrial and other resources that are effectively nonrenewable, it would be more accurate if this statement were qualified, e.g., "ability to generate electricity without air pollution or using nonrenewable fuel resources."

25. Page 291. The DEIS should have stated clearly whether the financial effects given in Table IV-29 are annual.

26. Pages 293, 298-302. The DEIS presents data on the amount of new capacity required under the No Action Alternative and each modified flow alternative, as well as the reduction in available Glen Canyon capacity for each modified flow alternative. However, these various data are not calculated on a comparable basis. Notably, the data on new capacity requirements is for the large systems only (PRC 1993), while the estimates of reductions in Glen Canyon capacity are for total output sold to both large and small systems. Moreover, the capacity figures for power purchases include short-term purchases that do not continue through the entire planning period (PRC 1993). The EIS should present data on the amount of new capacity required by both large and small systems; short-term power purchases should be excluded from the total so that the results will accurately represent the addition of long-term capacity.

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Appendix A

BIOGRAPHICAL SKETCHES OF COMMITTEE MEMBERS

William Lewis (Chair) is Professor and Chair of the Department of Environmental, Population, and Organismic Biology at the University of Colorado, Boulder, and also serves as Director of the Center for Limnology at CU-Boulder. Professor Lewis received his Ph.D. degree in 1974 at Indiana University with emphasis on limnology, the study of inland waters. His research interests, as reflected by over 120 journal articles and books, include productivity and other metabolic aspects of aquatic ecosystems, aquatic food webs, composition of biotic communities, nutrient cycling, and the quality of inland waters. The geographic extent of Professor Lewis's work encompasses not only the montane and plains areas of Colorado, but also Latin America and southeast Asia, where he has conducted extensive studies of tropical aquatic systems. Professor Lewis has served on the National Academy of Sciences/National Research Council Committee on Irrigation-Induced Water Quality Problems and is currently Chair of the NRC Wetlands Characterization Committee. He is a member of the NRC's Water Science and Technology Board.

Garrick A. Bailey earned his B.A. in history from the University of Oklahoma, and his M.A. and Ph.D. in anthropology from the University of Oregon. He is a professor in the Department of Anthropology and is Director of the Indian Studies Program at the University of Tulsa. Dr. Bailey specializes in North American Indians, legal systems, cultural ecology, ethnohistoric methods, and social organization. He is a member of the American Anthropological Association, Plains Anthropological Society, American Ethnological Society, and the American Society of Ethnohistory.

Bonnie Colby is Associate Professor of Agricultural and Resource Economics at the University of Arizona Department of Agricultural Economics. Her undergraduate degree is from the University of California and Ph.D. from the University of Wisconsin. Her research, teaching and consulting focus is on the economics of water resources management and policy. She has authored over 40 publications in this area, including a number of journal articles and a book, Water Marketing in Theory and Practice: Market Transfers, Water Values and Public Policy, 1987. In addition to her work on water reallocation, she specialized in research on water quality, valuation of water rights and environmental amenities, and natural resource management in developing tribal and rural economies. Dr. Colby served on the NRC's Committee on Western Water Management.

David Dawdy received his M.S. in statistics from Stanford University. His professional experience is with U.S. Geological Survey from 1951 to 1976 as a research hydraulic engineer; Adjunct Professor of Civil Engineering from 1969 to 1972 at Colorado State University, Ft. Collins; and Assistant District Chief for Programming, California District, Water Resources Division from 1972 to 1975. He has served on numerous advisory groups including NRC committees. From 1976 to 1980 he was Chief Hydrologist with Dames and Moore in Washington, D.C., and is currently a private consultant in surface water hydrology.

Robert C. Euler is a consulting anthropologist specializing in the applied anthropology, archeology, ethnology, and ethnohistory of the American Southwest and Great Basin. As such, he conducts research in cross-cultural resources management, social and economic impact assessments, Indian legal claims cases, and archaeological investigations, especially those related to environmental impacts. Dr. Euler is also Adjunct Professor of Anthropology at Arizona State University, Tempe. In addition, he serves as Tribal Anthropologist for the Yavapai-Prescott Indian Tribe. Dr. Euler earned his B.A. and M.A. in economics from Northern Arizona University, and his Ph.D. in anthropology from the University of New Mexico.

Ian Goodman earned his B.S. in civil engineering from Massachusetts Institute of Technology in 1977. Initially in his career, he performed research at MIT where he developed inputs to a policy-specific model of energy use for intercity goods movement. He began consulting in 1978 and was employed with several firms in the Boston area working on various aspects of utility regulation and economics. He is now the principal of his own consulting firm, The Goodman Group, where his work includes assessing electric and gas resource planning, demand forecasts, supply options, and environmental effects. Mr. Goodman also evaluates conservation potential and cost-effectiveness, program design, and utility demand-side management initiatives.

William Graf obtained his Ph.D. from the University of Wisconsin, Madison with a major in physical geography and a minor in water resources management. He specialized in fluvial geomorphology, hydrology, conservation policy and public land management, and aerial photographic interpretation. He has served as Consulting Geomorphologist for the U.S. Army Corps of Engineers in a research and advisory role concerning the environmental impact assessment of flood control works, Salt and Gila Rivers in Arizona; and for Camp, Dresser, and McKee, Inc. for geomorphology and geology, and the state of Arizona for fluvial geomorphology. His research activities have emphasized fluvial geomorphology and the effects of human activities on streams; public land management, especially wilderness preservation, and rapids in canyon rivers; dynamics and recreation management; and the problems of heavy metal and radionuclide transport in river systems. Dr. Graf has published about 50 articles and book chapters on the impact of suburbanization on fluvial geomorphology; resources, the environment and the American experience; and the effect of dam closure on downstream rapids. His books include The Geomorphic Systems of North America, The Colorado River: Basin Stability and Management, Fluvial Processes and Dryland Rivers, Wilderness Preservation and the Sagebrush Rebellions, and Plutonium and the Rio Grande. Dr. Graf is a member of the NRC's Water Science and Technology Board.

Clark Hubbs received his Ph.D. in biology from Stanford University in 1951. He joined the faculty of The University of Texas at Austin in 1949, became Professor of Zoology in 1963 and the Clark Hubbs Regents Professor in 1989 and has been Regents Professor Emeritus since 1991. He served as Chairman of Biology 1974-76 and Chairman of Zoology 1978-85. He was concurrently Visiting Professor of Zoology at the University of Oklahoma 1973-86 and on the faculty of Texas A&M 1975-81. He has served as Curator of Ichthyology at the Texas Memorial Museum from 1975 to the present. He has received the Award of Excellence from the American Fisheries Society and the Lifetime Achievement Award from the American Society of Ichthyologists. He has published more than 250 papers on aquatic biology. His research interests include distribution and speciation of fishes; hybridization of freshwater fishes; environmental modification of freshwater fishes. Dr. Hubbs has a history of work with endangered fishes and now has a substantial program on predation of adults on their young.

Trevor C. Hughes acquired his Ph.D. in civil engineering from Utah State University. His professional experience includes teaching since 1972 at Utah State University in the Civil and Environmental Engineering Department; research experience as NDEA Fellow at Utah State; Associate Professor of Civil and Environmental Engineering, Utah Water Research Lab; and Research Scientist at International Institute of Applied Systems Analysis, Austria. Since 1971 he has conducted research projects on the management of salinity in the Colorado Basin; drought management analysis and policy design; regional planning of rural water supply systems; economic analysis of alternative water conservation concepts; river system operational models--Sevier River; and application and development of water demand function for domestic water systems at recreation developments.

Roderick F. Nash received an M.A. and Ph.D. in 1961 and 1964 from the University of Wisconsin. He specialized in American intellectual history under Professor Merle Curti. Before his appointment at University of California at Santa Barbara in 1966, he taught for two years at Dartmouth College. Dr. Nash published the first collection of documents relating to environmental history, The American Environment, 1968. His most significant recent work is The Rights of Nature: A History of Environmental Ethics, 1989. A national leader in the field of conservation, environmental management, and environmental education, Dr. Nash has a special interest in problems relating to wilderness and its preservation.

A. Dan Tarlock obtained his LL.B. from Stanford University. His professional experience includes private practice, San Francisco, 1966; professor in residence at a law firm in Nebraska, summers of 1977 to 1979; and consultant. He has been a Professor of Law at Chicago Kent College of Law since 1981. He has authored and co-authored many publications and articles concerning water resources management and environmental law and policy. Mr. Tarlock served as a member of an NRC Committee on Pest Management, is Vice Chair of the NRC's Water Science and Technology Board, and co-authored one of the basic casebooks in water law.

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